

**FORT ENERGY CORPORATION**

**8B REFRIGERATION UNIT**

**FORT ASSINIBOINE, ALBERTA**

**LSD: 15-10-62-06-W5M**

**SEPTEMBER, 2005**

**S.O.#: 054468**

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**SECTION 1: HAZARD WARNING**

**CAUTION**

**CAUTION**

**CAUTION**

**BEWARE! GAS PROCESSING UNITS ARE COMPLICATED AND DANGEROUS PIECES OF EQUIPMENT IF YOU ARE NOT FULLY TRAINED AND FAMILIAR WITH THEIR OPERATION.**

**BEFORE STARTING THIS UNIT  
FAMILIARIZE YOURSELF WITH THE UNIT**

**A gas/air mixture under pressure can explode!!!  
Sour gas is extremely poisonous!!!  
You can be severely injured or killed.**

**Make sure the unit is sufficiently purged of any explosive mixture and there are no gas leaks before starting.  
Unit startup/shutdown procedure to be carried out by trained, authorized personnel only.**

**Operational inquiries can be directed to Propak.  
For replacement parts / maintenance assistance contact Propak.  
After completing the above, begin proper starting procedure.**

**CAUTION**

**CAUTION**

**CAUTION**

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### 3. BASIS OF DESIGN

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#### 3.1 Design Basis

The plant has been designed on the basis of the following inlet conditions, flowrates and analysis.

Gas flowrate:	339.8 x 10 <sup>3</sup> M3 (12.0 MMSCFD) (does not include recycle gas)
Inlet Pressure:	4800 kPa(g) (696 psig) (Fridge Plant)
Inlet Temperature:	normal 48.8°C (120 °F)
LTS Temperature:	-21°C (-5 °F) @ 12 MMSCFD
Equipment Design:	8963 kPa(g) @ -28.8 / 66°C (1300 psig)

#### INLET GAS COMPOSITION (mole percent)

H2O	Saturated
HE	0.03
N2	0.90
CO2	2.00
C1	90.37
C2	4.51
C3	1.33
I-C4	0.25
N-C4	0.26
I-C5	0.10
N-C5	0.08
C6	0.08
C7	0.09
C8	Trace
C9	Trace
C10	Trace
Cyclopentane	0.00
MCyclopentane	0.00
<u>Mcyclohexane</u>	<u>0.00</u>
TOTAL	100.00

## 4. DESIGN DESCRIPTION

### 4.1 Design Description

Gas enters the refrigeration unit 4800 kPag and 49°C. The gas is precooled by exchanging heat with cold residue gas in the Gas/Gas Exchanger E-600, and then chilled to -21°C (-5°F) by propane refrigerant in the Gas Chiller E-610. 5.8 L/min of 80 wt% ethylene glycol solution is spray injected into the heat exchangers to dehydrate the gas as it is chilled. The mixture of chilled gas, condensed hydrocarbon liquids and glycol/water enters the Low Temperature Separator V-620, where residence time is provided to disengage and separate the phases. The residue gas is reheated to 42°C by exchanging heat with incoming gas in the Gas/Gas Exchanger, and then flows offskid to the sales gas line. The condensed hydrocarbon liquids are preheated to 21°C by exchanging heat with warm propane refrigerant liquid in Refrigerant Subcooler E-615, and then fed to the top of the Deethanizer / Stabilizer T-630.

The Deethanizer / Stabilizer is a packed fractionating column designed to produce an LPG or 12 psia RVP stabilized product. The tower runs at 200 psia in a Deethanizer mode. Bottoms heat is supplied by a self-contained hot oil bath heater on temperature control complete with reboiler bundle. Overhead vapours from the tower are routed to inlet compression for recycle to optional Recycle Compressor. The liquid product is cooled to 49°C by air in the Stabilizer Product Cooler AC-610, metered and level controlled to storage by the owner.

Ethylene glycol/water solution from the Low Temperature Separator is level controlled to the glycol regenerator still column reflux coil and used to reflux the still to minimize glycol losses. The rich glycol is then preheated to 66°C by exchanging heat with hot lean glycol in the surge tank lean/rich exchanger coil. A Glycol Flash Tank V-640 is provided to preflash the rich glycol and minimize hydrocarbon emissions from the still. The rich glycol is then filtered in F-601 and enters the still column of Glycol Regenerator H-650. The glycol is regenerated at 121°C and 7 kPa(g) with heat supplied by a fire-tube on temperature control. Water vapour is vented to atmosphere.

## Design Description - (Continued)

The lean glycol at 80 wt% concentration is cooled to 66°C by exchanging heat with rich glycol in the surge tank lean/rich exchanger coil. 30 minutes retention time is provided to absorb volumetric surges. The lean glycol is then pumped to 6000 kPa(g) by Glycol Injection Pumps P-655A/B, further cooled to 49°C by exchanging heat with cold glycol in the Low Temperature Separator boot coil, and reinjected to the heat exchangers.

### 4.2 Product Specifications

The following product specifications are guaranteed by Propak Systems Ltd., based on the inlet conditions, flowrates and analysis stated earlier. Product rates may vary  $\pm 5\%$  due to uncertainty in equilibrium calculations.

Residue Gas Dewpoint :	under -14°C @ 5604 kPa(a)
Residue Gas Temperature:	under 49°C
Residue Gas Volume:	338.9 x 10 <sup>3</sup> M3/D (11.97 MMSCFD) not including fuel shrinkage
Plant Gas Pressure Drop:	275 kPa(g) maximum
C3+ Temperature:	49°C maximum
C3+ Pressure:	689 kPa(a)
C3+ Volume:	28.6 BBLS/D @ 12 MMSCFD and -21°C)

## 5. STANDARD REFRIGERATION PLANT DESCRIPTION

### 5.1. Introduction

It is recommended that the plant operating personnel review the design and flow conditions defined in this manual. The experienced operator will recognize conditions noted, are the "normal operating conditions" or the "target" conditions. They are subject to change based upon prevailing conditions such as variations in plant feed rate and/or composition, ambient air temperature and humidity, etc. It is advised, therefore, to view the conditions given in this section as guidelines to be used to establish the most reliable and economically advantageous operating conditions.

The equipment operating conditions presented on the following pages represent a complete list of all vessels, heat exchangers, filters, and pumps included in the plant.

#### **NOTES:**

Unless otherwise specified, units of measurement are given as follows:

Pressures are in psig

Temperatures are in °F.

Gas flowrates are in MMSCFD

Liquid flowrates are usgpm.

### 5.2. Principles of Operation

This section gives a very basic explanation of the theory of the system, and is intended for those who are totally unfamiliar with a refrigeration facility.

#### 5.2.1. Dew Point Control by Mechanical Refrigeration

The basic purpose of a refrigeration plant is to cool the gas stream to a lower temperature than it will normally reach in the transmission company's pipeline. As a result of this cooling, the heavier hydrocarbons will be condensed to a liquid and collected before they are re-injected into the pipeline. The entering gas is cooled in the Gas Chiller, then passes on to the Low Temperature Separator where any condensate droplets will be collected. In some process systems, the gas is cooled even further, as low as -40°F, so that revenue can be realized by selling the produced liquids.

Mechanical refrigeration is used to cool the gas stream during its passage through the Gas Chiller. The Gas/Gas Exchanger is added to this process so that the cold outlet gas can be used to pre-cool the inlet stream, thereby reducing the amount of refrigeration required.

### 5.2.2. Heat Absorption by Boiling Liquids

Whenever a liquid contacts a surface that is hotter than the boiling point of the liquid, the liquid removes a large amount of the heat from the surface. When water contacts a surface warmer than  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ) it boils and cools, or "refrigerates" the surface to  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ). Thus, when water boils on the kitchen stove, the cooking pot is actually being cooled by the boiling action of the water, and the temperature is maintained at the boiling point of the water, even though the stove can be red hot. A liquid can be chosen that boils below room temperature, and let it contact a warm surface. As the liquid boils it will "refrigerate" the surface and tend to cool that surface to the boiling point of the liquid. Many liquids boil below room temperature; for example, liquid propane boils at  $-42^{\circ}\text{C}$  ( $-44^{\circ}\text{F}$ ), and liquid ammonia boils at  $-33^{\circ}\text{C}$  ( $-28^{\circ}\text{F}$ ). A surface in contact with liquid propane would be cooled to the boiling point of the propane  $-42^{\circ}\text{C}$  ( $-44^{\circ}\text{F}$ ) just as a cooking pot is cooled to  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ) by boiling water.

### 5.2.3. Condensation of a Vapour

Condensation of a vapour is closely associated with boiling. Steam above the previously mentioned cooking pot will condense on any surface cooler than  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ). We are confused by condensation because we normally only see water condensed as dew on cool summer mornings, but that is because the water vapour is mixed with air. However, directly above a boiling cooking pot where the air is displaced by steam, the steam condenses on any surface cooler than  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ). Thus with water we can see two things:

- a) Boiling of liquid water when in contact with a surface hotter than  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ).
- b) Condensation of vapour water (steam) when in contact with a surface cooler than  $100^{\circ}\text{C}$  ( $212^{\circ}\text{F}$ ).

These properties are exhibited by other fluids having different boiling points than water, such as propane or ammonia as previously mentioned.

We can devise a system where, for example, propane is boiled or "evaporated" in one heat exchanger and condensed to a liquid in another.

### 5.2.4. Pressure Dependence of Evaporation and Condensation

The boiling point of a liquid is measured at atmospheric pressure at sea level. Thus we see that water actually boils at a lower temperature in Alberta (about  $96^{\circ}\text{C}$ ,  $205^{\circ}\text{F}$ ) where the atmospheric pressure is lower due to the altitude above sea level. Water in a pressure cooker boils at a higher pressure and temperature, reducing cooking time. For any single fluid at a given pressure, there will be a corresponding temperature called the Saturation Temperature. If liquid contacts a surface having a higher temperature than the saturation temperature, evaporation of the fluid will cool the surface. If vapour contacts a surface having a lower temperature than the saturation temperature, the vapour will begin to condense.

The pressure-temperature chart for the refrigeration used in your refrigeration system is given at the end of this section. This chart shows the pressure and corresponding saturation temperature.

5.2.5. To summarize how this applies to a refrigeration plant:

The low-pressure (L-P) refrigerant vapour (cold) from the evaporator is inducted into the compressor, which raises the vapour pressure and temperature for delivery to the condenser. The refrigerant must be compressed sufficiently to have a saturation temperature higher than the temperature of the cooling medium employed so that heat can be dissipated in the condenser. After heat removal and condensation in the condenser, the liquid refrigerant may pass to a receiver, or accumulator vessel. The high-pressure (H-P) liquid refrigerant next passes through the expansion valve, where the refrigerant throttles (drops) to the evaporator pressure of the system.

In passing through the expansion valve the liquid refrigerant cools itself at the expense of evaporating a portion of the liquid. In a refrigerant system, low pressure in the evaporator is determined by the temperature which is desired to be maintained in the evaporator. The high pressure in the condenser is determined ultimately by the temperature of the available cooling medium, i.e., the atmosphere (air temperature). The process is one in which the refrigerant absorbs heat at a low temperature and then, by the action of mechanical work, the refrigerant is raised to a sufficiently high pressure (temperature) to allow rejection of this heat. Note that the mechanical work or energy supplied to the compressor is the means used to raise the temperature of the system.



TABLE 1 - PROPERTIES OF LIQUID AND SATURATED VAPOUR - PROPANE

TEMP. °F	PRESSURE		VOLUME		ENTHALPY**	
	lb/in <sup>2</sup>		ft/lb		Btu/lb	
	ABS.	GAGE	LIQUID	VAPOUR	LIQUID	VAPOUR
t	p	p	v f	v g	h f	h g
-100	2.8814	24.0544*	0.025998	29.947548	-32.045	164.156
- 95	3.4094	22.9794*	.026119	25.615080	-29.432	165.566
- 90	4.0131	21.7503*	.026243	22.016696	-26.810	166.976
- 85	4.7001	20.3515*	.026369	19.012023	-24.178	168.386
- 80	5.4786	18.7665*	.026497	16.490260	-21.536	169.795
- 75	6.3570	16.9781*	0.026627	14.363439	-18.884	171.204
- 70	7.3441	14.9683*	.026760	12.561302	-16.221	172.611
- 65	8.4492	12.7183*	.026896	11.027431	-13.547	174.017
- 60	9.6818	10.2087*	.027034	9.716279	-10.861	175.420
- 55	11.0519	7.4192*	.027175	8.590887	- 8.164	176.822
- 50	12.5697	4.3290*	0.027319	7.621119	- 5.455	178.220
- 45	14.2459	0.9164*	.027466	6.782281	- 2.733	179.616
- 43.73	14.696	0	.0275	6.587	- 2.04	179.97
- 40	16.0912	1.3952	.027616	6.054052	0.000	181.008
- 35	18.1170	3.4210	.027769	5.419633	2.747	182.396
- 30	20.3346	5.6386	0.027926	4.865079	5.508	183.780
- 25	22.7558	8.0598	.028086	4.378764	8.282	185.160
- 20	25.3927	10.6967	.028249	3.950964	11.070	186.535
- 15	28.2574	13.5614	.028416	3.573505	13.873	187.905
- 10	31.3624	16.6664	.028587	3.239501	16.690	189.269
- 5	34.7204	20.0244	0.028762	2.943125	19.523	190.627
0	38.3443	23.6483	.028941	2.679428	22.372	191.979
5	42.2472	27.5512	.029125	2.444198	25.237	193.325
10	46.4425	31.7465	.029313	2.233834	28.119	194.663
15	50.9435	36.2475	.029506	2.045252	31.019	195.993
20	55.7640	41.0680	0.029703	1.876024	33.920	197.318
25	60.9179	46.2219	.029906	1.723444	36.854	198.632
30	66.4191	51.7231	.030115	1.585733	39.806	199.937
35	72.2820	57.5860	.030329	1.461176	42.779	201.232
40	78.5210	63.8250	.030549	1.348284	45.772	202.516
45	85.1506	70.4546	0.030775	1.245760	48.788	203.788
50	92.1856	77.4896	.031008	1.152468	51.826	205.048
55	99.6411	84.9451	.031248	1.067416	54.889	206.295
60	107.5323	92.8363	.031496	0.989734	57.976	207.527
65	115.8747	101.1787	.031751	0.918654	61.090	208.743
70	124.6838	109.9878	0.032015	0.853500	64.232	209.943
75	133.9756	119.2796	.032287	.793674	67.403	211.124
80	143.7665	129.0705	.032570	.738648	70.605	212.284
85	154.0727	139.3767	.032862	.687951	73.840	213.423

**TABLE 1 - PROPERTIES OF LIQUID AND SATURATED VAPOUR - PROPANE**

TEMP. °F  t	PRESSURE lb/in <sup>2</sup>		VOLUME ft/lb		ENTHALPY** Btu/lb	
	ABS.	GAGE	LIQUID	VAPOUR	LIQUID	VAPOUR
	p	p	v f	v g	h f	h g
90	164.9112	150.2152	.033165	.641167	77.110	214.538
95	176.2991	161.6031	0.033480	0.597922	80.417	215.627
100	188.2541	173.5581	.033808	.557884	83.763	216.687
105	200.7939	186.0979	.034150	.520755	87.151	217.716
110	213.9371	199.2411	.034506	.486268	90.584	218.709
115	227.7026	213.0066	.034879	.454182	94.065	219.664
120	242.1099	227.4139	0.035270	0.424281	97.597	220.576
125	257.1791	242.4831	.035681	.396367	101.185	221.440
130	272.9311	258.2351	.036114	.370263	104.833	222.250
135	289.3874	274.6914	.036571	.345805	108.547	222.999
140	306.5706	291.8746	.037057	.322844	112.332	223.681
145	324.5043	309.8083	0.037574	0.301243	116.197	224.284
150	343.2132	328.5172	.038128	.280873	120.149	224.797
155	362.7234	348.0274	.038725	.261612	124.198	225.207
160	383.0629	368.3669	.039373	.243343	128.359	225.494
165	404.2614	389.5654	.040082	.225955	132.646	225.636
170	426.3511	411.6551	0.040866	0.209337	137.078	225.603
175	449.3675	434.6715	.041747	.193335	141.695	225.347
180	473.3497	458.6537	.042755	.177836	146.526	224.814
185	498.3426	483.6466	.043940	.162651	151.637	223.908
190	524.3983	509.7023	.045390	.147505	157.139	222.469
195	551.5803	536.8843	0.047288	0.131948	163.233	220.200
200	579.9705	565.2745	.050130	.114907	170.443	216.354
205	609.6855	594.9895	.056858	.091171	181.491	207.180
206.26c	617.4000	602.7040	.072799	.073517	197.56	197.56

+ From unpublished data of York Division, Borg-Warner Corp.  
Used by permission.

\*\* Based on zero for the saturated liquid at -40°F

\* Inches of mercury below one standard atmosphere.

### 5.3. Glycol Injection for Refrigeration Units

#### 5.3.1. Introduction

The presence of cold gas and high velocities in the Gas/Gas Exchanger, Gas Chiller, and Low Temperature Separator of a refrigeration unit would quickly result in the formation of hydrates and eventual blockage of the gas flow.

A common method used to prevent this problem is injection of glycol into the Gas/Gas Exchanger and Gas Chiller gas streams or onto the exchanger tube sheets. Besides keeping the heat exchangers from "freezing-off" there is the added benefit of removing water from the gas stream and thus meeting water dew point requirements as well.

The glycol carries through the exchangers and is collected in the Low Temperature Separator. Since the glycol and hydrocarbons separate, the glycol can be totally recovered, put through a reboiler to drive off water vapour and then re-injected into the Gas Chiller and Gas/Gas Exchanger.

#### 5.3.2. Application

For a glycol dehydration system to perform satisfactorily operational conditions must all be within the range of limitations of the unit.

The extent of dew point depression is determined by inlet gas temperature and pressure, type of liquid absorbent used, concentration of absorbent, circulation rate and the quantity of contaminants in the absorbent.

The two types of glycol used in injection systems are ethylene and diethylene. The normal operating reconcentration temperature for 80% glycol solution would be:

Ethylene Glycol: 125°C (255°F) (preferred)

Diethylene Glycol: 115°C (240°F)

A setting of 124°C (250°F) is normally used with either glycol.

When glycol is accumulated above a certain level in the cold separator, it is dumped from the cold separator (by level control) to near atmospheric pressure.

The wet glycol then passes through a heat exchanger coil in the still column, exchanging heat with the steam from the reboiler. It passes into the surge tank coil and then into the flash tank. Here any HC vapour is flashed off. The glycol is then level controlled to pass through a glycol filter, a charcoal filter and finally into the still column.

Water vapour and some glycol vapour are driven from the reboiler up the Still Column. The glycol vapour is condensed by the cooler entering wet glycol. Any glycol vapour above the feed point is retained by condensing a small amount of

water reflux in the top of the column.

The wide difference in the boiling points of water and glycol provides an easy, effective separation of the two components.

Hot reconcentrated glycol flows from the reboiler through a downcomer pipe into the surge tank. The surge tank acts as a reservoir as well as normally containing the glycol-to-glycol heat exchanger.

The glycol pump takes suction from the surge tank and discharges back to the gas/gas exchanger and chiller injection nozzles to complete the cycle.

### 5.3.3. Glycol Regenerator Assembly

The Glycol Regenerator is complete with all interconnecting piping.

It is desirable to pipe the water vapour discharge away from the unit. This stream normally contains some gas and may contain liquid hydrocarbon if the level controller should fail.

A sloped line approximately three meters (10 ft.) in length is tied into a closed drain system.

Line size should be the same as the still column vapour connection.

## 5.4. Start-Up

### 5.4.1. Introduction

The procedures presented in this section are concerned with initial start-up and operation of the plant. Initial start-up is herein also considered to mean start-up after any shutdown requirements, plant turnaround, or any long period of idleness.

In order to become more familiar with the plant facilities, the operator is encouraged to read the individual manufacturer's operation manuals. The procedure presented here is intended only as a guideline. It does not remove responsibility from the operator for safety or the application of these written instructions to the existing field conditions. The operator must exercise his own judgment and experience.

### 5.4.2. Safety

Open flames or smoking is prohibited in all areas of the plant. Welding and cutting should not be allowed unless all safety precautions have been taken and the appropriate hot work permit has been issued.

All personnel should be familiar with the location of safety equipment and portable fire extinguishers and should be completely familiar with their proper usage.

The degree of an individual's safety is largely dependent on his knowledge of what is safe and what is dangerous or harmful. This makes it essential for the operator and other plant personnel to have as complete an understanding as possible of the process and equipment being used.

#### 5.4.3. Process Equipment

Before work on vessels, piping and valves is attempted, that piece of equipment should be isolated, depressurized and purged. An attempt to stop a leak while the equipment is pressurized can be dangerous. For example, when attempting to stop a thread leak in a nipple by tightening, it is possible to break the nipple under the stress from the pipe wrench.

#### 5.4.4. Operating Machinery

Process equipment operating machinery, such as pumps and compressors, should be isolated, depressurized, and purged before work is started. Electrical connections should be locked out at the MCC and/or switchgear. Care should be taken that the machinery cannot be started while work is being done. Work should be carried out with proper tools and equipment, as well as sufficient maintenance personnel for the particular job.

#### 5.4.5. Start-Up Procedures

Listed below are the recommended steps to follow in initial start-up of this gas plant. As operating experience is gained, this start-up procedure may be modified to give optimum handling of the plant. A detailed description on the start-up of each system is given in the following sections. One should read the complete operation before any start-up action is taken becoming familiar with all phases of operational equipment before actual start-up is commenced. Should this brief start-up description be unclear, the operator is to check a detailed description on settings and adjustments in the operating manuals.

### 5.5. Commission Utility Systems

#### 5.5.1. Electrical Check

Before any gas is allowed into the plant, the continuity and proper connection of all electrical circuits must be checked.

It is important to carry out this check before gas is allowed into the plant, as conditions may exist (such as short circuits) for explosion hazards.

All level, temperature, flame failure, pressure, and vibration switches should be activated to ensure their proper operation. Solenoid valves should be energized to check for proper operation, especially solenoid valves that activate emergency shutdown valves or depressurizing valves. Gas and fire detection devices should

be fully operational (if applicable). The plant control panel should be checked and be fully operational for start-up. The bypass should be turned on. All electrical motors should be bumped to check for direction of rotation before start-up.

#### 5.5.2. Flowsheet Check

All field piping should be checked against the as built mechanical flowsheet. All manual valves should be in their correct location, with no stems rotated below a horizontal position. All check valves must be mounted in the correct direction of flow. Control valves and their controllers should be properly located with instrument gas connections completed; pressure regulators must also be mounted in the proper direction. All process and solenoid switches must be installed and operational.

### 5.6. Gas Purging

#### 5.6.1. General

Purging will take place using the sweet inlet gas stream.

It is very important that the piping throughout the plant, pipe rack, etc., be properly purged of its air content. Air and natural gas form an explosive mixture that can be ignited by static electricity, galvanic potential or frictional heat. Therefore all air must be removed and purged before safe plant operation is assured. Purge until the vent gas oxygen content is less than 1%.

The following procedure will be applicable for future plant start-ups as well as the initial start-up. This procedure assumes that all vessels and piping have been previously pressure tested.

The operator must have mechanical flowsheets to trace all piping and vessels to make sure everything is purged.

Safety precautions require that all valves used as gas purge vent valves must be field piped to discharge outside any building. If possible all venting should be to the flare header but the **Flare Stack Igniter MUST BE SHUT OFF during the gas purge.**

#### 5.6.2. Purging Procedure

Remove the necessary blinds if applicable and slowly bring in the gas to a maximum of 35 kPag from the pipelines. Purge the individual pieces of equipment and piping making sure not to over pressure the system. Using the mechanical flowsheets, mark off the sections completed once the oxygen content of the vented gas is less than 1 percent.

Start bleeding gas through the plant in the following order:

- a) Line to the Gas/Gas Exchanger (E-310) Chiller, (E-320) and LTS (V-160).
- b) The line from the LTS through the Refrigerant Subcooler (E-330) to LV-160.
- c) Now bleed gas through LV-160 and on through any off skid condensate storage equipment (by others).

### 5.6.3. Refrigeration System

- a) Attach a vacuum pump to the Gas Chiller (E-320) and open all block or bypass valves back to the Propane Accumulator (V-170) and all block valves to the propane compressors and remove all air from the lines and vessels.
- b) Open slowly the propane supply from the propane storage tank and fill all refrigerant lines with propane vapours until all non-condensable vapours are purged.

## 5.7. Pressuring Up

### 5.7.1. General

This operation will bring the plant up to operating pressure levels in distinct stages. At each pressure level, the piping, equipment, and vessels must be checked for gas leakage by:

- a) Checking for audible leaks first.
- b) Wrap masking tape around all flanges. Wait 10 to 15 minutes, and then check for gas leakage by poking the sensing tube of an oxygen or explosion meter through the masking tape.
- c) Soap test screwed fittings for gas leakage.

### 5.7.2. Pressuring Procedure

Prior to introducing gas, close all the drain, vent, and flare valves through the entire plant. Pressure up the plant in stages and check for leaks. Depressurize the plant to fix any leaks.

Pressure up the Gas/Gas Exchanger, Chiller, and LTS first. You may pressure up to about 75% of operating but usually 700-1500 kPa will reveal most leaks. Then using the bypass around LV-160 to gradually pressure up any off skid condensate

storage equipment (by others). Finally, pressure up the glycol regeneration and fuel gas systems. They operate at a lower pressure and should only require about 350 kPa. Use the same procedure, gradually raising the pressure and checking small sections of the plant at a time.

#### 5.8. Instrument Check

Check all pneumatic controllers and control valves for proper operation. When checking the control valves make sure the block and bypass valves are closed in order to maintain the proper system pressures. Continue the following check for each controller:

- 5.8.1. Blowdown the air supply regulator while checking that the supply pressure to the controller is 210 kPag minimum.
- 5.8.2. Manually trip the controller over its entire operating range to verify that the output signal varies from 20 to 100 kPag, or 40 to 200 kPag as applicable.
- 5.8.3. Check each valve for reverse or direct action and fail-safe position. Also, check the set point for each controller.
- 5.8.4. Set the controller for throttling action in temperature or pressure control service.

Liquid level controllers should be set for throttling action, unless there is normally no flow, where snap acting is preferred.

#### 5.9. Flare System

Once the plant is completely pressurized and leak tested, check the operation of the flare ignition system.

#### 5.10. Glycol Regenerator Start-Up Procedures

The start-up procedure will vary somewhat depending upon the particular application and type of equipment and auxiliaries supplied. However, certain generalities usually apply. When combined with special procedures as pointed out, start-up should be carried out with a minimum of difficulty.

##### 5.10.1. Initial Start

Fill the Glycol Regenerator (H-601) with 80 wt% ethylene glycol, through the fill connections until the ethylene glycol spills over the stand pipe and registers a level of approximately half full in the glycol surge section. Check that the filters are clean in both, the Particulate Filter (F-601) and Carbon Filter (F-603). Check all instruments for proper operation.

5.10.2. The Glycol Injection Pump (P-655A/B) can now be started by following the steps



outlined below:

- a) Open bypass valve
- b) Open suction valve
- c) Start pump
- d) Open discharge valve
- e) Close the bypass valve

After the bypass valve is closed, note the operating discharge pressure (approximately 700 kPag above inlet gas pressure).

5.10.3. Add glycol to the reboiler as the level is pumped down. Caution should be taken however, it should not be filled too full. Glycol will expand as it comes up to the operating temperature. In the case of injection systems, there will also be considerable dilution of the glycol when it reaches the operating concentration.

5.10.4. Readjust the temperature controller dial (TC-601) until temperature in the regenerator is raised in 20°C intervals (rather than one temperature adjustment). Continue until 100°C is reached, at that point the temperature increase should be limited to a maximum of 5°C increments to operating temperature (124°C).

Check the liquid level after the operating temperature is reached.

5.10.5. Gas can now flow through the plant to bring it up to operating pressure or inlet pressure. Apply slowly and continuously while checking for leaks.

5.10.6. Normally an injection pressure of 350-690 kPag above the Low Temperature Separator operating pressure will give sufficient dew point control, and this is what should be used unless problems are encountered. When a level is reached in the cold separator, check to see that the level control valve (LV-161) dumps glycol back to the reboiler. This level controller setting is critical. Glycol only, and no hydrocarbons, should go through to the reboiler. This adjustment may be refined as the refrigeration unit is placed in operation and a hydrocarbon level is reached.

#### 5.11. Glycol Regenerator Shutdown Procedure

- a) Turn off gas to plant.
- b) Stop pumps.
- c) Turn off glycol lines to Glycol Regenerator.
- d) Bleed pressure off plant if unit is to be down for any extended period of time.
- e) Standard maintenance procedures should apply to a unit being taken out of service for an extended period of time. The Glycol Reconcetrator should be water flushed and drained. The pumps should be cleaned, the packing removed and plungers coated with a rust preventative. This is not necessary on short duration shutdowns.

### 5.12. Glycol Regenerator, Maintenance

- a) For maintenance of pumps, and other auxiliary equipment, consult the appropriate service bulletin.
- b) Pump strainer screen should be cleaned periodically.
- c) Filter cartridges should be cleaned when the pressure drop reaches approximately 100 kPa.
- d) Check glycol level in surge tank, and always maintain a level in the gauge glasses or damage to the pump will result.

### 5.13. Glycol Regenerator, Trouble Shooting

The most obvious indication of a malfunction is high water content (dew point) of the outgoing gas stream or blockage of the gas flow by a hydrate formation.

In the majority of cases, this is brought about by insufficient glycol circulation or by insufficient reconcentration of the glycol. These two factors can be caused by a variety of contributing causes as listed below.

In addition to mechanical causes, high dew points may be found due to existing operating conditions for which the equipment was not designed.

These conditions can sometimes be at least partially alleviated by both changes in process condition and mechanical operation.

#### 5.13.1. High Dew Points

- a) Cause: Insufficient glycol circulation.
  - i) Verify adequate circulation by shutting off glycol discharge from cold separator and timing fill rate in the gauge column.
  - ii) Pump stroking but not pumping. Check the valves to see if they are seating properly.
  - iii) Check pump suction strainer for stoppage.
  - iv) Open bleeder valve to eliminate air lock.
  - v) Be sure surge level is sufficiently high.
  - vi) Plugged injection nozzles or injection filters.

#### 5.13.2. Cause: Insufficient reconcentration.

If adequate circulation is verified and the unit is not producing design dew points,

improper reconcentration can then be suspected.

- a) Verify reboiler temperature with a test thermometer and set at 124°C.
- b) Check glycol-to-glycol heat exchanger for leakage of wet glycol into the dry glycol.
- c) Reboiler temperature may be increased by 5°C increments to increase glycol concentration if hydrate problem is persistent. This should only be done as a last resort.
- d) Refrigeration system must be operating at the proper set temperature.

#### 5.14. Start-Up of the Refrigeration Cycle.

##### 5.14.1. Initial Start-up

The initial start-up of a refrigeration system should be done by qualified refrigeration experts who will be familiar with control adjustments and design operating conditions. The following are general procedures for start-up:

- a) Check that unit sits level; install all filters, etc.
- b) Charge approximately 1034 kPag instrument air into system and leak check all joints with soap and water.
- c) Hook a vacuum pump to high and low pressure sides of the refrigeration system and evacuate air and water vapour from the system.
- d) Charge oil into the compressor (check compressor manual).
- e) Charge refrigerant into the Refrigerant Accumulator, (V-170), and fill to near 3/4 the sight glass (i.e. vessel 3/4 full maximum). **NEVER over-fill the system.** A high liquid level in the chiller can cause compressor damage if liquid should reach the compressor. Using the bypass valves progressively fill the Gas Chiller (E-320) to its normal operating level. 1/2 sight glass is ample in the Gas Chiller.
- f) Start compressor with special attention to oil pressure. Within 15 seconds, the oil pressure should climb to over 30 psi above the suction pressure. If it does not rise, then shut down compressor. Bleed vapour lock out of oil lines by loosening any fitting at a high point in the oil system. Then try starting. The start-up personnel will be of assistance if this problem should occur.
- g) As compressor suction pressure drops with compressor running, check operation of low suction pressure cut-out and re-adjust if necessary.

- h) With compressor running, pinch discharge valve and set high discharge pressure cut-out.
- i) Simulate oil failure by blocking the oil sensing line with a temporary needle valve and gauge.
- j) Check oil-failure pressure switch operation and any other safety and operating adjustments.
- k) Carefully observe the system for a few hours, noting initial operating conditions, chiller level, etc.
- l) Have any problems checked immediately by qualified personnel.

#### 5.15. Compressor Unloading

The refrigeration system will normally be oversized during wintertime due to the ambient air temperatures.

To allow the refrigeration system to operate efficiently under all foreseeable conditions, several control features have been included to cope with reduced cooling loads.

Liquid propane is admitted into E-320, the Gas Chiller, through LV-320, in response to a low-level signal from LC-320. Propane upstream of LV-320 will normally be a warm subcooled liquid under pressure from the Propane Accumulator V-170. As the Chiller is maintained at a much lower pressure, there will be some flashing across LV-320, which acts as the expansion valve. Liquid propane will therefore be dumped to the Chiller at a rate sufficient to maintain the liquid level setting of LC-320. If there are no other forms of control, the rate at which propane vapour is generated would be determined only by the operating duty of the Chiller.

The propane compressor (K-670), however requires a constant suction volume. If this volume is not available, the suction pressure will drop thus lowering the temperature in the Chiller. This would result in the shutdown of the compressor.

This can be compensated for in 2 ways:

- a) By unloading the compressor.
- b) By recycling hot discharge gas from the compressor back into the Gas Chiller.

At lower turndown ratios, there is a hot propane bypass to the Chiller through PCV-350, which supplies hot propane vapour from the compressor discharge. As the propane pressure in the Chiller falls below hot propane bypass set pressure, PCV-350 opens to make-up the propane volume demanded by the propane compressor.

The largest operating cost of the refrigeration system is the power required to run the propane compressor, K-670. Given a constant suction pressure and propane volume, the

amount of work done by the propane compressor is proportional to the propane condensing temperature in the Cooler, AC-910.

The Compressor and Cooler were sized for a maximum condensing temperature of 43°C. The power required to run the compressor will be decreased if the condensing temperature is lowered. Under most operating conditions, this is achieved simply by allowing the cooler to run at full tilt with the louvers wide open.

When lowering the condensing temperature, the limiting factor is the backpressure which must be maintained on the Propane Accumulator, V-170, to allow liquid propane to be dumped to the Gas Chiller, E-320. A reasonable backpressure on the Accumulator is between 345 and 1000 kPa. Below this pressure, there is the risk that LV-320 will not be able to dump propane to the chiller at the required rate. The gas regulator to the Propane Accumulator (PCV-171) will bypass hot gas to maintain this pressure on very cold days.

A system is in place to help maintain a minimum condensing temperature:

- a) The backpressure control valve, PCV-170, can be set to maintain the minimum required backpressure.
- b) Louver in the Condenser may be set manually to restrict the cooling airflow.

## 5.16. Routine Maintenance

### 5.16.1. Condenser

Grease all shaft bearings every two (2) weeks (see condenser manual).

### 5.16.2. Compressor (read compressor manual)

Check oil daily; add if necessary. Record operating conditions daily.

### 5.16.3. Chiller

Record inlet and outlet temperature daily. Remove oil from lowest point of chiller daily.

### 5.16.4. Cold Separator and Gas/Gas Exchanger

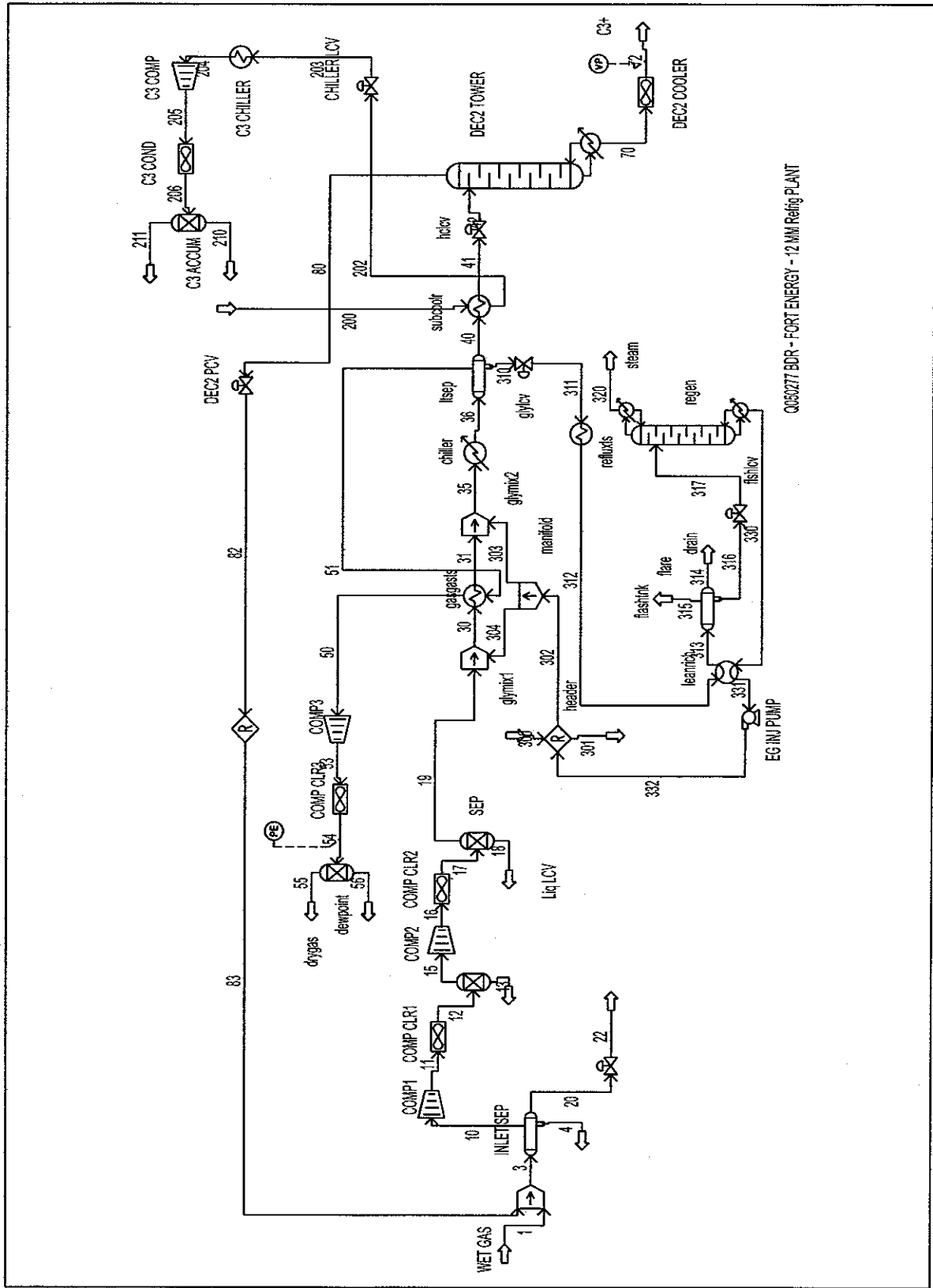
Record operating pressure and temperature.

## 5.17. Shutdown Procedure

For short periods (less than 24 hour), shut compressor down and close liquid feed valve to chiller. When shutting down for long periods of time, first close compressor suction valve. Allow compressor to shut off on low suction pressure. Then close compressor discharge valve and chiller feed valve.

#### 5.18. Restart (Refrigeration Compressor)

Open all valves except compressor suction valve. Open compressor suction valve 1/4 open. Start compressor, carefully observing that oil pressure is reached within thirty (30) seconds. Make sure system reaches normal operating conditions before leaving it unattended. Open the suction valve fully.



Q06277 BDR - FORT ENERGY - 12 MM Refrig PLANT

PROSIM VERSION 98.3  
GENERAL PURPOSE HYDROCARBON PROCESS SIMULATOR  
COPYRIGHT (c) 1996-2000 BRE LTD.  
LICENSED TO PROPAK SYSTEMS, LTD.  
RUN INITIATED JUN 17, 2005 AT 14:10:12

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

CONFIGURATION FILE USED:  
C:\ENGPRGMS\BRE983\prosim.cfg

PARAMETER INFORMATION

ECHO INPUT DECK = NO  
ECHO BLOCK RESULTS = NO  
STD PRESSURE = 14.696 PSIA  
STD TEMPERATURE = 60.000 F  
LENGTH OF PAGE = 100  
WIDTH OF PAGE = 120  
INTERACTIVE FLAG = NO  
DEW POINT PRINT = NO  
BUBBLE POINT PRINT = NO  
EOS = GPASRK  
UNITS = ENGLISH  
COMPOSITION = MOLE PERCENT  
D86-TBP CONVERSION = API 80  
LOTUS FILE = NO  
COLUMN INFORMATION = SUMMARY  
TRANSFER CURVES = BOTH  
DENSITY CORRELATION = RACKETT  
SG CORR. FOR HYPOS = WHITSON  
MW CORR. FOR HYPOS = HARIU-SAGE  
TC CORR. FOR HYPOS = KESLER-LEE  
PC CORR. FOR HYPOS = KESLER-LEE  
VC CORR. FOR HYPOS = TWU  
AC CORR. FOR HYPOS = EDMISTER  
CP CORR. FOR HYPOS = KESLER-LEE  
VIS CORR. FOR HYPOS = TWU  
RI CORR. FOR HYPOS = RIAZI-DAUBERT  
SOLIDS THRESHOLD T = 10.000 F  
PRTLIN PRINT LINES = YES



BLOCK NUMBER: 1.00 TYPE: MIXR NAME: MIXR1.0 STATUS: CURRENT

STREAM CROSS REFERENCE.  
 STREAM 1 COMES FROM BLOCK 0.00 (INLET )  
 STREAM 83 COMES FROM BLOCK 36.00 (RCYL36.0 )  
 STREAM 3 GOES TO BLOCK 2.00 (INLET SEP )

BLOCK NUMBER: 2.00 TYPE: FLSH NAME: INLET SEP STATUS: CURRENT

\* TEMPERATURE 60.000 F  
 \* PRESSURE 134.000 PSIA  
 \* PERCENTAGE LIQUID 0.000 %  
 \* DUTY 421.125 BTU/HR  
 \* LIQUID IS PRIMARILY OIL YES

STREAM CROSS REFERENCE.  
 STREAM 3 COMES FROM BLOCK 1.00 (MIXR1.0 )  
 STREAM 10 GOES TO BLOCK 10.00 (COMP1 )  
 STREAM 20 GOES TO BLOCK 3.00 (Liq LCV )  
 STREAM 4 GOES TO BLOCK 0.00 (OUTLET )

BLOCK NUMBER: 3.00, NAME: Liq LCV  
 WARNING P1014. STREAM 20 TO BLOCK 3.00 HAS ZERO FLOW.

!!  
 !!!NOTE!!!!!!!!!!!!!!!!!!!!!!!!!!!!A WARNING IS PRESENT!!!!!!!!!!!!!!!!!!!!NOTE!!!  
 ! BLOCK NUMBER: 3.00 TYPE: JTVL NAME: Liq LCV STATUS: CURRENT!  
 !  
 ! PRESSURE AT OUTLET 0.000 PSIA !  
 ! \* PRESSURE DROP FROM INLET 5.000 PSI !  
 !!!

STREAM CROSS REFERENCE.  
 STREAM 20 COMES FROM BLOCK 2.00 (INLET SEP )  
 STREAM 22 GOES TO BLOCK 0.00 (OUTLET )

BLOCK NUMBER: 10.00 TYPE: TRBN NAME: COMP1 STATUS: CURRENT

ADIABATIC EFFICIENCY 84.017 %  
 \* POLYTROPIC EFFICIENCY 85.000 %  
 \* MECHANICAL EFFICIENCY 100.000 %  
 \* OUTLET PRESSURE 249.000 PSIA  
 CHANGE IN PRESSURE 115.000 PSI  
 BRAKE POWER 414.275 HORSEPOWER  
 \* OTHER SIDE OF TURBINE -1.000  
 COMPRESSION RATIO 1.858  
 ACTUAL TEMPERATURE RISE 87.995 F  
 OUTLET TEMPERATURE 147.995 F  
 PERCENT LIQUID IN DISCHARGE 0.000 %  
 \* INITIAL TEMPERATURE GUESS 147.995 F  
 INLET FLOW RATE 897.673 ACFM  
 OUTLET FLOW RATE 565.154 ACFM  
 ISENTROPIC EXPONENT 1.276  
 POLYTROPIC EXPONENT 1.339  
 ADIABATIC HEAD 28656.268 FT  
 POLYTROPIC HEAD 28991.659 FT  
 TOTAL GROUP POWER REQUIRED 1654.648 HORSEPOWER  
 TOTAL GROUP POWER SUPPLIED 0.000 HORSEPOWER  
 NET GROUP POWER 1654.648 HORSEPOWER

STREAM CROSS REFERENCE.  
 STREAM 10 COMES FROM BLOCK 2.00 (INLET SEP )  
 STREAM 11 GOES TO BLOCK 11.00 (COMP CLR1 )

BLOCK NUMBER: 11.00 TYPE: EXCH NAME: COMP CLR1 STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-27.995	F
* OUTLET TEMPERATURE	120.000	F
DUTY	-366696.113	BTU/HR
LOG MEAN VISCOSITY	0.012370	CP
LOG MEAN THERMAL CONDUCTIVITY	0.021889	BTU/FT HR F
MEAN HEAT CAPACITY	0.545	BTU/F LB
LOG MEAN DENSITY	0.720	LB/FT^3
PERCENT TOTAL LIQUID IN OUTLET	0.000	%

STREAM CROSS REFERENCE.

STREAM 11	COMES FROM BLOCK	10.00 (COMP1	)
STREAM 12	GOES TO BLOCK	12.00 (FLSH12.0	)

BLOCK NUMBER: 12.00 TYPE: FLSH NAME: FLSH12.0 STATUS: CURRENT

TEMPERATURE	120.000	F
PRESSURE	244.000	PSIA
PERCENTAGE LIQUID	0.000	%

STREAM CROSS REFERENCE.

STREAM 12	COMES FROM BLOCK	11.00 (COMP CLR1	)
STREAM 15	GOES TO BLOCK	13.00 (COMP2	)
STREAM 13	GOES TO BLOCK	0.00 (OUTLET	)

BLOCK NUMBER: 13.00 TYPE: TRBN NAME: COMP2 STATUS: CURRENT

ADIABATIC EFFICIENCY	83.342	%
* POLYTROPIC EFFICIENCY	85.000	%
* MECHANICAL EFFICIENCY	100.000	%
* OUTLET PRESSURE	719.000	PSIA
CHANGE IN PRESSURE	475.000	PSI
BRAKE POWER	850.738	HORSEPOWER
* OTHER SIDE OF TURBINE	-1.000	
COMPRESSION RATIO	2.947	
ACTUAL TEMPERATURE RISE	171.212	F
OUTLET TEMPERATURE	291.212	F
PERCENT LIQUID IN DISCHARGE	0.000	%
* INITIAL TEMPERATURE GUESS	291.212	F
INLET FLOW RATE	547.727	ACFM
OUTLET FLOW RATE	243.237	ACFM
ISENTROPIC EXPONENT	1.272	
POLYTROPIC EXPONENT	1.331	
ADIABATIC HEAD	58374.572	FT
POLYTROPIC HEAD	59535.999	FT
TOTAL GROUP POWER REQUIRED	1654.648	HORSEPOWER
TOTAL GROUP POWER SUPPLIED	0.000	HORSEPOWER
NET GROUP POWER	1654.648	HORSEPOWER

STREAM CROSS REFERENCE.

STREAM 15	COMES FROM BLOCK	12.00 (FLSH12.0	)
STREAM 16	GOES TO BLOCK	14.00 (COMP CLR2	)

BLOCK NUMBER: 14.00 TYPE: EXCH NAME: COMP CLR2 STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-171.212	F
* OUTLET TEMPERATURE	120.000	F
DUTY	-2.4828E+06	BTU/HR
LOG MEAN VISCOSITY	0.014057	CP
LOG MEAN THERMAL CONDUCTIVITY	0.026353	BTU/FT HR F
MEAN HEAT CAPACITY	0.603	BTU/F LB
LOG MEAN DENSITY	1.931	LB/FT^3
PERCENT TOTAL LIQUID IN OUTLET	0.000	%

STREAM CROSS REFERENCE.

STREAM 16	COMES FROM BLOCK	13.00 (COMP2	)
STREAM 17	GOES TO BLOCK	15.00 (SEP	)

BLOCK NUMBER: 15.00 TYPE: FLSH NAME: SEP STATUS: CURRENT

TEMPERATURE	120.000	F
PRESSURE	714.000	PSIA
PERCENTAGE LIQUID	0.000	%

STREAM CROSS REFERENCE.

STREAM 17	COMES FROM BLOCK	14.00 (COMP CLR2	)
STREAM 19	GOES TO BLOCK	20.00 (glymix1	)
STREAM 18	GOES TO BLOCK	0.00 (OUTLET	)

BLOCK NUMBER: 16.00 TYPE: TRBN NAME: COMP3 STATUS: CURRENT

ADIABATIC EFFICIENCY	83.956	%
* POLYTROPIC EFFICIENCY	85.000	%
* MECHANICAL EFFICIENCY	100.000	%
* OUTLET PRESSURE	1219.000	PSIA
CHANGE IN PRESSURE	527.000	PSI
BRAKE POWER	389.635	HORSEPOWER
* OTHER SIDE OF TURBINE	-1.000	
COMPRESSION RATIO	1.762	
ACTUAL TEMPERATURE RISE	88.389	F
OUTLET TEMPERATURE	195.389	F
PERCENT LIQUID IN DISCHARGE	0.000	%
* INITIAL TEMPERATURE GUESS	196.473	F
INLET FLOW RATE	178.207	ACFM
OUTLET FLOW RATE	119.263	ACFM
ISENTROPIC EXPONENT	1.330	
POLYTROPIC EXPONENT	1.410	
ADIABATIC HEAD	27372.897	FT
POLYTROPIC HEAD	27713.273	FT
TOTAL GROUP POWER REQUIRED	1654.648	HORSEPOWER
TOTAL GROUP POWER SUPPLIED	0.000	HORSEPOWER
NET GROUP POWER	1654.648	HORSEPOWER

STREAM CROSS REFERENCE.

STREAM 50	COMES FROM BLOCK	21.01 (gasgasts-1	)
STREAM 53	GOES TO BLOCK	17.00 (COMP CLR3	)

BLOCK NUMBER: 17.00 TYPE: EXCH NAME: COMP CLR3 STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-75.389	F
* OUTLET TEMPERATURE	120.000	F
DUTY	-1.1461E+06	BTU/HR
LOG MEAN VISCOSITY	0.014348	CP
LOG MEAN THERMAL CONDUCTIVITY	0.026358	BTU/FT HR F
MEAN HEAT CAPACITY	0.642	BTU/F LB
LOG MEAN DENSITY	3.609	LB/FT^3
PERCENT TOTAL LIQUID IN OUTLET	0.000	%

STREAM CROSS REFERENCE.

STREAM 53	COMES FROM BLOCK	16.00 (COMP3	)
STREAM 54	GOES TO BLOCK	28.00 (dewpoint	)

BLOCK NUMBER: 20.00 TYPE: MIXR NAME: glymix1 STATUS: CURRENT

* PRESSURE DROP	0.000	PSI
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STREAM CROSS REFERENCE.

STREAM 304	COMES FROM BLOCK	57.00 (manifold	)
STREAM 19	COMES FROM BLOCK	15.00 (SEP	)
STREAM 30	GOES TO BLOCK	21.00 (gasgasts	)

BLOCK NUMBER: 21.00 TYPE: EXCH NAME: gasgasts STATUS: CURRENT

* PRESSURE DROP	2.000	PSI
* COMPLEX EXCH. OR DUTY FROM	21.010	
CHANGE IN TEMPERATURE	-106.092	F
OUTLET TEMPERATURE	14.798	F
DUTY	-1.6481E+06	BTU/HR
APPROACH TEMPERATURE	13.890	F
LOG MEAN TEMPERATURE DIFFERENCE	16.670	F
APPROACH/UA TOLERANCE	5.000	%
* INCREMENTS ON TRANSFER CURVE	10.000	
* INITIAL TEMPERATURE GUESS	13.946	F
* MINIMUM ALLOWABLE APPROACH	9.000	F
ENDPOINT UA	98867.191	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	1.402	%

STREAM CROSS REFERENCE.

STREAM 30 COMES FROM BLOCK	20.00 (glymix1	)
STREAM 31 GOES TO BLOCK	22.00 (glymix2	)

BLOCK NUMBER: 21.01 TYPE: EXCH NAME: gasgasts-1 STATUS: CURRENT

* PRESSURE DROP	15.000	PSI
* COMPLEX EXCH. OR DUTY FROM	21.000	
CHANGE IN TEMPERATURE	112.000	F
* OUTLET TEMPERATURE	107.000	F
DUTY	1.6481E+06	BTU/HR
APPROACH TEMPERATURE	13.890	F
LOG MEAN VISCOSITY	0.011893	CP
LOG MEAN THERMAL CONDUCTIVITY	0.020730	BTU/FT HR F
MEAN HEAT CAPACITY	0.622	BTU/F LB
LOG MEAN DENSITY	2.680	LB/FT^3
LOG MEAN TEMPERATURE DIFFERENCE	16.670	F
APPROACH/UA TOLERANCE	5.000	%
* INCREMENTS ON TRANSFER CURVE	10.000	
* MINIMUM ALLOWABLE APPROACH	9.000	F
ENDPOINT UA	98867.191	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	0.000	%

STREAM CROSS REFERENCE.

STREAM 51 COMES FROM BLOCK	24.00 (ltsep	)
STREAM 50 GOES TO BLOCK	16.00 (COMP3	)

BLOCK NUMBER: 22.00 TYPE: MIXR NAME: glymix2 STATUS: CURRENT

* PRESSURE DROP	0.000	PSI
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STREAM CROSS REFERENCE.

STREAM 303 COMES FROM BLOCK	57.00 (manifold	)
STREAM 31 COMES FROM BLOCK	21.00 (gasgasts	)
STREAM 35 GOES TO BLOCK	23.00 (chiller	)

BLOCK NUMBER: 23.00 TYPE: EXCH NAME: chiller STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-20.914	F
* OUTLET TEMPERATURE	-5.000	F
DUTY	-349939.822	BTU/HR
* INCREMENTS ON TRANSFER CURVE	10.000	
PERCENT TOTAL LIQUID IN OUTLET	2.111	%

STREAM CROSS REFERENCE.

STREAM 35 COMES FROM BLOCK	22.00 (glymix2	)
STREAM 36 GOES TO BLOCK	24.00 (ltsep	)

BLOCK NUMBER: 24.00 TYPE: FLSH NAME: ltsep STATUS: CURRENT

TEMPERATURE	-5.000	F
PRESSURE	707.000	PSIA
PERCENTAGE LIQUID	2.111	%
PERCENT LIQUID A	0.473	%
PERCENT LIQUID B	1.638	%

\* LIQUID IS PRIMARILY OIL YES

STREAM CROSS REFERENCE.

STREAM 36	COMES FROM BLOCK	23.00	(chiller	)
STREAM 51	GOES TO BLOCK	21.01	(gasgasts-1	)
STREAM 40	GOES TO BLOCK	30.00	(subcoolr	)
STREAM 310	GOES TO BLOCK	25.00	(glylcv	)

BLOCK NUMBER: 25.00 TYPE: JTVL NAME: glylcv STATUS: CURRENT

* PRESSURE AT OUTLET	75.000	PSIA
PRESSURE DROP FROM INLET	632.000	PSI
TEMPERATURE	-2.151	F
PERCENTAGE LIQUID	99.882	%

STREAM CROSS REFERENCE.

STREAM 310	COMES FROM BLOCK	24.00	(ltsep	)
STREAM 311	GOES TO BLOCK	50.00	(refluxts	)

BLOCK NUMBER: 28.00 TYPE: FLSH NAME: dewpoint STATUS: CURRENT

TEMPERATURE	-9.655	F
* PRESSURE	813.000	PSIA
* PERCENTAGE LIQUID	0.001000	%
DUTY	-1.7096E+06	BTU/HR

STREAM CROSS REFERENCE.

STREAM 54	COMES FROM BLOCK	17.00	(COMP CLR3	)
STREAM 55	GOES TO BLOCK	0.00	(OUTLET	)
STREAM 56	GOES TO BLOCK	0.00	(OUTLET	)

BLOCK NUMBER: 30.00 TYPE: EXCH NAME: subcoolr STATUS: CURRENT

* PRESSURE DROP	1.000	PSI
* COMPLEX EXCH. OR DUTY FROM	30.010	
CHANGE IN TEMPERATURE	75.000	F
* OUTLET TEMPERATURE	70.000	F
DUTY	16078.121	BTU/HR
APPROACH TEMPERATURE	40.000	F
LOG MEAN TEMPERATURE DIFFERENCE	69.415	F
APPROACH/UA TOLERANCE	5.000	%
* INCREMENTS ON TRANSFER CURVE	10.000	
* MINIMUM ALLOWABLE APPROACH	10.000	F
ENDPOINT UA	231.622	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	85.000	%

STREAM CROSS REFERENCE.

STREAM 40	COMES FROM BLOCK	24.00	(ltsep	)
STREAM 41	GOES TO BLOCK	31.00	(hclcv	)

BLOCK NUMBER: 30.01 TYPE: EXCH NAME: subcoolr-1 STATUS: CURRENT

* PRESSURE DROP	1.000	PSI
* COMPLEX EXCH. OR DUTY FROM	30.000	
CHANGE IN TEMPERATURE	-4.405	F
OUTLET TEMPERATURE	105.595	F
DUTY	-16078.121	BTU/HR
APPROACH TEMPERATURE	40.000	F
LOG MEAN VISCOSITY	0.080947	CP
LOG MEAN THERMAL CONDUCTIVITY	0.061945	BTU/FT HR F
MEAN HEAT CAPACITY	0.782	BTU/F LB
LOG MEAN DENSITY	28.996	LB/FT^3
LOG MEAN TEMPERATURE DIFFERENCE	69.415	F
APPROACH/UA TOLERANCE	5.000	%
* INCREMENTS ON TRANSFER CURVE	10.000	
* INITIAL TEMPERATURE GUESS	105.427	F
MINIMUM ALLOWABLE APPROACH	10.000	F
ENDPOINT UA	231.622	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	100.000	%

STREAM CROSS REFERENCE.

STREAM 200 COMES FROM BLOCK	0.00 (INLET	)
STREAM 202 GOES TO BLOCK	40.00 (CHILLER LCV	)

BLOCK NUMBER: 31.00 TYPE: JTVL NAME: hc1cv STATUS: CURRENT

* PRESSURE AT OUTLET	200.000	PSIA
PRESSURE DROP FROM INLET	506.000	PSI
TEMPERATURE	49.086	F
PERCENTAGE LIQUID	63.700	%

STREAM CROSS REFERENCE.

STREAM 41 COMES FROM BLOCK	30.00 (subcoolr	)
STREAM 42 GOES TO BLOCK	32.00 (DEC2 TOWER	)

BLOCK NUMBER: 32.00 TYPE: STIL NAME: DEC2 TOWER STATUS: CURRENT

* NUMBER OF IDEAL STAGES	15.000	
* PRESSURE	200.000	PSIA
* PRESSURE DROP	1.000	PSI
* PACKING FACTOR	28.000	1/FT
* PERCENT OF FLOOD	70.000	%
* ERROR TOLERANCE	1.0000E-05	%
* REBOILER PRESSURE DROP	0.000	PSI
REBOILER DUTY	36871.080	BTU/HR
PERCENT OF FEED TO BOTTOMS	53.522	%
BOTTOMS FLOW RATE	3.399	LBMOL/HR
BOTTOMS TEMPERATURE	258.855	F
PERCENTAGE OF FEED TO OVERHEADS	46.478	%
OVERHEAD FLOW RATE	2.952	LBMOL/HR
OVERHEAD TEMPERATURE	54.973	F
* RECALCULATE INITIAL PROFILES	NO	
* ALTERNATE INITIAL PROFILES	NO	
* VAPOR STAGE EFFICIENCY	YES	
* MAXIMUM NUMBER OF STEPS	150.000	
* COLUMN SYSTEM FACTOR	1.000	

SPECIFICATION=ETHANE /PROPANE  
 STAGE=BOTTOM ,MOLAR RATIO = 0.020000

STREAM CROSS REFERENCE.

STREAM 42 COMES FROM BLOCK	31.00 (hc1cv	)	TO STAGE	1
STREAM 80 GOES TO BLOCK	35.00 (DEC2 PCV	)		
STREAM 70 GOES TO BLOCK	33.00 (DEC2 COOLER	)		
INTERNAL STREAM 33 COMES FROM REBOILER AND GOES TO STAGE	14			
INTERNAL STREAM 34 COMES FROM STAGE 14 AND GOES TO REBOILER				

BLOCK NUMBER: 33.00 TYPE: EXCH NAME: DEC2 COOLER STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-138.855	F
* OUTLET TEMPERATURE	120.000	F
DUTY	-23607.184	BTU/HR
LOG MEAN VISCOSITY	0.152	CP
LOG MEAN THERMAL CONDUCTIVITY	0.061641	BTU/FT HR F
MEAN HEAT CAPACITY	0.636	BTU/F LB
LOG MEAN DENSITY	35.350	LB/FT^3
* INCREMENTS ON TRANSFER CURVE	10.000	
PERCENT TOTAL LIQUID IN OUTLET	100.000	%

STREAM CROSS REFERENCE.

STREAM 70 COMES FROM BLOCK	32.00 (DEC2 TOWER	)
STREAM 72 GOES TO BLOCK	0.00 (OUTLET	)

BLOCK NUMBER: 34.00 TYPE: TEST NAME: TEST34.0 STATUS: CURRENT

* Type of Test	REID	
Reid Vapor Pressure	34.392	PSIA
True Vapor Pressure @ 100F(38C)	38.536	PSIA

STREAM CROSS REFERENCE.

STREAM 72 COMES FROM BLOCK	33.00 (DEC2 COOLER	)
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BLOCK NUMBER: 35.00 TYPE: JTVL NAME: DEC2 PCV STATUS: CURRENT

PRESSURE AT OUTLET	200.000	PSIA
* PRESSURE DROP FROM INLET	0.000	PSI
TEMPERATURE	54.973	F
PERCENTAGE LIQUID	0.000	%

STREAM CROSS REFERENCE.

STREAM 80 COMES FROM BLOCK	32.00 (DEC2 TOWER	)
STREAM 82 GOES TO BLOCK	36.00 (RCYL36.0	)

BLOCK NUMBER: 36.00 TYPE: RCYL NAME: RCYL36.0 STATUS: CURRENT

* MAXIMUM NUMBER OF RECYCLE LOOPS	30.000	
* ERROR TOLERANCE	1.000	%
CURRENT LOOP	1.000	
CURRENT ERROR	0.297	%
LIMITING VARIABLE	TEMPERATURE	
* WEGSTEIN QMAX	0.000	
* WEGSTEIN QMIN	-9.000	

STREAM CROSS REFERENCE.

STREAM 82 COMES FROM BLOCK	35.00 (DEC2 PCV	)
STREAM 83 GOES TO BLOCK	1.00 (MIXR1.0	)

BLOCK NUMBER: 38.00 TYPE: TEST NAME: TEST38.0 STATUS: CURRENT

* Type of Test	PHASE	
* Number of Test Stages	1.000	
* Type of stages	RATIO	
* Lowest Pressure	200.000	PSIA
* Final Temperature	-40.000	F
* Start Vapor Quality	100.000	%
Cricondenbar Temperature	-44.746	F
Cricondenbar Pressure	1071.964	PSIA
Cricondentherm Temperature	-1.218	F
Cricondentherm Pressure	483.805	PSIA
Critical Temperature	-81.116	F
Critical Pressure	913.043	PSIA
* Dry basis used in calculations?	YES	
* Number of points on Solids Line	0.000	

STREAM CROSS REFERENCE.

STREAM 54 COMES FROM BLOCK	17.00 (COMP CLR3	)
----------------------------	------------------	---

BLOCK NUMBER: 40.00 TYPE: JTVL NAME: CHILLER LCV STATUS: CURRENT

* PRESSURE AT OUTLET	28.500	PSIA
PRESSURE DROP FROM INLET	190.700	PSI
TEMPERATURE	-14.477	F
PERCENTAGE LIQUID	55.521	%

STREAM CROSS REFERENCE.

STREAM 202 COMES FROM BLOCK	30.01 (subcoolr-1	)
STREAM 203 GOES TO BLOCK	41.00 (C3 CHILLER	)

BLOCK NUMBER: 41.00 TYPE: EXCH NAME: C3 CHILLER STATUS: CURRENT

* PRESSURE DROP	0.000	PSI
CHANGE IN TEMPERATURE	1.108	F
OUTLET TEMPERATURE	-13.369	F
DUTY	465664.605	BTU/HR
* PERCENT TOTAL LIQUID IN OUTLET	0.000	%

STREAM CROSS REFERENCE.

STREAM 203 COMES FROM BLOCK	40.00 (CHILLER LCV	)
STREAM 204 GOES TO BLOCK	42.00 (C3 COMP	)

BLOCK NUMBER: 42.00 TYPE: TRBN NAME: C3 COMP STATUS: CURRENT

ADIABATIC EFFICIENCY	68.406	%
* POLYTROPIC EFFICIENCY	71.000	%
* MECHANICAL EFFICIENCY	100.000	%
* OUTLET PRESSURE	220.000	PSIA
CHANGE IN PRESSURE	191.500	PSI
BRAKE POWER	111.524	HORSEPOWER
COMPRESSION RATIO	7.719	
ACTUAL TEMPERATURE RISE	176.987	F
OUTLET TEMPERATURE	163.618	F
PERCENT LIQUID IN DISCHARGE	0.000	%
INLET FLOW RATE	281.076	ACFM
OUTLET FLOW RATE	44.580	ACFM
ISENTROPIC EXPONENT	1.068	
POLYTROPIC EXPONENT	1.110	
ADIABATIC HEAD	32345.060	FT
POLYTROPIC HEAD	33571.698	FT

STREAM CROSS REFERENCE.

STREAM 204 COMES FROM BLOCK	41.00 (C3 CHILLER	)
STREAM 205 GOES TO BLOCK	43.00 (C3 COND	)

BLOCK NUMBER: 43.00 TYPE: EXCH NAME: C3 COND STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
CHANGE IN TEMPERATURE	-55.460	F
OUTLET TEMPERATURE	108.158	F
* DUTY	-733300.000	BTU/HR
* INCREMENTS ON TRANSFER CURVE	10.000	
PERCENT TOTAL LIQUID IN OUTLET	98.897	%

STREAM CROSS REFERENCE.

STREAM 205 COMES FROM BLOCK	42.00 (C3 COMP	)
STREAM 206 GOES TO BLOCK	44.00 (C3 ACCUM	)

BLOCK NUMBER: 44.00 TYPE: FLSH NAME: C3 ACCUM STATUS: CURRENT

* TEMPERATURE	110.000	F
PRESSURE	220.123	PSIA
* PERCENTAGE LIQUID	100.000	%
DUTY	-48.739	BTU/HR

STREAM CROSS REFERENCE.

STREAM 206 COMES FROM BLOCK	43.00 (C3 COND	)
STREAM 211 GOES TO BLOCK	0.00 (OUTLET	)
STREAM 210 GOES TO BLOCK	0.00 (OUTLET	)



BLOCK NUMBER: 50.00 TYPE: EXCH NAME: refluxts STATUS: CURRENT

* PRESSURE DROP	5.000	PSI
* COMPLEX EXCH. OR DUTY FROM	54.000	
CHANGE IN TEMPERATURE	21.440	F
OUTLET TEMPERATURE	19.289	F
DUTY	12755.912	BTU/HR
APPROACH TEMPERATURE	218.723	F
LOG MEAN TEMPERATURE DIFFERENCE	217.237	F
APPROACH/UA TOLERANCE	5.000	%
* INITIAL TEMPERATURE GUESS	19.289	F
* MINIMUM ALLOWABLE APPROACH	1.000	F
* OTHER SIDE IS CONDENSER	YES	
ENDPOINT UA	58.719	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	99.876	%

STREAM CROSS REFERENCE.

STREAM 311 COMES FROM BLOCK	25.00 (glylcv	)
STREAM 312 GOES TO BLOCK	51.01 (leanrich-1	)

BLOCK NUMBER: 51.00 TYPE: EXCH NAME: leanrich STATUS: CURRENT

* PRESSURE DROP	0.000	PSI
* COMPLEX EXCH. OR DUTY FROM	51.010	
CHANGE IN TEMPERATURE	-139.652	F
OUTLET TEMPERATURE	113.135	F
DUTY	-82278.976	BTU/HR
APPROACH TEMPERATURE	93.846	F
LOG MEAN VISCOSITY	2.139	CP
LOG MEAN THERMAL CONDUCTIVITY	0.181	BTU/FT HR F
MEAN HEAT CAPACITY	0.732	BTU/F LB
LOG MEAN DENSITY	64.891	LB/FT^3
LOG MEAN TEMPERATURE DIFFERENCE	95.802	F
APPROACH/UA TOLERANCE	5.000	%
* INITIAL TEMPERATURE GUESS	113.135	F
* MINIMUM ALLOWABLE APPROACH	1.000	F
ENDPOINT UA	858.840	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	100.000	%

STREAM CROSS REFERENCE.

STREAM 330 COMES FROM BLOCK	54.00 (regen	)
STREAM 331 GOES TO BLOCK	55.00 (EG INJ PUMP	)

BLOCK NUMBER: 51.01 TYPE: EXCH NAME: leanrich-1 STATUS: CURRENT

* PRESSURE DROP	20.000	PSI
* COMPLEX EXCH. OR DUTY FROM	51.000	
CHANGE IN TEMPERATURE	135.711	F
* OUTLET TEMPERATURE	155.000	F
DUTY	82278.976	BTU/HR
APPROACH TEMPERATURE	93.846	F
LOG MEAN TEMPERATURE DIFFERENCE	95.802	F
APPROACH/UA TOLERANCE	5.000	%
MINIMUM ALLOWABLE APPROACH	1.000	F
ENDPOINT UA	858.840	BTU/HR F
PERCENT TOTAL LIQUID IN OUTLET	99.810	%

STREAM CROSS REFERENCE.

STREAM 312 COMES FROM BLOCK	50.00 (refluxts	)
STREAM 313 GOES TO BLOCK	52.00 (flashtnk	)

BLOCK NUMBER: 52.00 TYPE: FLSH NAME: flashtnk STATUS: CURRENT

TEMPERATURE	154.972	F
* PRESSURE	65.000	PSIA
PERCENTAGE LIQUID	99.828	%
* DUTY	0.000	BTU/HR
* LIQUID IS PRIMARILY OIL	NO	

STREAM CROSS REFERENCE.

STREAM 313 COMES FROM BLOCK	51.01 (leanrich-1	)
STREAM 315 GOES TO BLOCK	0.00 (OUTLET	)
STREAM 314 GOES TO BLOCK	0.00 (OUTLET	)
STREAM 316 GOES TO BLOCK	53.00 (flshlcv	)

BLOCK NUMBER: 53.00 TYPE: JTVL NAME: flshlcv STATUS: CURRENT

* PRESSURE AT OUTLET	20.000	PSIA
PRESSURE DROP FROM INLET	45.000	PSI
TEMPERATURE	155.079	F
PERCENTAGE LIQUID	99.953	%
JOULE THOMSON COEFFICIENT	-0.002374	F/PSI

STREAM CROSS REFERENCE.

STREAM 316 COMES FROM BLOCK	52.00 (flashtnk	)
STREAM 317 GOES TO BLOCK	54.00 (regen	)

BLOCK NUMBER: 54.00 TYPE: STILL NAME: regen STATUS: CURRENT

* NUMBER OF IDEAL STAGES	4.000	
* PRESSURE	14.000	PSIA
* PRESSURE DROP	0.000	PSI
* PACKING FACTOR	48.000	1/FT
* PERCENT OF FLOOD	70.000	%
* ERROR TOLERANCE	1.0000E-05	%
* REBOILER PRESSURE DROP	0.000	PSI
REBOILER DUTY	119942.372	BTU/HR
PERCENT OF FEED TO BOTTOMS	87.980	%
BOTTOMS FLOW RATE	19.317	LEMOL/HR
BOTTOMS TEMPERATURE	252.786	F
* CONDENSER TYPE OR % LIQUID	0.000	%
* CONDENSER PRESSURE DROP	0.000	PSI
CONDENSER HEAT DUTY	-12756.007	BTU/HR
COND COMPLEX EXCH. OR DUTY FROM	50.000	
PERCENTAGE OF FEED TO OVERHEADS	12.020	%
OVERHEAD FLOW RATE	2.639	LEMOL/HR
OVERHEAD TEMPERATURE	213.608	F
CONDENSER MINIMUM APPROACH	1.000	F
CONDENSER APPROACH TEMPERATURE	218.723	F
CONDENSER LMTD	217.238	F
* REFLUX RATIO	0.250	
* TOP TEMPERATURE ESTIMATE	200.000	F
* BOTTOM TEMPERATURE ESTIMATE	255.000	F
* RECALCULATE INITIAL PROFILES	NO	
* ALTERNATE INITIAL PROFILES	NO	
* T AT SECOND STAGE GUESS	210.000	F
CONDENSER ENDEPOINT UA	58.719	BTU/HR F
* VAPOR STAGE EFFICIENCY	YES	
* MAXIMUM NUMBER OF STEPS	150.000	
* COLUMN SYSTEM FACTOR	1.000	

SPECIFICATION=ETHYLENE GLYCOL, STAGE=BOTTOM, COMA= 80.000000

STREAM CROSS REFERENCE.

STREAM 317 COMES FROM BLOCK	53.00 (flshlcv	)	TO STAGE	2
STREAM 320 GOES TO BLOCK	0.00 (OUTLET	)		
STREAM 330 GOES TO BLOCK	51.00 (leanrich	)		
INTERNAL STREAM	38 COMES FROM CONDENSER AND GOES TO STAGE	2		
INTERNAL STREAM	47 COMES FROM REBOILER AND GOES TO STAGE	3		
INTERNAL STREAM	37 COMES FROM STAGE	2 AND GOES TO CONDENSER		
INTERNAL STREAM	39 COMES FROM STAGE	3 AND GOES TO REBOILER		

BLOCK NUMBER: 55.00 TYPE: PUMP NAME: EG INJ PUMP STATUS: CURRENT

* OVERALL EFFICIENCY	75.000	%
* PRESSURE AT OUTLET	1163.000	PSIA
CHANGE IN PRESSURE	1149.000	PSI
DYNAMIC HEAD	2473.990	FT
BRAKE POWER	1.342	HORSEPOWER

STREAM CROSS REFERENCE.

STREAM 331 COMES FROM BLOCK	51.00 (leanrich	)
STREAM 332 GOES TO BLOCK	56.00 (header	)

BLOCK NUMBER: 56.00 TYPE: RCYL NAME: header STATUS: CURRENT

* MAXIMUM NUMBER OF RECYCLE LOOPS	40.000
* ERROR TOLERANCE	2.000 %
CURRENT LOOP	1.000
CURRENT ERROR	0.321 %
LIMITING VARIABLE	TEMPERATURE
* FLOW RATE UNITS	LIQUID FLOW RATE
* RECYCLE FLOWRATE	1.500 GPM
MATERIAL MADE UP	0.000644 GPM
* WEGSTEIN QMAX	0.000
* WEGSTEIN QMIN	-9.000

STREAM CROSS REFERENCE.

STREAM 332 COMES FROM BLOCK	55.00 (EG INJ PUMP	)
STREAM 300 COMES FROM BLOCK	0.00 (INLET	)
STREAM 302 GOES TO BLOCK	57.00 (manifold	)
STREAM 301 GOES TO BLOCK	0.00 (OUTLET	)

BLOCK NUMBER: 57.00 TYPE: SPLT NAME: manifold STATUS: CURRENT

* PRESSURE DROP	0.000 PSI
* FIRST STREAM	67.000 %
SECOND STREAM	33.000 %

STREAM CROSS REFERENCE.

STREAM 302 COMES FROM BLOCK	56.00 (header	)
STREAM 304 GOES TO BLOCK	20.00 (glymix1	)
STREAM 303 GOES TO BLOCK	22.00 (glymix2	)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005  
 GENERAL STREAM LIST

STREAM NUMBER	1 TOTAL S001	3 TOTAL	10 TOTAL	11 TOTAL	12 TOTAL	15 TOTAL	16 TOTAL
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	0.1996	0.1992	0.1992	0.1992	0.1992	0.1992	0.1992
HELIUM	2.9940E-02	2.9879E-02	2.9879E-02	2.9879E-02	2.9879E-02	2.9879E-02	2.9879E-02
NITROGEN	0.8982	0.8967	0.8967	0.8967	0.8967	0.8967	0.8967
CARBON DIOXIDE	1.996	2.001	2.001	2.001	2.001	2.001	2.001
METHANE	90.19	90.13	90.13	90.13	90.13	90.13	90.13
ETHANE	4.501	4.537	4.537	4.537	4.537	4.537	4.537
PROPANE	1.327	1.340	1.340	1.340	1.340	1.340	1.340
I-BUTANE	0.2495	0.2520	0.2520	0.2520	0.2520	0.2520	0.2520
N-BUTANE	0.2595	0.2621	0.2621	0.2621	0.2621	0.2621	0.2621
I-PENTANE	9.9801E-02	0.1006	0.1006	0.1006	0.1006	0.1006	0.1006
N-PENTANE	7.9841E-02	8.0484E-02	8.0484E-02	8.0484E-02	8.0484E-02	8.0484E-02	8.0484E-02
N-HEXANE	7.9841E-02	8.0124E-02	8.0124E-02	8.0124E-02	8.0124E-02	8.0124E-02	8.0124E-02
N-HEPTANE	5.9880E-02	5.9893E-02	5.9893E-02	5.9893E-02	5.9893E-02	5.9893E-02	5.9893E-02
N-OCTANE	2.9940E-02	2.9900E-02	2.9900E-02	2.9900E-02	2.9900E-02	2.9900E-02	2.9900E-02
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	0.0000E+00	2.6340E-08	2.6340E-08	2.6340E-08	2.6340E-08	2.6340E-08	2.6340E-08
TEMPERATURE F	60.0	60.0	60.0	148.0	120.0	120.0	291.2
PRESSURE PSIA	134.0	134.0	134.0	249.0	244.0	244.0	719.0
PERCENT LIQUID (A) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	1320.2	1323.2	1323.2	1323.2	1323.2	1323.2	1323.2
FLOW LB/HR	23978.5	24049.2	24049.2	24049.2	24049.2	24049.2	24049.2
MOLE WT LB/LEMOLE	18.2	18.2	18.2	18.2	18.2	18.2	18.2
DENSITY LB/FT^3	0.4462	0.4465	0.4465	0.7092	0.7318	0.7318	1.6479
Z FACTOR	0.9782	0.9782	0.9782	0.9787	0.9743	0.9743	0.9843
FLOW ACFH	53742.2	53856.6	53860.4	33909.3	32863.6	32863.6	14594.2
FLOW MMSCFD	12.0240	12.0509	12.0509	12.0509	12.0509	12.0509	12.0509
FLOW GPM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD FLOW GPM @60F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD FLOW BBL/D @60F	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENTHALPY BTU/HR	5.501E+06	5.514E+06	5.514E+06	6.568E+06	6.202E+06	6.202E+06	8.366E+06
ENTHALPY BTU/LB	229.4	229.3	229.3	273.1	257.9	257.9	347.9
CP BTU/F LB	0.5205	0.5204	0.5204	0.5531	0.5459	0.5459	0.6204
IDEAL GAS CP/CV	1.2763	1.2762	1.2762	1.2579	1.2637	1.2637	1.2295
VISCOSITY CP	0.01097	0.01097	0.01097	0.01261	0.01214	0.01214	0.01533
K BTU/FT HR F	0.01850	0.01849	0.01849	0.02248	0.02130	0.02130	0.03005
SURTN DYNES/CM	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FROM BLOCK	INLET	MIXR1.0	INLET SEP	COMP1	COMP CLR1	FLSH12.0	COMP2
TO BLOCK	MIXR1.0	INLET SEP	COMP1	COMP CLR1	FLSH12.0	COMP2	COMP CLR2

STREAM NUMBER	17 TOTAL	19 TOTAL	30 TOTAL	30 VAPOR	30 LIQ A	31 TOTAL	31 VAPOR
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	0.1992	0.1992	0.6457	0.1368	49.45	0.6457	4.2825E-03
HELIUM	2.9879E-02	2.9879E-02	2.9589E-02	2.9897E-02	1.6586E-05	2.9589E-02	3.0007E-02
NITROGEN	0.8967	0.8967	0.8880	0.8972	1.8139E-03	0.8880	0.9004
CARBON DIOXIDE	2.001	2.001	1.981	2.002	4.7601E-02	1.981	2.004
METHANE	90.13	90.13	89.26	90.19	0.1616	89.26	90.46
ETHANE	4.537	4.537	4.493	4.540	1.1707E-02	4.493	4.538
PROPANE	1.340	1.340	1.327	1.341	2.9502E-03	1.327	1.326
I-BUTANE	0.2520	0.2520	0.2496	0.2522	3.2679E-04	0.2496	0.2445
N-BUTANE	0.2621	0.2621	0.2596	0.2623	5.9992E-04	0.2596	0.2507
I-PENTANE	0.1006	0.1006	9.9672E-02	0.1007	1.6477E-04	9.9672E-02	9.0047E-02
N-PENTANE	8.0484E-02	8.0484E-02	7.9704E-02	8.0534E-02	1.7248E-04	7.9704E-02	6.9530E-02
N-HEXANE	8.0124E-02	8.0124E-02	7.9347E-02	8.0172E-02	2.1263E-04	7.9347E-02	5.2076E-02
N-HEPTANE	5.9893E-02	5.9893E-02	5.9312E-02	5.9929E-02	1.7262E-04	5.9312E-02	2.2600E-02
N-OCTANE	2.9900E-02	2.9900E-02	2.9611E-02	2.9918E-02	1.3120E-04	2.9611E-02	5.2164E-03
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	2.6340E-08	2.6340E-08	0.5206	1.3336E-03	50.32	0.5206	5.4234E-06
TEMPERATURE F	120.0	120.0	120.9	120.9	120.9	14.8	14.8
PRESSURE PSIA	714.0	714.0	714.0	714.0	714.0	712.0	712.0
PERCENT LIQUID (A) %	0.0	0.0	1.0	0.0	100.0	0.2	0.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	1.2	0.0
FLOW LBMOL/HR	1323.2	1323.2	1336.1	1322.3	13.8	1336.1	1317.4
FLOW LB/HR	24049.2	24049.2	24589.0	24034.7	554.3	24589.0	23810.4
MOLE WT LB/LBMOLE	18.2	18.2	18.4	18.2	40.2	18.4	18.1
DENSITY LB/FT^3	2.2449	2.2449	2.2902	2.2403	66.4581	3.1024	3.0093
Z FACTOR	0.9294	0.9294	0.9210	0.9299	0.0693	0.8296	0.8400
FLOW ACFH	10712.6	10712.6	10736.6	10728.2	8.3	7925.7	7912.2
FLOW MMSCFD	12.0509	12.0509	0.0000	12.0432	0.0000	0.0000	11.9982
FLOW GPM	0.0000	0.0000	0.0000	0.0000	1.0398	0.0000	0.0000
STD FLOW GPM @60F	0.0000	0.0000	0.0000	0.0000	1.0202	0.0000	0.0000
STD FLOW BBL/D @60F	0.0	0.0	0.0	0.0	35.0	0.0	0.0
ENTHALPY BTU/HR	5.884E+06	5.884E+06	5.693E+06	5.893E+06	-2.001E+05	4.045E+06	4.321E+06
ENTHALPY BTU/LB	244.6	244.6	231.5	245.2	-361.0	164.5	181.5
CP BTU/F LB	0.5958	0.5958	0.0000	0.5958	0.7086	0.0000	0.6406
IDEAL GAS CP/CV	1.2637	1.2637	1.2624	1.2635	1.1888	1.2846	1.2868
VISCOSITY CP	0.01286	0.01286	0.00000	0.01287	3.46652	0.00000	0.01142
K BTU/FT HR F	0.02297	0.02297	0.00000	0.02301	0.18296	0.00000	0.01958
SURTN DYNES/CM	0.00	0.00	0.00	0.00	49.43	0.00	0.00
FROM BLOCK	COMP CLR2	SEP	glymix1	glymix1	glymix1	gasgasts	gasgasts
TO BLOCK	SEP	glymix1	gasgasts	gasgasts	gasgasts	glymix2	glymix2

STREAM NUMBER	31 LIQ A	31 LIQ B	33 TOTAL FROM RBLR	34 TOTAL TO RBLR	35 TOTAL	35 VAPOR	35 LIQ A
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	3.9330E-03	55.07	3.0801E-08	1.6736E-08	0.8625	4.2561E-03	3.8939E-03
HELIUM	1.1343E-03	2.8627E-06	0.0000E+00	0.0000E+00	2.9448E-02	3.0004E-02	1.1370E-03
NITROGEN	0.1013	1.2037E-03	0.0000E+00	0.0000E+00	0.8838	0.9003	0.1014
CARBON DIOXIDE	1.626	0.1081	1.5517E-05	8.2959E-06	1.972	2.004	1.610
METHANE	26.30	0.1195	1.1495E-08	5.9306E-09	88.83	90.46	26.13
ETHANE	8.053	1.0200E-02	1.440	0.8224	4.472	4.538	7.966
PROPANE	8.021	2.4782E-03	37.80	24.75	1.321	1.327	7.919
I-BUTANE	3.599	2.0469E-04	13.00	10.00	0.2484	0.2449	3.551
N-BUTANE	5.247	4.3041E-04	16.56	13.63	0.2584	0.2513	5.176
I-PENTANE	4.592	1.0863E-04	8.772	9.204	9.9199E-02	9.0630E-02	4.539
N-PENTANE	4.702	1.3771E-04	7.844	8.689	7.9326E-02	7.0110E-02	4.656
N-HEXANE	11.81	1.1427E-04	8.391	14.06	7.8970E-02	5.3274E-02	11.81
N-HEPTANE	15.62	7.2504E-05	4.708	12.43	5.9030E-02	2.3572E-02	15.89
N-OCTANE	10.32	2.4512E-05	1.484	6.405	2.9470E-02	5.5267E-03	10.64
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	4.5007E-04	44.69	2.5391E-04	2.6186E-04	0.7734	6.1923E-06	5.0880E-04
TEMPERATURE F	14.8	14.8	258.9	204.2	15.9	15.9	15.9
PRESSURE PSIA	712.0	712.0	201.0	201.0	712.0	712.0	712.0
PERCENT LIQUID (A) %	100.0	0.0	0.0	100.0	0.2	0.0	100.0
PERCENT LIQUID (B) %	0.0	100.0	0.0	0.0	1.6	0.0	0.0
FLOW LBMOL/HR	3.2	15.6	3.1	6.5	1342.5	1317.5	3.0
FLOW LB/HR	191.3	587.3	187.1	454.6	24854.8	23816.8	184.3
MOLE WT LB/LBMOLE	60.4	37.7	59.9	69.7	18.5	18.1	60.8
DENSITY LB/FT^3	38.0553	68.6352	1.9097	32.9947	3.1216	2.9977	38.0984
Z FACTOR	0.2219	0.0769	0.8179	0.0596	0.8275	0.8414	0.2226
FLOW ACFH	5.0	8.6	98.0	13.8	7962.3	7945.0	4.8
FLOW MMSCFD	0.0000	0.0000	0.0284	0.0000	0.0000	11.9993	0.0000
FLOW GPM	0.6266	1.0668	0.0000	1.7177	0.0000	0.0000	0.6032
STD FLOW GPM @60F	0.6529	1.0860	0.0000	1.4781	0.0000	0.0000	0.6277
STD FLOW BBL/D @60F	22.4	37.2	0.0	50.7	0.0	0.0	21.5
ENTHALPY BTU/HR	-7.335E+03	-2.689E+05	3.898E+04	2.684E+04	3.951E+06	4.338E+06	-6.988E+03
ENTHALPY BTU/LB	-38.3	-457.9	208.3	59.0	159.0	182.2	-37.9
CP BTU/F LB	0.5387	0.7046	0.5551	0.6829	0.0000	0.6394	0.5385
IDEAL GAS CP/CV	1.0957	1.2259	1.0699	1.0638	1.2839	1.2866	1.0949
VISCOSITY CP	0.21847	33.15897	0.01070	0.11191	0.00000	0.01144	0.21958
K BTU/FT HR F	0.08254	0.18059	0.01664	0.05701	0.00000	0.01960	0.08242
SURTN DYNES/CM	9.86	55.65	0.00	6.55	0.00	0.00	9.90
FROM BLOCK	gasgasts	gasgasts	DEC2 TOWER	DEC2 TOWER	glymix2	glymix2	glymix2
TO BLOCK	glymix2	glymix2	DEC2 TOWER	DEC2 TOWER	chiller	chiller	chiller

STREAM NUMBER	35 LIQ B	36 TOTAL	36 VAPOR	36 LIQ A	36 LIQ B	37 TOTAL S037	38 TOTAL S038
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	52.47	0.8625	1.7039E-03	1.6629E-03	52.54	97.65	91.76
HELIUM	3.2705E-06	2.9448E-02	3.0078E-02	1.0814E-03	2.2123E-06	5.1169E-07	0.0000E+00
NITROGEN	1.1912E-03	0.8838	0.9023	0.1020	1.0493E-03	7.6218E-04	2.8376E-08
CARBON DIOXIDE	0.1084	1.972	2.003	1.925	0.1333	0.4885	1.4253E-04
METHANE	0.1202	88.83	90.60	29.75	0.1058	7.1069E-02	1.9854E-06
ETHANE	1.0377E-02	4.472	4.521	9.767	9.2524E-03	9.2850E-03	2.8731E-07
PROPANE	2.5016E-03	1.321	1.300	10.05	2.0734E-03	2.0206E-03	4.5479E-08
I-BUTANE	2.1120E-04	0.2484	0.2319	4.523	1.5584E-04	1.0835E-04	1.3375E-09
N-BUTANE	4.4294E-04	0.2584	0.2324	6.527	3.3668E-04	3.8409E-04	1.0203E-08
I-PENTANE	1.1311E-04	9.9199E-02	7.5427E-02	5.361	7.3351E-05	6.8698E-05	0.0000E+00
N-PENTANE	1.4409E-04	7.9326E-02	5.5725E-02	5.237	9.5065E-05	1.0656E-04	1.3052E-09
N-HEXANE	1.2409E-04	7.8970E-02	3.0362E-02	10.41	5.8040E-05	8.5815E-05	1.5172E-09
N-HEPTANE	8.1783E-05	5.9030E-02	9.6320E-03	10.48	2.8065E-05	4.4857E-05	0.0000E+00
N-OCTANE	2.9111E-05	2.9470E-02	1.8155E-03	5.854	8.2081E-06	1.8973E-05	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	47.28	0.7734	1.5488E-06	1.4955E-04	47.21	1.781	8.240
TEMPERATURE F	15.9	-5.0	-5.0	-5.0	-5.0	238.0	213.6
PRESSURE PSIA	712.0	707.0	707.0	707.0	707.0	14.0	14.0
PERCENT LIQUID(A) %	0.0	0.5	0.0	100.0	0.0	0.0	100.0
PERCENT LIQUID(B) %	100.0	1.6	0.0	0.0	100.0	0.0	0.0
FLOW LEMOL/HR	22.0	1342.5	1314.2	6.4	22.0	3.3	0.7
FLOW LB/HR	853.6	24854.8	23662.2	338.2	854.4	62.4	14.3
MOLE WT LB/LBMOLE	38.9	18.5	18.0	53.3	38.8	18.9	21.6
DENSITY LB/FT^3	68.8125	3.3613	3.2094	37.1373	69.2856	0.0357	60.5261
Z FACTOR	0.0788	0.7982	0.8130	0.2078	0.0812	0.9927	0.0007
FLOW ACFH	12.4	7394.3	7372.9	9.1	12.3	1751.2	0.2
FLOW MMSCFD	0.0000	0.0000	11.9687	0.0000	0.0000	0.0300	0.0000
FLOW GPM	1.5466	0.0000	0.0000	1.1354	1.5374	0.0000	0.0294
STD FLOW GPM @60F	1.5748	0.0000	0.0000	1.2130	1.5762	0.0000	0.0278
STD FLOW BBL/D @60F	54.0	0.0	0.0	41.6	54.0	0.0	1.0
ENTHALPY BTU/HR	-3.806E+05	3.601E+06	4.010E+06	-1.544E+04	-3.937E+05	1.881E+04	-8.039E+03
ENTHALPY BTU/LB	-445.9	144.9	169.5	-45.7	-460.8	301.2	-562.9
CP BTU/F LB	0.6959	0.0000	0.6651	0.5454	0.6969	0.4520	0.9261
IDEAL GAS CP/CV	1.2216	1.2882	1.2918	1.1122	1.2249	1.3049	1.2741
VISCOSITY CP	34.75256	0.0000	0.01119	0.19618	71.26511	0.01335	0.38521
K BTU/FT HR F	0.17749	0.0000	0.01906	0.08467	0.17729	0.01503	0.31936
SURFN DYNES/CM	55.14	0.00	0.00	9.24	56.20	0.00	53.00
FROM BLOCK	glymix2	chiller	chiller	chiller	chiller	regen	regen
TO BLOCK	chiller	ltsep	ltsep	ltsep	ltsep	regen	regen

STREAM NUMBER	39 TOTAL S039	40 TOTAL?	41 TOTAL	41 VAPOR	41 LIQ A	42 TOTAL	42 VAPOR
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	58.62	1.6629E-03	1.6629E-03	2.4920E-03	1.5166E-03	1.6629E-03	3.2527E-03
HELIUM	0.0000E+00	1.0814E-03	1.0814E-03	5.6822E-03	2.6946E-04	1.0814E-03	2.9285E-03
NITROGEN	0.0000E+00	0.1020	0.1020	0.4248	4.4985E-02	0.1020	0.2680
CARBON DIOXIDE	2.1381E-07	1.925	1.925	3.072	1.722	1.925	3.832
METHANE	0.0000E+00	29.75	29.75	81.64	20.59	29.75	71.89
ETHANE	0.0000E+00	9.767	9.767	8.810	9.936	9.767	14.02
PROPANE	0.0000E+00	10.05	10.05	3.564	11.20	10.05	6.372
I-BUTANE	0.0000E+00	4.523	4.523	0.7716	5.185	4.523	1.278
N-BUTANE	0.0000E+00	6.527	6.527	0.8434	7.530	6.527	1.327
I-PENTANE	0.0000E+00	5.361	5.361	0.3271	6.250	5.361	0.4320
N-PENTANE	0.0000E+00	5.237	5.237	0.2617	6.115	5.237	0.3295
N-HEXANE	0.0000E+00	10.41	10.41	0.1842	12.22	10.41	0.1806
N-HEPTANE	0.0000E+00	10.48	10.48	7.3584E-02	12.32	10.48	5.5492E-02
N-OCTANE	0.0000E+00	5.854	5.854	1.6923E-02	6.884	5.854	9.9526E-03
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECAANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	41.38	1.4955E-04	1.4955E-04	7.6290E-06	1.7460E-04	1.4955E-04	1.0301E-05
TEMPERATURE F	238.8	-5.0	70.0	70.0	70.0	49.1	49.1
PRESSURE PSIA	14.0	707.0	706.0	706.0	706.0	200.0	200.0
PERCENT LIQUID (A) %	100.0	100.0	85.0	0.0	100.0	63.7	0.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	25.6	6.4	6.4	1.0	5.4	6.4	2.3
FLOW LB/HR	928.5	338.2	338.2	19.4	318.8	338.2	52.1
MOLE WT LB/LBMOLE	36.2	53.3	53.3	20.4	59.0	53.3	22.6
DENSITY LB/FT^3	62.7534	37.1373	21.9202	2.9419	36.1369	5.0778	0.8790
Z FACTOR	0.0011	0.2078	0.3018	0.8616	0.2030	0.3842	0.9423
FLOW ACFH	14.8	9.1	15.4	6.6	8.8	66.6	59.3
FLOW MMSCFD	0.0000	0.0000	0.0000	0.0087	0.0000	0.0000	0.0210
FLOW GPM	1.8447	1.1354	0.0000	0.0000	1.0997	0.0000	0.0000
STD FLOW GPM @60F	1.7190	1.2130	0.0000	0.0000	1.1012	0.0000	0.0000
STD FLOW BBL/D @60F	58.9	41.6	0.0	0.0	37.8	0.0	0.0
ENTHALPY BTU/HR	-2.878E+05	-1.544E+04	6.340E+02	3.749E+03	-3.115E+03	6.340E+02	9.712E+03
ENTHALPY BTU/LB	-310.0	-45.7	1.9	192.8	-9.8	1.9	186.4
CP BTU/F LB	0.7957	0.5454	0.0000	0.5989	0.5806	0.0000	0.4879
IDEAL GAS CP/CV	1.1689	1.1122	1.1001	1.2515	1.0905	1.1032	1.2377
VISCOSITY CP	0.78470	0.19618	0.00000	0.01212	0.16180	0.00000	0.01047
K BTU/FT HR F	0.20158	0.08467	0.00000	0.02022	0.07644	0.00000	0.01617
SURTN DYNES/CM	44.37	9.24	0.00	0.00	8.21	0.00	0.00
FROM BLOCK	regen	ltsep	subcoolr	subcoolr	subcoolr	hclcv	hclcv
TO BLOCK	regen	subcoolr	hclcv	hclcv	hclcv	DEC2 TOWER	DEC2 TOWER

? SOLIDS MAY FORM IN THIS STREAM.



STREAM NUMBER	42 LIQ A	47 TOTAL S047	50 TOTAL	51 TOTAL?	53 TOTAL	54 TOTAL	55 TOTAL?
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	7.5692E-04	96.46	1.7039E-03	1.7039E-03	1.7039E-03	1.7039E-03	1.7039E-03
HELIUM	2.8791E-05	0.0000E+00	3.0078E-02	3.0078E-02	3.0078E-02	3.0078E-02	3.0078E-02
NITROGEN	7.3750E-03	0.0000E+00	0.9023	0.9023	0.9023	0.9023	0.9023
CARBON DIOXIDE	0.8374	8.6847E-07	2.003	2.003	2.003	2.003	2.003
METHANE	5.740	2.8850E-09	90.60	90.60	90.60	90.60	90.60
ETHANE	7.343	0.0000E+00	4.521	4.521	4.521	4.521	4.521
PROPANE	12.15	0.0000E+00	1.300	1.300	1.300	1.300	1.300
I-BUTANE	6.373	0.0000E+00	0.2319	0.2319	0.2319	0.2319	0.2319
N-BUTANE	9.490	0.0000E+00	0.2324	0.2324	0.2324	0.2324	0.2323
I-PENTANE	8.170	0.0000E+00	7.5427E-02	7.5427E-02	7.5427E-02	7.5427E-02	7.5379E-02
N-PENTANE	8.034	0.0000E+00	5.5725E-02	5.5725E-02	5.5725E-02	5.5725E-02	5.5678E-02
N-HEXANE	16.24	0.0000E+00	3.0362E-02	3.0362E-02	3.0362E-02	3.0362E-02	3.0273E-02
N-HEPTANE	16.43	0.0000E+00	9.6320E-03	9.6320E-03	9.6320E-03	9.6320E-03	9.5483E-03
N-OCTANE	9.184	0.0000E+00	1.8155E-03	1.8155E-03	1.8155E-03	1.8155E-03	1.7723E-03
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	2.2890E-04	3.540	1.5488E-06	1.5488E-06	1.5488E-06	1.5488E-06	1.5475E-06
TEMPERATURE F	49.1	252.8	107.0	-5.0	195.4	120.0	-9.7
PRESSURE PSIA	200.0	14.0	692.0	707.0	1219.0	1214.0	813.0
PERCENT LIQUID (A) %	100.0	0.0	0.0	0.0	0.0	0.0	0.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	4.0	6.3	1314.2	1314.2	1314.2	1314.2	1314.1
FLOW LB/HR	286.1	123.3	23662.2	23662.2	23662.2	23662.2	23661.6
MOLE WT LB/LBMOLE	70.7	19.6	18.0	18.0	18.0	18.0	18.0
DENSITY LB/FT^3	39.1302	0.0361	2.2130	3.2094	3.3067	3.9294	3.9112
Z FACTOR	0.0662	0.9928	0.9260	0.8130	0.9444	0.8944	0.7751
FLOW ACFH	7.3	3415.2	10692.4	7372.9	7155.8	6021.8	6049.7
FLOW MMSCFD	0.0000	0.0574	11.9687	11.9687	11.9687	11.9687	11.9686
FLOW GPM	0.9115	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD FLOW GPM @60F	0.9281	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD FLOW BBL/D @60F	31.8	0.0	0.0	0.0	0.0	0.0	0.0
ENTHALPY BTU/HR	-9.078E+03	3.782E+04	5.658E+06	4.010E+06	6.650E+06	5.503E+06	3.794E+06
ENTHALPY BTU/LB	-31.7	306.7	239.1	169.5	281.0	232.6	160.3
CP BTU/F LB	0.5404	0.4505	0.5949	0.6651	0.6378	0.6555	0.7233
IDEAL GAS CP/CV	1.0781	1.2931	1.2686	1.2918	1.2505	1.2659	1.2927
VISCOSITY CP	0.24689	0.01356	0.01263	0.01119	0.01477	0.01393	0.01157
K BTU/FT HR F	0.07876	0.01524	0.02249	0.01906	0.02765	0.02511	0.01974
SURTIN DYNES/CM	14.29	0.00	0.00	0.00	0.00	0.00	0.00
FROM BLOCK	hclcv	regen	gasgasts-1	ltsep	COMP3	COMP CLR3	dewpoint
TO BLOCK	DEC2 TOWER	regen	COMP3	gasgasts-1	COMP CLR3	dewpoint	OUTLET

? SOLIDS MAY FORM IN THIS STREAM.

STREAM NUMBER	56 TOTAL?	70 TOTAL	72 TOTAL	80 TOTAL	82 TOTAL	83 TOTAL S083	200 TOTAL S200
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	1.8284E-03	3.8148E-09	3.8148E-09	3.5778E-03	3.5778E-03	3.5783E-03	0.0000E+00
HELIUM	1.3536E-03	0.0000E+00	0.0000E+00	2.3267E-03	2.3267E-03	2.3261E-03	0.0000E+00
NITROGEN	0.1228	0.0000E+00	0.0000E+00	0.2194	0.2194	0.2193	0.0000E+00
CARBON DIOXIDE	2.171	1.6612E-06	1.6612E-06	4.141	4.141	4.140	0.0000E+00
METHANE	35.04	0.0000E+00	0.0000E+00	64.01	64.01	64.01	0.0000E+00
ETHANE	10.57	0.2553	0.2553	20.72	20.72	20.72	1.000
PROPANE	10.25	12.77	12.77	6.931	6.931	6.932	98.00
I-BUTANE	4.407	7.247	7.247	1.387	1.387	1.387	0.9999
N-BUTANE	6.247	10.93	10.93	1.451	1.451	1.451	0.0000E+00
I-PENTANE	4.896	9.601	9.601	0.4793	0.4793	0.4794	0.0000E+00
N-PENTANE	4.700	9.465	9.465	0.3684	0.3684	0.3684	0.0000E+00
N-HEXANE	8.893	19.27	19.27	0.2067	0.2067	0.2067	0.0000E+00
N-HEPTANE	8.374	19.53	19.53	6.5403E-02	6.5403E-02	6.5401E-02	0.0000E+00
N-OCTANE	4.327	10.93	10.93	1.2064E-02	1.2064E-02	1.2064E-02	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	1.2866E-04	2.6916E-04	2.6916E-04	1.1809E-05	1.1809E-05	1.1807E-05	0.0000E+00
TEMPERATURE F	-9.7	258.9	120.0	55.0	55.0	55.0	110.0
PRESSURE PSIA	813.0	201.0	196.0	200.0	200.0	200.0	220.2
PERCENT LIQUID (A) %	100.0	100.0	100.0	0.0	0.0	0.0	100.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	0.0	3.4	3.4	3.0	3.0	3.0	105.9
FLOW LB/HR	0.6	267.5	267.5	70.7	70.7	70.7	4670.0
MOLE WT LB/LEMOLE	48.4	78.7	78.7	24.0	24.0	24.0	44.1
DENSITY LB/FT^3	36.0360	32.6690	38.1732	0.9269	0.9269	0.9269	28.8483
Z FACTOR	0.2262	0.0628	0.0650	0.9361	0.9361	0.9361	0.0551
FLOW ACFH	0.0	8.2	7.0	76.3	76.3	76.3	161.9
FLOW MMSCFD	0.0000	0.0000	0.0000	0.0269	0.0269	0.0269	0.0000
FLOW GPM	0.0022	1.0208	0.8736	0.0000	0.0000	0.0000	20.1826
STD FLOW GPM @60F	0.0024	0.8337	0.8337	0.0000	0.0000	0.0000	18.4304
STD FLOW BBL/D @60F	0.1	28.6	28.6	0.0	0.0	0.0	631.9
ENTHALPY BTU/HR	-2.765E+01	2.473E+04	1.124E+03	1.277E+04	1.277E+04	1.277E+04	4.272E+04
ENTHALPY BTU/LB	-43.5	92.5	4.2	180.6	180.6	180.6	9.1
CP BTU/F LB	0.5604	0.7081	0.5764	0.4803	0.4803	0.4803	0.7910
IDEAL GAS CP/CV	1.1240	1.0527	1.0629	1.2266	1.2266	1.2266	1.1169
VISCOSITY CP	0.16885	0.10622	0.20852	0.01044	0.01044	0.01044	0.07982
K BTU/FT HR F	0.08500	0.05374	0.07029	0.01573	0.01573	0.01573	0.06136
SURTN DYNES/CM	7.66	5.81	13.11	0.00	0.00	0.00	4.85
FROM BLOCK	dewpoint	DEC2 TOWER	DEC2 COOLER	DEC2 TOWER	DEC2 PCV	RCYL36.0	INLET
TO BLOCK	OUTLET	DEC2 COOLER	OUTLET	DEC2 PCV	RCYL36.0	MIXR1.0	subcoolr-1

? SOLIDS MAY FORM IN THIS STREAM.

STREAM NUMBER	202 TOTAL	203 TOTAL	203 VAPOR	203 LIQ A	204 TOTAL	205 TOTAL	206 TOTAL
	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %	MOLE %
WATER	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHANE	1.000	1.000	1.816	0.3468	1.000	1.000	1.000
PROPANE	98.00	98.00	97.78	98.17	98.00	98.00	98.00
I-BUTANE	0.9999	0.9999	0.4027	1.478	0.9999	0.9999	0.9999
N-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
I-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEPTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-OCTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TEMPERATURE F	105.6	-14.5	-14.5	-14.5	-13.4	163.6	108.2
PRESSURE PSIA	219.2	28.5	28.5	28.5	28.5	220.0	215.0
PERCENT LIQUID (A) %	100.0	55.5	0.0	100.0	0.0	0.0	98.9
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	105.9	105.9	47.1	58.8	105.9	105.9	105.9
FLOW LB/HR	4670.0	4670.0	2067.8	2602.2	4670.0	4670.0	4670.0
MOLE WT LB/LBMOLE	44.1	44.1	43.9	44.3	44.1	44.1	44.1
DENSITY LB/FT^3	29.1445	0.6180	0.2763	35.2059	0.2769	1.7459	25.2608
Z FACTOR	0.0547	0.4257	0.9477	0.0075	0.9477	0.8308	0.0616
FLOW ACFH	160.2	7556.9	7483.0	73.9	16864.6	2674.8	184.9
FLOW MMSCFD	0.0000	0.0000	0.4290	0.0000	0.9646	0.9646	0.0000
FLOW GPM	19.9775	0.0000	0.0000	9.2151	0.0000	0.0000	0.0000
STD FLOW GPM @60F	18.4304	0.0000	0.0000	10.2439	0.0000	0.0000	0.0000
STD FLOW BBL/D @60F	631.9	0.0	0.0	351.2	0.0	0.0	0.0
ENTHALPY BTU/HR	2.664E+04	2.664E+04	2.176E+05	-1.910E+05	4.923E+05	7.761E+05	4.277E+04
ENTHALPY BTU/LB	5.7	5.7	105.2	-73.4	105.4	166.2	9.2
CP BTU/F LB	0.7751	0.0000	0.3726	0.5790	0.3730	0.5140	0.0000
IDEAL GAS CP/CV	1.1176	1.1420	1.1426	1.1415	1.1417	1.1087	1.1172
VISCOSITY CP	0.08208	0.00000	0.00694	0.17124	0.00694	0.01020	0.00000
K BTU/FT HR F	0.06254	0.00000	0.00757	0.09054	0.00758	0.01443	0.00000
SURTN DYNES/CM	5.15	0.00	0.00	13.84	0.00	0.00	0.00
FROM BLOCK	subcoolr-1	CHILLER LCV	CHILLER LCV	CHILLER LCV	C3 CHILLER	C3 COMP	C3 COND
TO BLOCK	CHILLER LCV	C3 CHILLER	C3 CHILLER	C3 CHILLER	C3 COMP	C3 COND	C3 ACCUM

STREAM NUMBER	206 VAPOR	206 LIQ A	210 TOTAL	300 TOTAL S300	302 TOTAL S302	303 TOTAL	304 TOTAL
	MOLE %	MOLE %	MOLE %	WEIGHT %	WEIGHT %	WEIGHT %	WEIGHT %
WATER	0.0000E+00	0.0000E+00	0.0000E+00	20.00	20.00	20.00	20.00
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHANE	2.468	0.9838	1.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
PROPANE	97.06	98.01	98.00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
I-BUTANE	0.4711	1.006	0.9999	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
I-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEPTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-OCTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	0.0000E+00	0.0000E+00	0.0000E+00	80.00	80.00	80.00	80.00
TEMPERATURE F	108.2	108.2	110.0	120.0	114.9	114.9	114.9
PRESSURE PSIA	215.0	215.0	220.1	1115.0	1115.0	1115.0	1115.0
PERCENT LIQUID (A) %	0.0	100.0	100.0	100.0	100.0	100.0	100.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	1.2	104.7	105.9	0.0	19.3	6.4	12.9
FLOW LB/HR	51.2	4618.8	4670.0	0.2	805.5	265.8	539.7
MOLE WT LB/LBMOLE	43.8	44.1	44.1	41.7	41.7	41.7	41.7
DENSITY LB/FT^3	2.0145	28.9653	28.8481	66.8110	66.9441	66.9441	66.9441
Z FACTOR	0.7675	0.0537	0.0550	0.1118	0.1126	0.1126	0.1126
FLOW ACFH	25.4	159.5	161.9	0.0	12.0	4.0	8.1
FLOW MMSCFD	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FLOW GPM	0.0000	19.8807	20.1827	0.0004	1.5002	0.4951	1.0051
STD FLOW GPM @60F	0.0000	18.2273	18.4304	0.0004	1.4760	0.4871	0.9889
STD FLOW BBL/D @60F	0.0	624.9	631.9	0.0	50.6	16.7	33.9
ENTHALPY BTU/HR	7.103E+03	3.566E+04	4.272E+04	-7.863E+01	-2.846E+05	-9.391E+04	-1.907E+05
ENTHALPY BTU/LB	138.8	7.7	9.1	-349.7	-353.3	-353.3	-353.3
CP BTU/F LB	0.5145	0.7851	0.7911	0.6981	0.6962	0.6962	0.6962
IDEAL GAS CP/CV	1.1180	1.1172	1.1169	1.1840	1.1856	1.1856	1.1856
VISCOSITY CP	0.00956	0.08077	0.07982	3.84127	4.17815	4.17815	4.17815
K BTU/FT HR F	0.01256	0.06185	0.06136	0.17990	0.17958	0.17958	0.17958
SURTN DYNES/CM	0.00	4.98	4.85	49.27	49.53	49.53	49.53
FROM BLOCK	C3 COND	C3 COND	C3 ACCUM	INLET	header	manifold	manifold
TO BLOCK	C3 ACCUM	C3 ACCUM	OUTLET	header	manifold	glymix2	glymix1

STREAM NUMBER	310 TOTAL	311 TOTAL	311 VAPOR	311 LIQ A	312 TOTAL	312 VAPOR	312 LIQ A
	WEIGHT %	WEIGHT %	WEIGHT %	WEIGHT %	WEIGHT %	WEIGHT %	WEIGHT %
WATER	24.37	24.37	1.1915E-02	24.38	24.37	3.1888E-02	24.38
HELIUM	2.2798E-07	2.2798E-07	3.5680E-04	1.2087E-09	2.2798E-07	3.2302E-04	1.6450E-09
NITROGEN	7.5676E-04	7.5676E-04	1.074	7.4009E-05	7.5676E-04	0.9737	7.4530E-05
CARBON DIOXIDE	0.1510	0.1510	25.54	0.1349	0.1510	32.15	0.1286
METHANE	4.3683E-02	4.3683E-02	60.83	5.0268E-03	4.3683E-02	55.25	4.9722E-03
ETHANE	7.1617E-03	7.1617E-03	8.475	1.7764E-03	7.1617E-03	7.832	1.6749E-03
PROPANE	2.3535E-03	2.3535E-03	2.746	6.0840E-04	2.3535E-03	2.527	5.8329E-04
I-BUTANE	2.3316E-04	2.3316E-04	0.3088	3.6945E-05	2.3316E-04	0.2802	3.6880E-05
N-BUTANE	5.0373E-04	5.0373E-04	0.5526	1.5259E-04	5.0373E-04	0.5111	1.4570E-04
I-PENTANE	1.3623E-04	1.3623E-04	0.1539	3.8471E-05	1.3623E-04	0.1414	3.7185E-05
N-PENTANE	1.7656E-04	1.7656E-04	0.1646	7.2022E-05	1.7656E-04	0.1560	6.7276E-05
N-HEXANE	1.2875E-04	1.2875E-04	0.1002	6.5083E-05	1.2875E-04	9.7131E-02	6.0737E-05
N-HEPTANE	7.2393E-05	7.2393E-05	3.6053E-02	4.9510E-05	7.2393E-05	3.7323E-02	4.6274E-05
N-OCTANE	2.4135E-05	2.4135E-05	7.0114E-03	1.9691E-05	2.4135E-05	7.7984E-03	1.8684E-05
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	75.43	75.43	2.1246E-05	75.47	75.43	9.8576E-05	75.48
TEMPERATURE F	-5.0	-2.2	-2.2	-2.2	19.3	19.3	19.3
PRESSURE PSIA	707.0	75.0	75.0	75.0	70.0	70.0	70.0
PERCENT LIQUID (A) %	100.0	99.9	0.0	100.0	99.9	0.0	100.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	22.0	22.0	0.0	22.0	22.0	0.0	22.0
FLOW LB/HR	854.4	854.4	0.5	853.8	854.4	0.6	853.8
MOLE WT LB/LBMOLE	38.8	38.8	20.9	38.9	38.8	22.0	38.9
DENSITY LB/FT^3	69.2856	61.0379	0.3267	69.2194	59.3923	0.3047	68.7391
Z FACTOR	0.0812	0.0097	0.9792	0.0086	0.0089	0.9828	0.0077
FLOW ACFH	12.3	14.0	1.7	12.3	14.4	2.0	12.4
FLOW MMSCFD	0.0000	0.0000	0.0002	0.0000	0.0000	0.0002	0.0000
FLOW GPM	1.5374	0.0000	0.0000	1.5379	0.0000	0.0000	1.5485
STD FLOW GPM @60F	1.5762	0.0000	0.0000	1.5733	0.0000	0.0000	1.5732
STD FLOW BBL/D @60F	54.0	0.0	0.0	53.9	0.0	0.0	53.9
ENTHALPY BTU/HR	-3.937E+05	-3.937E+05	9.300E+01	-3.938E+05	-3.809E+05	1.026E+02	-3.810E+05
ENTHALPY BTU/LB	-460.8	-460.8	171.3	-461.2	-445.8	171.4	-446.3
CP BTU/F LB	0.6969	0.0000	0.4329	0.6973	0.0000	0.4157	0.6968
IDEAL GAS CP/CV	1.2249	1.2245	1.2897	1.2245	1.2212	1.2853	1.2211
VISCOSITY CP	71.26511	0.00000	0.01024	65.59659	0.00000	0.01074	31.83847
K BTU/FT HR F	0.17729	0.00000	0.01479	0.17764	0.00000	0.01521	0.17814
SURTIN DYNES/CM	56.20	0.00	0.00	56.17	0.00	0.00	55.09
FROM BLOCK	ltsep	glylcv	glylcv	glylcv	refluxts	refluxts	refluxts
TO BLOCK	glylcv	refluxts	refluxts	refluxts	leanrich-1	leanrich-1	leanrich-1

STREAM NUMBER	313 TOTAL	313 VAPOR	313 LIQ A	315 TOTAL	316 TOTAL	317 TOTAL	320 TOTAL
	WEIGHT %	WEIGHT %	WEIGHT %	MOLE %	WEIGHT %	WEIGHT %	MOLE %
WATER	24.37	2.795	24.40	3.336	24.39	24.39	99.12
HELIUM	2.2798E-07	1.6326E-04	5.5627E-09	1.2405E-03	7.9185E-09	7.9185E-09	6.3961E-07
NITROGEN	7.5676E-04	0.5119	5.9491E-05	0.5431	8.2550E-05	8.2550E-05	9.5272E-04
CARBON DIOXIDE	0.1510	59.82	6.9619E-02	34.87	8.3103E-02	8.3103E-02	0.6105
METHANE	4.3683E-02	29.74	3.1730E-03	55.25	4.4075E-03	4.4075E-03	8.8836E-02
ETHANE	7.1617E-03	4.676	7.9170E-04	4.565	1.0793E-03	1.0793E-03	1.1606E-02
PROPANE	2.3535E-03	1.542	2.5298E-04	1.028	3.4444E-04	3.4444E-04	2.5258E-03
I-BUTANE	2.3316E-04	0.1582	1.7690E-05	8.1080E-02	2.4344E-05	2.4344E-05	1.3543E-04
N-BUTANE	5.0373E-04	0.3228	6.4049E-05	0.1621	8.6300E-05	8.6300E-05	4.8011E-04
I-PENTANE	1.3623E-04	8.9644E-02	1.4122E-05	3.6622E-02	1.9160E-05	1.9160E-05	8.5872E-05
N-PENTANE	1.7656E-04	0.1134	2.2093E-05	4.5936E-02	2.9720E-05	2.9720E-05	1.3320E-04
N-HEXANE	1.2875E-04	7.8625E-02	2.1663E-05	2.6237E-02	2.8588E-05	2.8588E-05	1.0727E-04
N-HEPTANE	7.2393E-05	4.3406E-02	1.3275E-05	1.2394E-02	1.7376E-05	1.7376E-05	5.6071E-05
N-OCTANE	2.4135E-05	1.2853E-02	6.6332E-06	3.1147E-03	8.3779E-06	8.3779E-06	2.3716E-05
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	75.43	9.6170E-02	75.53	3.3551E-02	75.52	75.52	0.1664
TEMPERATURE F	155.0	155.0	155.0	155.0	155.0	155.1	213.6
PRESSURE PSIA	50.0	50.0	50.0	65.0	65.0	20.0	14.0
PERCENT LIQUID (A) %	99.8	0.0	100.0	0.0	100.0	100.0	0.0
PERCENT LIQUID (B) %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOW LBMOL/HR	22.0	0.0	22.0	0.0	22.0	22.0	2.6
FLOW LB/HR	854.4	1.2	853.2	1.0	853.4	853.4	48.2
MOLE WT LB/LEMOLE	38.8	27.8	38.9	27.1	38.9	38.9	18.2
DENSITY LB/FT^3	46.1300	0.2125	65.4162	0.2688	65.4166	52.0025	0.0356
Z FACTOR	0.0064	0.9936	0.0045	0.9920	0.0059	0.0023	0.9923
FLOW ACFH	18.5	5.5	13.0	3.8	13.0	16.4	1351.3
FLOW MMSCFD	0.0000	0.0004	0.0000	0.0003	0.0000	0.0000	0.0240
FLOW GPM	0.0000	0.0000	1.6261	0.0000	1.6264	2.0459	0.0000
STD FLOW GPM @60F	0.0000	0.0000	1.5717	0.0000	1.5721	1.5721	0.0000
STD FLOW BBL/D @60F	0.0	0.0	53.9	0.0	53.9	53.9	0.0
ENTHALPY BTU/HR	-2.986E+05	2.077E+02	-2.988E+05	1.884E+02	-2.988E+05	-2.988E+05	1.409E+04
ENTHALPY BTU/LB	-349.5	178.4	-350.2	183.9	-350.2	-350.2	292.6
CP BTU/F LB	0.0000	0.3489	0.7328	0.3609	0.7328	0.7330	0.4558
IDEAL GAS CP/CV	1.1830	1.2600	1.1829	1.2592	1.1829	1.1829	1.3166
VISCOSITY CP	0.00000	0.01465	2.04107	0.01447	2.04004	2.04213	0.01290
K BTU/FT HR F	0.00000	0.01750	0.18957	0.01795	0.18950	0.18971	0.01455
SURTN DYNES/CM	0.00	0.00	48.23	0.00	48.23	48.25	0.00
FROM BLOCK	leanrich-1	leanrich-1	leanrich-1	flashtnk	flashtnk	flshlcv	regen
TO BLOCK	flashtnk	flashtnk	flashtnk	OUTLET	flshlcv	regen	OUTLET

STREAM NUMBER	330 TOTAL	331 TOTAL	332 TOTAL
	WEIGHT %	WEIGHT %	WEIGHT %
WATER	20.00	20.00	20.00
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	0.0000E+00	0.0000E+00	0.0000E+00
METHANE	0.0000E+00	0.0000E+00	0.0000E+00
ETHANE	0.0000E+00	0.0000E+00	0.0000E+00
PROPANE	0.0000E+00	0.0000E+00	0.0000E+00
I-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00
N-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00
I-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00
N-HEXANE	0.0000E+00	0.0000E+00	0.0000E+00
N-HEPTANE	0.0000E+00	0.0000E+00	0.0000E+00
N-OCTANE	0.0000E+00	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	80.00	80.00	80.00
TEMPERATURE F	252.8	113.1	114.7
PRESSURE PSIA	14.0	14.0	1163.0
PERCENT LIQUID (A) %	100.0	100.0	100.0
PERCENT LIQUID (B) %	0.0	0.0	0.0
FLOW LBMOL/HR	19.3	19.3	19.3
FLOW LB/HR	805.2	805.2	805.2
MOLE WT LB/LEMOLE	41.7	41.7	41.7
DENSITY LB/FT^3	62.9431	66.8782	66.9542
Z FACTOR	0.0012	0.0014	0.1175
FLOW ACFH	12.8	12.0	12.0
FLOW MMSCFD	0.0000	0.0000	0.0000
FLOW GPM	1.5949	1.5011	1.4994
STD FLOW GEM @60F	1.4753	1.4753	1.4753
STD FLOW BBL/D @60F	50.6	50.6	50.6
ENTHALPY BTU/HR	-2.057E+05	-2.880E+05	-2.845E+05
ENTHALPY BTU/LB	-255.5	-357.7	-353.3
CP BTU/F LB	0.7722	0.6977	0.6961
IDEAL GAS CP/CV	1.1446	1.1861	1.1857
VISCOSITY CP	0.86164	4.30053	4.19250
K BTU/FT HR F	0.18309	0.17944	0.17957
SURTN DYNES/CM	42.47	49.64	49.54
FROM BLOCK	regen	leanrich	EG INJ PUMP
TO BLOCK	leanrich	EG INJ PUMP	header

PLANT PIPING DATA: HORIZONTAL FLOW

STREAM NUMBER	DIAM OR SIZE* IN	PRESSURE DROP PSI/100 FT	LIQUID HOLDUP	2-PHASE CORR.	FLOW REGIME	FRICTION GRADIENT PSI/100 FT	ELEVATION GRADIENT PSI/100 FT
1	6.000	0.8066	0.000	DUKLER	GAS	0.8034	
3	6.000	0.8106	0.000	DUKLER	GAS	0.8074	
10	6.000	0.8107	0.000	DUKLER	GAS	0.8074	
11	6.000	0.5106	0.000	DUKLER	GAS	0.5099	
12	6.000	0.4944	0.000	DUKLER	GAS	0.4938	
15	6.000	0.4944	0.000	DUKLER	GAS	0.4938	
16	5.000	0.5702	0.000	DUKLER	GAS	0.5699	
17	5.000	0.4171	0.000	DUKLER	GAS	0.4169	
19	5.000	0.4171	0.000	DUKLER	GAS	0.4169	
30	4.000	1.544	0.007	DUKLER	TWO_PH	1.543	
31	4.000	1.550	0.011	DUKLER	TWO_PH	1.549	
33	0.750	0.4082	0.000	DUKLER	GAS	0.4082	
34	0.500	0.6517	1.000	DUKLER	LIQUID	0.6517	
35	4.000	1.709	0.014	DUKLER	TWO_PH	1.708	
36	4.000	1.882	0.023	DUKLER	TWO_PH	1.881	
37	1.000	0.8052	0.000	DUKLER	GAS	0.8023	
38	0.125	5.9046E-02	1.000	DUKLER	LIQUID	5.9046E-02	
39	0.750	0.4216	1.000	DUKLER	LIQUID	0.4216	
40	0.375	1.140	1.000	DUKLER	LIQUID	1.140	
41	0.375	1.850	0.686	DUKLER	TWO_PH	1.850	
42	0.750	0.5857	0.277	DUKLER	TWO_PH	0.5856	
47	1.250	0.7213	0.000	DUKLER	GAS	0.7179	
50	5.000	0.4096	0.000	DUKLER	GAS	0.4094	
51	4.000	0.9118	0.000	DUKLER	GAS	0.9113	
53	4.000	0.8876	0.000	DUKLER	GAS	0.8873	
54	4.000	0.7464	0.000	DUKLER	GAS	0.7462	
55	4.000	0.7483	0.000	DUKLER	GAS	0.7480	
56	0.125	1.9369E-03	1.000	DUKLER	LIQUID	1.9369E-03	
70	0.375	0.7796	1.000	DUKLER	LIQUID	0.7796	
72	0.375	0.7197	1.000	DUKLER	LIQUID	0.7197	
80	0.500	0.5406	0.000	DUKLER	GAS	0.5405	
82	0.500	0.5406	0.000	DUKLER	GAS	0.5405	
83	0.500	0.5405	0.000	DUKLER	GAS	0.5405	
200	1.250	1.109	1.000	DUKLER	LIQUID	1.109	
202	1.250	1.099	1.000	DUKLER	LIQUID	1.099	
203	3.000	1.084	0.015	DUKLER	TWO_PH	1.077	
204	3.500	0.8156	0.000	DUKLER	GAS	0.8076	
205	2.500	0.8479	0.000	DUKLER	GAS	0.8472	
206	1.250	0.9997	0.863	DUKLER	TWO_PH	0.9996	
210	1.250	1.109	1.000	DUKLER	LIQUID	1.109	
300	0.125	8.3986E-03	1.000	DUKLER	LIQUID	8.3986E-03	
302	0.500	1.143	1.000	DUKLER	LIQUID	1.143	
303	0.375	0.9553	1.000	DUKLER	LIQUID	0.9553	
304	0.500	0.7655	1.000	DUKLER	LIQUID	0.7655	
310	1.250	0.8242	1.000	DUKLER	LIQUID	0.8242	
311	0.750	1.355	0.969	DUKLER	TWO_PH	1.355	
312	0.750	1.122	0.958	DUKLER	TWO_PH	1.122	
313	0.750	0.6679	0.844	DUKLER	TWO_PH	0.6678	
315	0.125	3.5828E-02	0.000	DUKLER	GAS	3.5828E-02	
316	0.750	0.4389	1.000	DUKLER	LIQUID	0.4389	
317	0.750	0.5898	0.892	DUKLER	TWO_PH	0.5897	
320	1.000	0.4952	0.000	DUKLER	GAS	0.4941	
330	0.500	1.312	1.000	DUKLER	LIQUID	1.312	
331	0.500	1.177	1.000	DUKLER	LIQUID	1.177	
332	0.500	1.146	1.000	DUKLER	LIQUID	1.146	



PLANT PIPING DATA: VERTICAL FLOW

STREAM NUMBER	DIAM OR SIZE* IN	PRESSURE DROP		LIQUID HOLDUP	2-PHASE CORR.	FLOW REGIME	FRICTION GRADIENT		ELEVATION GRADIENT	
		PSI/100	FT				PSI/100 FT	PSI/100 FT		
1	6.000	1.118	0.000	0.000	ORKIS	GAS	0.8034	0.3098		
3	6.000	1.122	0.000	0.000	ORKIS	GAS	0.8074	0.3101		
10	6.000	1.122	0.000	0.000	ORKIS	GAS	0.8074	0.3101		
11	6.000	1.004	0.000	0.000	ORKIS	GAS	0.5099	0.4925		
12	6.000	1.003	0.000	0.000	ORKIS	GAS	0.4938	0.5082		
15	6.000	1.003	0.000	0.000	ORKIS	GAS	0.4938	0.5082		
16	5.000	1.715	0.000	0.000	ORKIS	GAS	0.5699	1.144		
17	5.000	1.977	0.000	0.000	ORKIS	GAS	0.4169	1.559		
19	5.000	1.977	0.000	0.000	ORKIS	GAS	0.4169	1.559		
30	4.000	3.147	-0.003	0.000	ORKIS	TRANS	1.705	1.440		
31	4.000	2.339	0.002	0.000	ORKIS	SLUG	0.1842	2.154		
33	0.750	1.735	0.000	0.000	ORKIS	GAS	0.4082	1.326		
34	0.500	23.56	1.000	0.000	ORKIS	LIQUID	0.6517	22.91		
35	4.000	2.373	0.002	0.000	ORKIS	SLUG	0.2052	2.168		
36	4.000	2.552	0.003	0.000	ORKIS	SLUG	0.2179	2.334		
37	1.000	0.8301	0.000	0.000	ORKIS	GAS	0.8023	2.4762E-02		
38	0.125	42.09	1.000	0.000	ORKIS	LIQUID	5.9046E-02	42.03		
39	0.750	44.00	1.000	0.000	ORKIS	LIQUID	0.4216	43.58		
40	0.375	26.93	1.000	0.000	ORKIS	LIQUID	1.140	25.79		
41	0.375	13.34	0.432	0.000	ORKIS	SLUG	1.345	12.00		
42	0.750	2.840	0.072	0.000	ORKIS	SLUG	0.3096	2.531		
47	1.250	0.7464	0.000	0.000	ORKIS	GAS	0.7179	2.5076E-02		
50	5.000	1.947	0.000	0.000	ORKIS	GAS	0.4094	1.537		
51	4.000	3.142	0.000	0.000	ORKIS	GAS	0.9113	2.229		
53	4.000	3.185	0.000	0.000	ORKIS	GAS	0.8873	2.296		
54	4.000	3.476	0.000	0.000	ORKIS	GAS	0.7462	2.729		
55	4.000	3.465	0.000	0.000	ORKIS	GAS	0.7480	2.716		
56	0.125	25.03	1.000	0.000	ORKIS	LIQUID	1.9369E-03	25.02		
70	0.375	23.47	1.000	0.000	ORKIS	LIQUID	0.7796	22.69		
72	0.375	27.23	1.000	0.000	ORKIS	LIQUID	0.7197	26.51		
80	0.500	1.184	0.000	0.000	ORKIS	GAS	0.5405	0.6437		
82	0.500	1.184	0.000	0.000	ORKIS	GAS	0.5405	0.6437		
83	0.500	1.184	0.000	0.000	ORKIS	GAS	0.5405	0.6437		
200	1.250	21.14	1.000	0.000	ORKIS	LIQUID	1.109	20.03		
202	1.250	21.34	1.000	0.000	ORKIS	LIQUID	1.099	20.24		
203	3.000	25.28	0.369	0.000	ORKIS	TRANS	16.15	9.132		
204	3.500	1.010	0.000	0.000	ORKIS	GAS	0.8076	0.1923		
205	2.500	2.061	0.000	0.000	ORKIS	GAS	0.8472	1.212		
206	1.250	14.57	0.652	0.000	ORKIS	SLUG	0.9706	13.60		
210	1.250	21.14	1.000	0.000	ORKIS	LIQUID	1.109	20.03		
300	0.125	46.40	1.000	0.000	ORKIS	LIQUID	8.3986E-03	46.40		
302	0.500	47.63	1.000	0.000	ORKIS	LIQUID	1.143	46.49		
303	0.375	47.44	1.000	0.000	ORKIS	LIQUID	0.9553	46.49		
304	0.500	47.25	1.000	0.000	ORKIS	LIQUID	0.7655	46.49		
310	1.250	48.94	1.000	0.000	ORKIS	LIQUID	0.8242	48.12		
311	0.750	51.16	0.931	0.000	ORKIS	BUBBLE	6.416	44.74		
312	0.750	69.10	1.353	0.000	ORKIS	SLUG	4.567	64.53		
313	0.750	33.56	0.725	0.000	ORKIS	SLUG	0.5854	32.97		
315	0.125	0.2225	0.000	0.000	ORKIS	GAS	3.5828E-02	0.1866		
316	0.750	45.87	1.000	0.000	ORKIS	LIQUID	0.4389	45.43		
317	0.750	36.72	0.797	0.000	ORKIS	SLUG	0.5207	36.20		
320	1.000	0.5200	0.000	0.000	ORKIS	GAS	0.4941	2.4749E-02		
330	0.500	45.02	1.000	0.000	ORKIS	LIQUID	1.312	43.71		
331	0.500	47.62	1.000	0.000	ORKIS	LIQUID	1.177	46.44		
332	0.500	47.64	1.000	0.000	ORKIS	LIQUID	1.146	46.50		

PLANT PIPING DATA: ADDITIONAL INFORMATION

STREAM NUMBER	DIAM OR SIZE* IN	PIPE* SCHEDULE	SUPERFIC LIQ VEL FT/SEC	SUPERFIC GAS VEL FT/SEC	MIXTURE VELOCITY FT/SEC	FRICTION FACTOR CORR.	ABSOLUTE ROUGHNESS FT
1	6.000	STD	3.404E-07	74.4	74.4	COLE	0.000150
3	6.000	STD	0.000E+00	74.6	74.6	COLE	0.000150
10	6.000	STD	0.000E+00	74.6	74.6	COLE	0.000150
11	6.000	STD	0.000E+00	46.9	46.9	COLE	0.000150
12	6.000	STD	0.000E+00	45.5	45.5	COLE	0.000150
15	6.000	STD	0.000E+00	45.5	45.5	COLE	0.000150
16	5.000	STD	0.000E+00	29.2	29.2	COLE	0.000150
17	5.000	STD	0.000E+00	21.4	21.4	COLE	0.000150
19	5.000	STD	0.000E+00	21.4	21.4	COLE	0.000150
30	4.000	STD	2.621E-02	33.7	33.7	COLE	0.000150
31	4.000	STD	4.268E-02	24.9	24.9	COLE	0.000150
33	0.750	STD	0.000E+00	7.35	7.35	COLE	0.000150
34	0.500	STD	1.81	0.000E+00	1.81	COLE	0.000150
35	4.000	STD	5.418E-02	25.0	25.0	COLE	0.000150
36	4.000	STD	6.736E-02	23.2	23.2	COLE	0.000150
37	1.000	STD	0.000E+00	81.0	81.0	COLE	0.000150
38	0.125	STD	0.166	0.000E+00	0.166	COLE	0.000150
39	0.750	STD	1.11	0.000E+00	1.11	COLE	0.000150
40	0.375	STD	1.91	0.000E+00	1.91	COLE	0.000150
41	0.375	STD	1.85	1.38	3.23	COLE	0.000150
42	0.750	STD	0.548	4.45	5.00	COLE	0.000150
47	1.250	STD	0.000E+00	91.3	91.3	COLE	0.000150
50	5.000	STD	0.000E+00	21.4	21.4	COLE	0.000150
51	4.000	STD	0.000E+00	23.2	23.2	COLE	0.000150
53	4.000	STD	0.000E+00	22.5	22.5	COLE	0.000150
54	4.000	STD	0.000E+00	18.9	18.9	COLE	0.000150
55	4.000	STD	0.000E+00	19.0	19.0	COLE	0.000150
56	0.125	STD	1.243E-02	0.000E+00	1.243E-02	COLE	0.000150
70	0.375	STD	1.72	0.000E+00	1.72	COLE	0.000150
72	0.375	STD	1.47	0.000E+00	1.47	COLE	0.000150
80	0.500	STD	0.000E+00	10.0	10.0	COLE	0.000150
82	0.500	STD	0.000E+00	10.0	10.0	COLE	0.000150
83	0.500	STD	0.000E+00	10.0	10.0	COLE	0.000150
200	1.250	STD	4.33	0.000E+00	4.33	COLE	0.000150
202	1.250	STD	4.29	0.000E+00	4.29	COLE	0.000150
203	3.000	STD	0.400	40.5	40.9	COLE	0.000150
204	3.500	STD	0.000E+00	68.2	68.2	COLE	0.000150
205	2.500	STD	0.000E+00	22.3	22.3	COLE	0.000150
206	1.250	STD	4.26	0.680	4.94	COLE	0.000150
210	1.250	STD	4.33	0.000E+00	4.33	COLE	0.000150
300	0.125	STD	2.369E-03	0.000E+00	2.369E-03	COLE	0.000150
302	0.500	STD	1.58	0.000E+00	1.58	COLE	0.000150
303	0.375	STD	0.832	0.000E+00	0.832	COLE	0.000150
304	0.500	STD	1.06	0.000E+00	1.06	COLE	0.000150
310	1.250	STD	0.330	0.000E+00	0.330	COLE	0.000150
311	0.750	STD	0.925	0.125	1.05	COLE	0.000150
312	0.750	STD	0.932	0.147	1.08	COLE	0.000150
313	0.750	STD	0.978	0.411	1.39	COLE	0.000150
315	0.125	STD	0.000E+00	2.68	2.68	COLE	0.000150
316	0.750	STD	0.978	0.000E+00	0.978	COLE	0.000150
317	0.750	STD	0.978	0.253	1.23	COLE	0.000150
320	1.000	STD	0.000E+00	62.5	62.5	COLE	0.000150
330	0.500	STD	1.68	0.000E+00	1.68	COLE	0.000150
331	0.500	STD	1.58	0.000E+00	1.58	COLE	0.000150
332	0.500	STD	1.58	0.000E+00	1.58	COLE	0.000150

PLANT PIPING DATA: MAXIMUM ALLOWABLE WORKING PRESSURE

STREAM NUMBER	DIAM OR SIZE* IN	CORROSION ALLOWANCE IN	JOINT EFFICIENCY	MAX ALLOW WORK PRES PSIA	MATERIAL
1	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
3	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
10	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
11	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
12	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
15	6.000	6.250E-02	1.00	1.141E+03	C Steel A106 B K03006
16	5.000	6.250E-02	1.00	1.217E+03	C Steel A106 B K03006
17	5.000	6.250E-02	1.00	1.217E+03	C Steel A106 B K03006
19	5.000	6.250E-02	1.00	1.217E+03	C Steel A106 B K03006
30	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
31	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
33	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
34	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
35	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
36	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
37	1.000	6.250E-02	1.00	1.709E+03	C Steel A106 B K03006
38	0.125	6.250E-02	1.00	C Steel A106 B K03006	
39	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
40	0.375	6.250E-02	1.00	1.051E+03	C Steel A106 B K03006
41	0.375	6.250E-02	1.00	1.051E+03	C Steel A106 B K03006
42	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
47	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
50	5.000	6.250E-02	1.00	1.217E+03	C Steel A106 B K03006
51	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
53	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
54	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
55	4.000	6.250E-02	1.00	1.337E+03	C Steel A106 B K03006
56	0.125	6.250E-02	1.00	C Steel A106 B K03006	
70	0.375	6.250E-02	1.00	1.051E+03	C Steel A106 B K03006
72	0.375	6.250E-02	1.00	1.051E+03	C Steel A106 B K03006
80	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
82	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
83	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
200	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
202	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
203	3.000	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
204	3.500	6.250E-02	1.00	1.405E+03	C Steel A106 B K03006
205	2.500	6.250E-02	1.00	1.670E+03	C Steel A106 B K03006
206	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
210	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
300	0.125	6.250E-02	1.00	C Steel A106 B K03006	
302	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
303	0.375	6.250E-02	1.00	1.051E+03	C Steel A106 B K03006
304	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
310	1.250	6.250E-02	1.00	1.504E+03	C Steel A106 B K03006
311	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
312	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
313	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
315	0.125	6.250E-02	1.00	C Steel A106 B K03006	
316	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
317	0.750	6.250E-02	1.00	1.440E+03	C Steel A106 B K03006
320	1.000	6.250E-02	1.00	1.709E+03	C Steel A106 B K03006
330	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
331	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006
332	0.500	6.250E-02	1.00	1.631E+03	C Steel A106 B K03006

\* PIPE SIZES ARE NOMINAL SIZES IF A SCHEDULE IS PROVIDED FOR THE PIPE AND FRACTIONAL SIZES OTHERWISE. MAWP CALCULATION REQUIRES SCHEDULE SPECIFICATION.

STREAM NUMBER: 38, NAME: S038  
WARNING P1117. SPECIFIED CORROSION ALLOWANCE EXCEEDS WALL THICKNESS.

STREAM NUMBER: 56, NAME:  
WARNING P1117. SPECIFIED CORROSION ALLOWANCE EXCEEDS WALL THICKNESS.

STREAM NUMBER: 300, NAME: S300  
WARNING P1117. SPECIFIED CORROSION ALLOWANCE EXCEEDS WALL THICKNESS.

STREAM NUMBER: 303, NAME:  
WARNING P1116. OPERATING PRESSURE OF 1115.0 PSIA EXCEEDS MAXIMUM ALLOWABLE WORKING PRESSURE OF 1050.6 PSIA

STREAM NUMBER: 315, NAME:  
WARNING P1117. SPECIFIED CORROSION ALLOWANCE EXCEEDS WALL THICKNESS.

PLANT OPERATIONS SUMMARY

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

	INLET STREAM 1		INLET STREAM 200	
	S001		S200	
	LEBOL/HR	MOLE %	LEBOL/HR	MOLE %
WATER	2.636	0.1996	0.0000E+00	0.0000E+00
HELIUM	0.3953	2.9940E-02	0.0000E+00	0.0000E+00
NITROGEN	11.86	0.8982	0.0000E+00	0.0000E+00
CARBON DIOXIDE	26.35	1.996	0.0000E+00	0.0000E+00
METHANE	1191.	90.19	0.0000E+00	0.0000E+00
ETHANE	59.42	4.501	1.059	1.000
PROPANE	17.52	1.327	103.8	98.00
I-BUTANE	3.294	0.2495	1.059	0.9999
N-BUTANE	3.426	0.2595	0.0000E+00	0.0000E+00
I-PENTANE	1.318	9.9801E-02	0.0000E+00	0.0000E+00
N-PENTANE	1.054	7.9841E-02	0.0000E+00	0.0000E+00
N-HEXANE	1.054	7.9841E-02	0.0000E+00	0.0000E+00
N-HEPTANE	0.7906	5.9880E-02	0.0000E+00	0.0000E+00
N-OCTANE	0.3953	2.9940E-02	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL FOR STREAM	1320.	100.0	105.9	100.0
FLOW (TOTAL)	0.0000E+00	LEBOL/HR	0.0000E+00	LEBOL/HR
FLOW BY VOLUME	12.02	MMSCFD	18.43	GPM @60F
TEMPERATURE	60.00	F	110.0	F
PRESSURE	134.0	PSIA	220.2	PSIA
MOLECULAR WEIGHT	18.16	LB/LBMOLE	44.09	LB/LBMOLE
GROSS HEATING VALUE	1056.	BTU/FT^3	2.1484E+04	BTU/LB
NET HEATING VALUE	954.3	BTU/FT^3	1.9793E+04	BTU/LB

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

INLET STREAM 300  
 S300

	LB/MOL/HR	MOLE %
WATER	2.4964E-03	46.27
HELIUM	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00
CARBON DIOXIDE	0.0000E+00	0.0000E+00
METHANE	0.0000E+00	0.0000E+00
ETHANE	0.0000E+00	0.0000E+00
PROPANE	0.0000E+00	0.0000E+00
I-BUTANE	0.0000E+00	0.0000E+00
N-BUTANE	0.0000E+00	0.0000E+00
I-PENTANE	0.0000E+00	0.0000E+00
N-PENTANE	0.0000E+00	0.0000E+00
N-HEXANE	0.0000E+00	0.0000E+00
N-HEPTANE	0.0000E+00	0.0000E+00
N-OCTANE	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	2.8984E-03	53.73
TOTAL FOR STREAM	5.3948E-03	100.0
FLOW (TOTAL)	0.0000E+00	LB/MOL/HR
FLOW BY VOLUME	4.1202E-04	GPM @60F
TEMPERATURE	120.0	F
PRESSURE	1115.	PSIA
MOLECULAR WEIGHT	41.68	LB/LBMOLE
GROSS HEATING VALUE	6600.	BTU/LB
NET HEATING VALUE	5651.	BTU/LB

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

VAPOR OUTLET 55 ( 11.97 MMSCFD)

	LB/MOL/HR	MOLE %	% PLANT FEED
WATER	2.2391E-02	1.7039E-03	0.8487
HELIUM	0.3953	3.0079E-02	100.00
NITROGEN	11.86	0.9023	100.00
CARBON DIOXIDE	26.32	2.003	99.89
METHANE	1191.	90.60	100.00
ETHANE	59.41	4.521	98.23
PROPANE	17.09	1.300	14.09
I-BUTANE	3.047	0.2319	70.00
N-BUTANE	3.053	0.2323	89.12
I-PENTANE	0.9906	7.5379E-02	75.18
N-PENTANE	0.7317	5.5678E-02	69.42
N-HEXANE	0.3978	3.0273E-02	37.74
N-HEPTANE	0.1255	9.5483E-03	15.87
N-OCTANE	2.3290E-02	1.7723E-03	5.892
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00
P-KYLENE	0.0000E+00	0.0000E+00	0.0000E+00
M-KYLENE	0.0000E+00	0.0000E+00	0.0000E+00
O-KYLENE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	2.0337E-05	1.5475E-06	0.7017
TOTAL FOR STREAM	1314.	100.0	92.15
FLOW (TOTAL)	1314.	LB/MOL/HR	
FLOW BY VOLUME	11.97	MMSCFD	
TEMPERATURE	-9.655	F	
PRESSURE	813.0	PSIA	
MOLECULAR WEIGHT	18.01	LB/LBMOLE	
GROSS HEATING VALUE	1050.	BTU/FT^3	
NET HEATING VALUE	948.3	BTU/FT^3	

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

LIQUID OUTLET A 56

( 8.1333E-02 BBL/D @60F)

	LB/MOL/HR	MOLE %	GPM @60F	% PLANT FEED
WATER	2.4028E-07	1.8284E-03	8.6532E-09	9.1075E-06
HELIUM	1.7789E-07	1.3536E-03	1.1238E-08	4.5003E-05
NITROGEN	1.6141E-05	0.1228	1.1167E-06	1.3611E-04
CARBON DIOXIDE	2.8528E-04	2.171	3.0505E-05	1.0826E-03
METHANE	4.6044E-03	35.04	4.9246E-04	3.8670E-04
ETHANE	1.3887E-03	10.57	2.3422E-04	2.2960E-03
PROPANE	1.3476E-03	10.25	2.3413E-04	1.1108E-03
I-BUTANE	5.7911E-04	4.407	1.1953E-04	1.3304E-02
N-BUTANE	8.2098E-04	6.247	1.6332E-04	2.3965E-02
I-PENTANE	6.4341E-04	4.896	1.4858E-04	4.8832E-02
N-PENTANE	6.1771E-04	4.700	1.4117E-04	5.8602E-02
N-HEXANE	1.1687E-03	8.893	3.0320E-04	0.1109
N-HEPTANE	1.1005E-03	8.374	3.2032E-04	0.1392
N-OCTANE	5.6859E-04	4.327	1.8366E-04	0.1438
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	1.6908E-08	1.2866E-04	1.8792E-09	5.8337E-04
TOTAL FOR STREAM	1.3142E-02	100.0	2.3722E-03	9.2148E-04

FLOW (TOTAL)	1.3142E-02	LB/MOL/HR
FLOW BY VOLUME	2.3722E-03	GPM @60F
TEMPERATURE	-9.655	F
PRESSURE	813.0	PSIA
MOLECULAR WEIGHT	48.42	LB/LBMOLE
GROSS HEATING VALUE	2.0892E+04	BTU/LB
NET HEATING VALUE	1.9254E+04	BTU/LB

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

LIQUID OUTLET A 72 ( 28.58 BBL/D @60F)

	LB/MOL/HR	MOLE %	GPM @60F	% PLANT FEED
WATER	1.2967E-10	3.8148E-09	4.6698E-12	4.9150E-09
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	5.6468E-08	1.6612E-06	6.0382E-09	2.1429E-07
METHANE	2.7816E-11	8.1831E-10	2.9750E-12	2.3361E-12
ETHANE	8.6789E-03	0.2553	1.4638E-03	1.4349E-02
PROPANE	0.4339	12.77	7.5395E-02	0.3577
I-BUTANE	0.2463	7.247	5.0846E-02	5.659
N-BUTANE	0.3717	10.93	7.3937E-02	10.85
I-PENTANE	0.3263	9.601	7.5360E-02	24.77
N-PENTANE	0.3217	9.465	7.3528E-02	30.52
N-HEXANE	0.6551	19.27	0.1699	62.15
N-HEPTANE	0.6640	19.53	0.1933	83.99
N-OCTANE	0.3714	10.93	0.1200	93.96
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	9.1494E-06	2.6916E-04	1.0168E-06	0.3157
TOTAL FOR STREAM	3.399	100.0	0.8337	0.2383
FLOW (TOTAL)	3.399	LB/MOL/HR		
FLOW BY VOLUME	0.8337	GPM @60F		
TEMPERATURE	120.0	F		
PRESSURE	196.0	PSIA		
MOLECULAR WEIGHT	78.69	LB/LBMOLE		
GROSS HEATING VALUE	2.0839E+04	BTU/LB		
NET HEATING VALUE	1.9294E+04	BTU/LB		



PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

LIQUID OUTLET A 210 ( 631.9 BBL/D @60F)

	LB/MOL/HR	MOLE %	GPM @60F	% PLANT FEED
WATER	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHANE	1.059	1.000	0.1787	1.751
PROPANE	103.8	98.00	18.03	85.56
I-BUTANE	1.059	0.9999	0.2186	24.33
N-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
I-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-HEPTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-OCTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL FOR STREAM	105.9	100.0	18.43	7.426
FLOW (TOTAL)	105.9	LB/MOL/HR		
FLOW BY VOLUME	18.43	GPM @60F		
TEMPERATURE	110.0	F		
PRESSURE	220.1	PSIA		
MOLECULAR WEIGHT	44.09	LB/LBMOLE		
GROSS HEATING VALUE	2.1484E+04	BTU/LB		
NET HEATING VALUE	1.9793E+04	BTU/LB		

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

VAPOR OUTLET 315 ( 3.4486E-04 MMSCFD)

	LEMOL/HR	MOLE %	% PLANT FEED
WATER	1.2632E-03	3.336	4.7879E-02
HELIUM	4.6970E-07	1.2405E-03	1.1883E-04
NITROGEN	2.0564E-04	0.5431	1.7341E-03
CARBON DIOXIDE	1.3205E-02	34.87	5.0112E-02
METHANE	2.0920E-02	55.25	1.7570E-03
ETHANE	1.7287E-03	4.565	2.8582E-03
PROPANE	3.8936E-04	1.028	3.2095E-04
I-BUTANE	3.0701E-05	8.1080E-02	7.0528E-04
N-BUTANE	6.1379E-05	0.1621	1.7917E-03
I-PENTANE	1.3867E-05	3.6622E-02	1.0524E-03
N-PENTANE	1.7394E-05	4.5936E-02	1.6501E-03
N-HEXANE	9.9345E-06	2.6237E-02	9.4249E-04
N-HEPTANE	4.6930E-06	1.2394E-02	5.9363E-04
N-OCTANE	1.1794E-06	3.1147E-03	2.9837E-04
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	1.2704E-05	3.3551E-02	0.4383
TOTAL FOR STREAM	3.7865E-02	100.0	2.6551E-03

FLOW (TOTAL)	3.7865E-02	LEMOL/HR
FLOW BY VOLUME	3.4486E-04	MMSCFD
TEMPERATURE	155.0	F
PRESSURE	65.00	PSIA
MOLECULAR WEIGHT	27.05	LB/LEMOLE
GROSS HEATING VALUE	680.0	BTU/FT^3
NET HEATING VALUE	613.1	BTU/FT^3

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

VAPOR OUTLET 320 ( 2.4037E-02 MMSCFD)

	LB/MOL/HR	MOLE %	% PLANT FEED
WATER	2.616	99.12	99.15
HELIUM	1.6881E-08	6.3961E-07	4.2706E-06
NITROGEN	2.5144E-05	9.5272E-04	2.1204E-04
CARBON DIOXIDE	1.6114E-02	0.6105	6.1148E-02
METHANE	2.3446E-03	8.8836E-02	1.9691E-04
ETHANE	3.0631E-04	1.1606E-02	5.0645E-04
PROPANE	6.6661E-05	2.5258E-03	5.4948E-05
I-BUTANE	3.5744E-06	1.3543E-04	8.2113E-05
N-BUTANE	1.2671E-05	4.8011E-04	3.6988E-04
I-PENTANE	2.2663E-06	8.5872E-05	1.7201E-04
N-PENTANE	3.5154E-06	1.3320E-04	3.3350E-04
N-HEXANE	2.8310E-06	1.0727E-04	2.6858E-04
N-HEPTANE	1.4798E-06	5.6071E-05	1.8719E-04
N-OCTANE	6.2592E-07	2.3716E-05	1.5835E-04
N-NONANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-UNDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-DODECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TRIDECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-TETRADECANE	0.0000E+00	0.0000E+00	0.0000E+00
N-PENTADECANE	0.0000E+00	0.0000E+00	0.0000E+00
BENZENE	0.0000E+00	0.0000E+00	0.0000E+00
TOLUENE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLBENZENE	0.0000E+00	0.0000E+00	0.0000E+00
P-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
M-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
O-XYLENE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOPENTANE	0.0000E+00	0.0000E+00	0.0000E+00
CYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
METHYLCYCLOHEXANE	0.0000E+00	0.0000E+00	0.0000E+00
ETHYLENE GLYCOL	4.3926E-03	0.1664	100.0
TOTAL FOR STREAM	2.639	100.0	0.1851

FLOW (TOTAL)	2.639	LB/MOL/HR
FLOW BY VOLUME	2.4037E-02	MMSCFD
TEMPERATURE	213.6	F
PRESSURE	14.00	PSIA
MOLECULAR WEIGHT	18.25	LB/LBMOLE
GROSS HEATING VALUE	53.42	BTU/FT^3
NET HEATING VALUE	3.211	BTU/FT^3

PLANT OPERATIONS SUMMARY (Continued)

Q050277 BDR - FORT ENERGY - 12 MM Refrig PLANT  
 PROSIM -- Version 98.3. File: Q050277b Fri Jun 17 14:10:12 2005

OVERALL HEAT BUDGET:

BLOCK			DUTY	TEMPERATURE
NUMBER	TYPE NAME		BTU/HR	F
32.00	RBLR DEC2 TOWER	REQUIRES	3.6871E+04	258.9
54.00	RBLR regen	REQUIRES	1.1994E+05	252.8
11.00	EXCH COMP CLR1	SUPPLIES	3.6670E+05	120.0
14.00	EXCH COMP CLR2	SUPPLIES	2.4828E+06	120.0
17.00	EXCH COMP CLR3	SUPPLIES	1.1461E+06	120.0
33.00	EXCH DEC2 COOLER	SUPPLIES	2.3607E+04	120.0
44.00	FLSH C3 ACCUM	SUPPLIES	48.74	110.0
43.00	EXCH C3 COND	SUPPLIES	7.3330E+05	108.2
2.00	FLSH INLET SEP	REQUIRES	421.1	60.00
23.00	EXCH chiller	SUPPLIES	3.4994E+05	-5.000
28.00	FLSH dewpoint	SUPPLIES	1.7096E+06	-9.655
41.00	EXCH C3 CHILLER	REQUIRES	4.6566E+05	-13.37

THIS PLANT SUPPLIES A NET -6.1892E+06 BTU/HR.  
 A TOTAL OF 1.5681E+05 BTU/HR IS REQUIRED FROM EXTERNAL SOURCES.

OVERALL POWER BUDGET:

BLOCK			POWER	THERMAL EQ.
NUMBER	TYPE NAME		HORSEPOWER	BTU/HR
10.00	TRBN COM1	REQUIRES	414.3	1.0541E+06
13.00	TRBN COM2	REQUIRES	850.7	2.1646E+06
16.00	TRBN COM3	REQUIRES	389.6	9.9140E+05
42.00	TRBN C3 COMP	REQUIRES	111.5	2.8376E+05
55.00	PUMP EG INJ PUMP	REQUIRES	1.342	3414.

THIS PLANT REQUIRES A NET 1768. HORSEPOWER OR 4.4973E+06 BTU/HR.

BLOCK NUMBER: 21.00 TYPE: EXCH NAME: gasgasts STATUS: CURRENT

\* PRESSURE DROP 2.000 PSI  
 \* COMPLEX EXCH. OR DUTY FROM 21.010  
 CHANGE IN TEMPERATURE -106.092 F  
 OUTLET TEMPERATURE 14.798 F  
 DUTY -1.6481E+06 BTU/HR  
 APPROACH TEMPERATURE 13.890 F  
 LOG MEAN TEMPERATURE DIFFERENCE 16.670 F  
 APPROACH/UA TOLERANCE 5.000 %  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 \* INITIAL TEMPERATURE GUESS 13.946 F  
 \* MINIMUM ALLOWABLE APPROACH 9.000 F  
 ENDPOINT UA 98867.191 BTU/HR F  
 PERCENT TOTAL LIQUID IN OUTLET 1.402 %

STREAM CROSS REFERENCE.

STREAM 30 COMES FROM BLOCK 20.00 (glymix1 )  
 STREAM 31 GOES TO BLOCK 22.00 (glymix2 )

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	120.9	714.0	0.0000E+00	99.92	98.97
1	110.2	713.8	-1.6481E+05	99.92	98.94
2	99.46	713.6	-3.2962E+05	99.92	98.91
3	88.65	713.4	-4.9443E+05	99.91	98.89
4	77.81	713.2	-6.5924E+05	99.91	98.87
5	66.95	713.0	-8.2405E+05	99.91	98.86
6	56.11	712.8	-9.8886E+05	99.91	98.85
7	45.49	712.6	-1.1537E+06	99.90	98.82
8	35.14	712.4	-1.3185E+06	99.88	98.76
9	24.89	712.2	-1.4833E+06	99.85	98.68
10	14.80	712.0	-1.6481E+06	99.83	98.60

VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LBMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	1322.	2.4035E+04	1.0728E+04	18.18	2.240	0.5958	1.2868E-02	2.3008E-02
1	1322.	2.4027E+04	1.0462E+04	18.18	2.296	0.5967	1.2713E-02	2.2619E-02
2	1322.	2.4020E+04	1.0192E+04	18.18	2.357	0.5981	1.2559E-02	2.2235E-02
3	1321.	2.4015E+04	9918.	18.18	2.421	0.6000	1.2405E-02	2.1857E-02
4	1321.	2.4011E+04	9639.	18.18	2.491	0.6027	1.2252E-02	2.1485E-02
5	1321.	2.4008E+04	9355.	18.18	2.566	0.6062	1.2101E-02	2.1123E-02
6	1321.	2.4006E+04	9067.	18.18	2.648	0.6107	1.1953E-02	2.0770E-02
7	1320.	2.3981E+04	8779.	18.16	2.732	0.6162	1.1811E-02	2.0442E-02
8	1319.	2.3927E+04	8493.	18.13	2.817	0.6228	1.1677E-02	2.0137E-02
9	1319.	2.3871E+04	8204.	18.10	2.910	0.6309	1.1547E-02	1.9847E-02
10	1317.	2.3810E+04	7912.	18.07	3.009	0.6406	1.1424E-02	1.9575E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
0	5.8929E+06	-94.64	679.0
1	5.7383E+06	-94.90	678.5
2	5.5827E+06	-95.11	678.1
3	5.4263E+06	-95.28	677.7
4	5.2690E+06	-95.41	677.4
5	5.1111E+06	-95.51	677.2
6	4.9526E+06	-95.58	677.1
7	4.7940E+06	-95.74	677.1
8	4.6361E+06	-96.00	677.4
9	4.4784E+06	-96.27	677.6
10	4.3210E+06	-96.54	677.9

LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	13.79	554.3	1.040	40.20	66.46	0.7086	3.467	0.1830
1	14.21	562.2	1.052	39.56	66.64	0.7089	3.999	0.1841
2	14.56	568.7	1.061	39.05	66.84	0.7087	4.697	0.1847
3	14.84	573.9	1.067	38.67	67.05	0.7083	5.621	0.1849
4	15.06	577.9	1.071	38.38	67.27	0.7076	6.858	0.1849
5	15.22	580.9	1.073	38.16	67.50	0.7068	8.533	0.1844
6	15.34	583.1	1.073	38.00	67.73	0.7060	10.83	0.1837
7	0.3314	23.38	7.4862E-02	70.56	38.94	0.5388	0.2415	7.9424E-02
8	1.136	76.40	0.2461	67.28	38.70	0.5377	0.2354	8.0309E-02
9	2.061	131.7	0.4273	63.88	38.41	0.5376	0.2277	8.1432E-02
10	3.168	191.3	0.6266	60.38	38.06	0.5387	0.2185	8.2538E-02

BLOCK: 21.00 EXCH NAME: gasgasts

STATUS: CURRENT

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
0	49.43	-2.0007E+05	769.4	1582.
1	50.15	-2.1022E+05	767.5	1603.
2	50.90	-2.1947E+05	766.1	1621.
3	51.56	-2.2785E+05	764.9	1634.
4	52.18	-2.3542E+05	764.1	1645.
5	52.82	-2.4229E+05	763.4	1653.
6	53.43	-2.4856E+05	763.0	1659.
7	10.57	-588.7	306.1	449.7
8	10.37	-2278.	287.8	460.5
9	10.13	-4506.	268.1	472.4
10	9.865	-7335.	247.3	485.2

LIQUID B PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
7	15.43	584.8	1.073	37.89	67.96	0.7054	13.97	0.1827
8	15.49	585.9	1.071	37.82	68.18	0.7050	18.27	0.1816
9	15.54	586.7	1.069	37.77	68.41	0.7045	24.38	0.1810
10	15.57	587.3	1.067	37.73	68.64	0.7046	33.16	0.1806

LIQUID B PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
7	54.01	-2.5425E+05	762.6	1663.
8	54.57	-2.5945E+05	762.3	1665.
9	55.11	-2.6428E+05	762.2	1668.
10	55.65	-2.6893E+05	762.1	1669.

BLOCK NUMBER: 21.01 TYPE: EXCH NAME: gasgasts-1 STATUS: CURRENT

\* PRESSURE DROP 15.000 PSI  
 \* COMPLEX EXCH. OR DUTY FROM 21.000  
 CHANGE IN TEMPERATURE 112.000 F  
 \* OUTLET TEMPERATURE 107.000 F  
 DUTY 1.6481E+06 BTU/HR  
 APPROACH TEMPERATURE 13.890 F  
 LOG MEAN VISCOSITY 0.011893 CP  
 LOG MEAN THERMAL CONDUCTIVITY 0.020730 BTU/FT HR F  
 MEAN HEAT CAPACITY 0.622 BTU/F LB  
 LOG MEAN DENSITY 2.680 LB/FT^3  
 LOG MEAN TEMPERATURE DIFFERENCE 16.670 F  
 APPROACH/UA TOLERANCE 5.000 %  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 MINIMUM ALLOWABLE APPROACH 9.000 F  
 ENDPOINT UA 98867.191 BTU/HR F  
 PERCENT TOTAL LIQUID IN OUTLET 0.000 %

STREAM CROSS REFERENCE.

STREAM 51 COMES FROM BLOCK 24.00 (1tsep )  
 STREAM 50 GOES TO BLOCK 16.00 (COMP3 )

? INDICATES SOLIDS MAY FORM AT THIS POINT.

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
? 0	-5.000	707.0	0.0000E+00	100.0	100.0
1	5.487	705.5	1.6481E+05	100.0	100.0
2	16.22	704.0	3.2962E+05	100.0	100.0
3	27.15	702.5	4.9443E+05	100.0	100.0
4	38.25	701.0	6.5924E+05	100.0	100.0
5	49.49	699.5	8.2405E+05	100.0	100.0
6	60.84	698.0	9.8886E+05	100.0	100.0
7	72.29	696.5	1.1537E+06	100.0	100.0
8	83.81	695.0	1.3185E+06	100.0	100.0
9	95.38	693.5	1.4833E+06	100.0	100.0
10	107.0	692.0	1.6481E+06	100.0	100.0

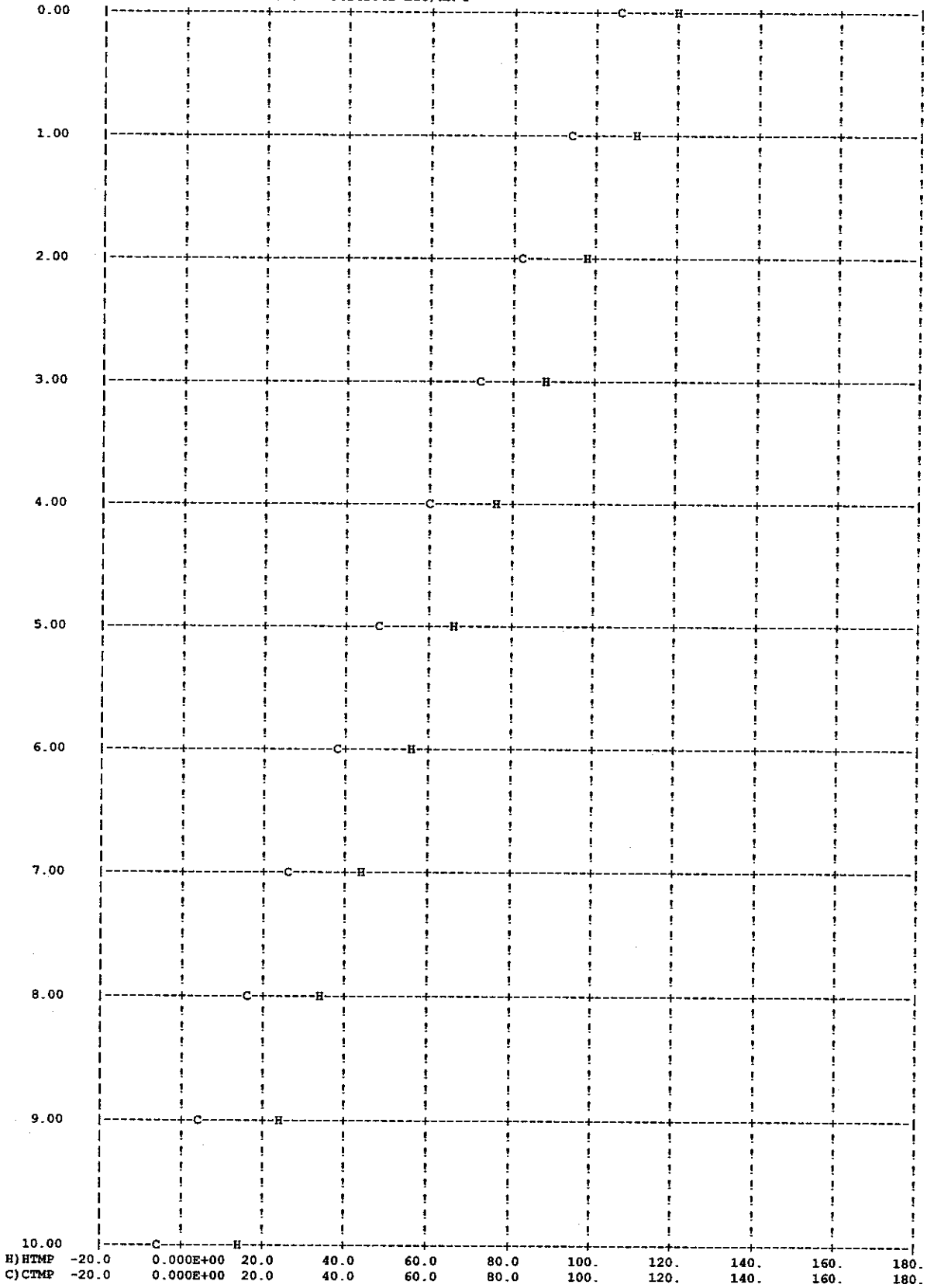
VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LEMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
? 0	1314.	2.3662E+04	7373.	18.01	3.209	0.6651	1.1185E-02	1.9061E-02
1	1314.	2.3662E+04	7715.	18.01	3.067	0.6491	1.1294E-02	1.9310E-02
2	1314.	2.3662E+04	8055.	18.01	2.938	0.6364	1.1415E-02	1.9588E-02
3	1314.	2.3662E+04	8392.	18.01	2.819	0.6261	1.1547E-02	1.9891E-02
4	1314.	2.3662E+04	8728.	18.01	2.711	0.6179	1.1687E-02	2.0215E-02
5	1314.	2.3662E+04	9060.	18.01	2.612	0.6113	1.1833E-02	2.0558E-02
6	1314.	2.3662E+04	9391.	18.01	2.520	0.6060	1.1986E-02	2.0917E-02
7	1314.	2.3662E+04	9719.	18.01	2.435	0.6019	1.2142E-02	2.1292E-02
8	1314.	2.3662E+04	1.0046E+04	18.01	2.355	0.5988	1.2302E-02	2.1681E-02
9	1314.	2.3662E+04	1.0370E+04	18.01	2.282	0.5965	1.2465E-02	2.2082E-02
10	1314.	2.3662E+04	1.0692E+04	18.01	2.213	0.5949	1.2630E-02	2.2494E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
? 0	4.0100E+06	-97.18	678.4
1	4.1748E+06	-97.18	678.4
2	4.3396E+06	-97.18	678.4
3	4.5044E+06	-97.18	678.4
4	4.6693E+06	-97.18	678.4
5	4.8341E+06	-97.18	678.4
6	4.9989E+06	-97.18	678.4
7	5.1637E+06	-97.18	678.4
8	5.3285E+06	-97.18	678.4
9	5.4933E+06	-97.18	678.4
10	5.6581E+06	-97.18	678.4

BLOCK NUMBER: 21.01 TYPE: EXCH NAME: gasgasts-1  
 EFFECTIVE OVERALL DELTA T: 17.11 F  
 EFFECTIVE OVERALL UA: 96345.41 BTU/HR F



H) HTMP	-20.0	0.000E+00	20.0	40.0	60.0	80.0	100.	120.	140.	160.	180.
C) CTMP	-20.0	0.000E+00	20.0	40.0	60.0	80.0	100.	120.	140.	160.	180.



BLOCK NUMBER: 23.00 TYPE: EXCH NAME: chiller STATUS: CURRENT

\* PRESSURE DROP 5.000 PSI  
 CHANGE IN TEMPERATURE -20.914 F  
 \* OUTLET TEMPERATURE -5.000 F  
 DUTY -349939.822 BTU/HR  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 PERCENT TOTAL LIQUID IN OUTLET 2.111 %

STREAM CROSS REFERENCE.  
 STREAM 35 COMES FROM BLOCK 22.00 (glymix2 )  
 STREAM 36 GOES TO BLOCK 24.00 (1tsep )

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	15.91	712.0	0.0000E+00	99.78	98.14
1	13.78	711.5	-3.4994E+04	99.78	98.12
2	11.66	711.0	-6.9988E+04	99.77	98.10
3	9.538	710.5	-1.0498E+05	99.76	98.08
4	7.431	710.0	-1.3998E+05	99.76	98.05
5	5.332	709.5	-1.7497E+05	99.75	98.03
6	3.244	709.0	-2.0996E+05	99.74	98.00
7	1.166	708.5	-2.4496E+05	99.74	97.98
8	-0.9010	708.0	-2.7995E+05	99.73	97.95
9	-2.957	707.5	-3.1495E+05	99.72	97.92
10	-5.000	707.0	-3.4994E+05	99.71	97.89

VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LBMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	1318.	2.3817E+04	7945.	18.08	2.998	0.6394	1.1438E-02	1.9604E-02
1	1317.	2.3803E+04	7889.	18.07	3.017	0.6416	1.1411E-02	1.9546E-02
2	1317.	2.3790E+04	7832.	18.06	3.038	0.6438	1.1384E-02	1.9488E-02
3	1317.	2.3775E+04	7775.	18.06	3.058	0.6461	1.1358E-02	1.9431E-02
4	1316.	2.3761E+04	7718.	18.05	3.079	0.6485	1.1332E-02	1.9375E-02
5	1316.	2.3746E+04	7661.	18.04	3.100	0.6510	1.1307E-02	1.9320E-02
6	1316.	2.3730E+04	7604.	18.04	3.121	0.6536	1.1282E-02	1.9266E-02
7	1315.	2.3714E+04	7546.	18.03	3.143	0.6563	1.1257E-02	1.9213E-02
8	1315.	2.3697E+04	7488.	18.02	3.165	0.6591	1.1233E-02	1.9161E-02
9	1315.	2.3680E+04	7431.	18.01	3.187	0.6620	1.1209E-02	1.9110E-02
10	1314.	2.3662E+04	7373.	18.01	3.209	0.6651	1.1185E-02	1.9061E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
0	4.3385E+06	-96.51	677.9
1	4.3055E+06	-96.57	677.9
2	4.2726E+06	-96.63	678.0
3	4.2396E+06	-96.70	678.0
4	4.2067E+06	-96.76	678.1
5	4.1739E+06	-96.83	678.2
6	4.1410E+06	-96.89	678.2
7	4.1082E+06	-96.96	678.3
8	4.0755E+06	-97.03	678.3
9	4.0427E+06	-97.11	678.4
10	4.0100E+06	-97.18	678.4

LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	3.033	184.3	0.6032	60.78	38.10	0.5385	0.2196	8.2416E-02
1	3.293	197.7	0.6484	60.04	38.02	0.5389	0.2175	8.2649E-02
2	3.566	211.4	0.6950	59.29	37.93	0.5393	0.2154	8.2881E-02
3	3.853	225.6	0.7430	58.55	37.85	0.5398	0.2132	8.3111E-02
4	4.154	240.1	0.7927	57.79	37.76	0.5403	0.2110	8.3340E-02
5	4.471	255.0	0.8442	57.04	37.66	0.5410	0.2087	8.3567E-02
6	4.806	270.5	0.8977	56.29	37.56	0.5417	0.2063	8.3792E-02
7	5.159	286.5	0.9534	55.53	37.46	0.5425	0.2039	8.4015E-02
8	5.533	303.1	1.0111	54.77	37.36	0.5434	0.2014	8.4235E-02
9	5.930	320.3	1.072	54.01	37.25	0.5443	0.1988	8.4452E-02
10	6.351	338.2	1.135	53.25	37.14	0.5454	0.1962	8.4667E-02

BLOCK: 23.00 EXCH NAME: chiller

STATUS: CURRENT

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
0	9.897	-6988.	249.7	483.8
1	9.841	-7664.	245.2	486.6
2	9.783	-8373.	240.7	489.4
3	9.723	-9117.	236.1	492.3
4	9.661	-9897.	231.5	495.3
5	9.597	-1.0715E+04	226.8	498.3
6	9.530	-1.1573E+04	222.1	501.3
7	9.462	-1.2473E+04	217.3	504.4
8	9.391	-1.3416E+04	212.5	507.5
9	9.317	-1.4406E+04	207.7	510.7
10	9.242	-1.5444E+04	202.8	513.9

LIQUID B PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LEMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LEMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	21.96	853.6	1.547	38.87	68.81	0.6959	34.75	0.1775
1	21.96	853.7	1.546	38.87	68.86	0.6959	37.21	0.1774
2	21.97	853.8	1.545	38.86	68.91	0.6959	39.87	0.1773
3	21.97	853.9	1.544	38.86	68.96	0.6960	42.75	0.1772
4	21.98	854.0	1.543	38.86	69.01	0.6961	45.89	0.1772
5	21.98	854.0	1.542	38.86	69.05	0.6962	49.29	0.1772
6	21.98	854.1	1.541	38.85	69.10	0.6963	52.98	0.1772
7	21.99	854.2	1.540	38.85	69.15	0.6964	56.99	0.1772
8	21.99	854.3	1.539	38.85	69.19	0.6966	61.36	0.1773
9	21.99	854.3	1.538	38.85	69.24	0.6967	66.10	0.1773
10	21.99	854.4	1.537	38.85	69.29	0.6969	71.27	0.1773

LIQUID B PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
0	55.14	-3.8065E+05	765.4	1627.
1	55.25	-3.8199E+05	765.4	1628.
2	55.36	-3.8333E+05	765.4	1628.
3	55.47	-3.8466E+05	765.4	1628.
4	55.57	-3.8597E+05	765.4	1628.
5	55.68	-3.8728E+05	765.4	1628.
6	55.79	-3.8858E+05	765.3	1628.
7	55.89	-3.8986E+05	765.3	1628.
8	56.00	-3.9114E+05	765.3	1628.
9	56.10	-3.9241E+05	765.3	1629.
10	56.20	-3.9367E+05	765.3	1629.

BLOCK NUMBER: 30.00 TYPE: EXCH NAME: subcoolr STATUS: CURRENT

\* PRESSURE DROP 1.000 PSI  
 \* COMPLEX EXCH. OR DUTY FROM 30.010  
 CHANGE IN TEMPERATURE 75.000 F  
 \* OUTLET TEMPERATURE 70.000 F  
 DUTY 16078.121 BTU/HR  
 APPROACH TEMPERATURE 40.000 F  
 LOG MEAN TEMPERATURE DIFFERENCE 69.415 F  
 APPROACH/UA TOLERANCE 5.000 %  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 \* MINIMUM ALLOWABLE APPROACH 10.000 F  
 ENDPOINT UA 231.622 BTU/HR F  
 PERCENT TOTAL LIQUID IN OUTLET 85.000 %

STREAM CROSS REFERENCE.

STREAM 40 COMES FROM BLOCK 24.00 (ltsep )  
 STREAM 41 GOES TO BLOCK 31.00 (hclcv )

? INDICATES SOLIDS MAY FORM AT THIS POINT.

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	-5.000	707.0	0.0000E+00	0.0000E+00	0.0000E+00
1	2.499	706.9	1608.	7.429	1.988
2	10.03	706.8	3216.	13.72	3.828
3	17.57	706.7	4823.	19.12	5.534
4	25.13	706.6	6431.	23.80	7.125
5	32.67	706.5	8039.	27.91	8.616
6	40.20	706.4	9647.	31.55	10.02
7	47.70	706.3	1.1255E+04	34.80	11.35
8	55.18	706.2	1.2862E+04	37.73	12.62
9	62.61	706.1	1.4470E+04	40.39	13.83
10	70.00	706.0	1.6078E+04	42.83	15.00

VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LBMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
1	0.1263	2.296	0.7268	18.18	3.159	0.6550	1.1273E-02	1.9177E-02
2	0.2431	4.467	1.434	18.38	3.116	0.6458	1.1365E-02	1.9294E-02
3	0.3515	6.531	2.122	18.58	3.078	0.6375	1.1459E-02	1.9413E-02
4	0.4525	8.509	2.794	18.80	3.045	0.6300	1.1554E-02	1.9531E-02
5	0.5472	10.42	3.452	19.04	3.018	0.6232	1.1650E-02	1.9649E-02
6	0.6364	12.27	4.099	19.29	2.995	0.6172	1.1746E-02	1.9766E-02
7	0.7209	14.09	4.735	19.55	2.976	0.6118	1.1841E-02	1.9882E-02
8	0.8014	15.88	5.365	19.82	2.961	0.6070	1.1936E-02	1.9993E-02
9	0.8785	17.66	5.988	20.11	2.950	0.6027	1.2029E-02	2.0105E-02
10	0.9527	19.44	6.608	20.40	2.942	0.5989	1.2121E-02	2.0216E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
1	396.0	-94.92	678.8
2	782.9	-92.58	679.0
3	1162.	-90.14	679.1
4	1535.	-87.59	679.0
5	1904.	-84.92	678.8
6	2271.	-82.13	678.5
7	2637.	-79.23	678.0
8	3004.	-76.22	677.4
9	3374.	-73.09	676.7
10	3749.	-69.85	675.8

LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	6.351	338.2	1.135	53.25	37.14	0.5454	0.1962	8.4667E-02
1	6.225	335.9	1.129	53.96	37.09	0.5480	0.1930	8.3894E-02
2	6.108	333.7	1.124	54.64	37.02	0.5509	0.1896	8.3067E-02
3	5.999	331.7	1.119	55.28	36.95	0.5540	0.1861	8.2190E-02
4	5.898	329.7	1.115	55.89	36.86	0.5573	0.1825	8.1261E-02
5	5.804	327.8	1.112	56.48	36.76	0.5609	0.1790	8.0280E-02
6	5.715	325.9	1.109	57.03	36.65	0.5645	0.1754	7.9474E-02
7	5.630	324.1	1.106	57.57	36.53	0.5684	0.1719	7.8750E-02
8	5.550	322.3	1.104	58.08	36.41	0.5723	0.1684	7.8003E-02
9	5.472	320.5	1.102	58.57	36.27	0.5764	0.1651	7.7233E-02
10	5.398	318.8	1.100	59.05	36.14	0.5806	0.1618	7.6436E-02

BLOCK: 30.00 EXCH NAME: subcoolr

STATUS: CURRENT

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA	
?	0	9.242	-1.5444E+04	202.8	513.9
	1	9.199	-1.4232E+04	208.8	512.3
	2	9.140	-1.3011E+04	214.5	510.7
	3	9.064	-1.1783E+04	219.9	509.2
	4	8.973	-1.0548E+04	225.1	507.7
	5	8.870	-9309.	229.9	506.3
	6	8.755	-8068.	234.5	505.0
	7	8.630	-6826.	238.9	503.7
	8	8.496	-5586.	243.1	502.4
	9	8.356	-4348.	247.1	501.2
	10	8.209	-3115.	250.9	500.0

BLOCK NUMBER: 30.01 TYPE: EXCH NAME: subcoolr-1 STATUS: CURRENT

\* PRESSURE DROP 1.000 PSI  
 \* COMPLEX EXCH. OR DUTY FROM 30.000  
 CHANGE IN TEMPERATURE -4.405 F  
 OUTLET TEMPERATURE 105.595 F  
 DUTY -16078.121 BTU/HR  
 APPROACH TEMPERATURE 40.000 F  
 LOG MEAN VISCOSITY 0.080947 CP  
 LOG MEAN THERMAL CONDUCTIVITY 0.061945 BTU/FT HR F  
 MEAN HEAT CAPACITY 0.782 BTU/F LB  
 LOG MEAN DENSITY 28.996 LB/FT^3  
 LOG MEAN TEMPERATURE DIFFERENCE 69.415 F  
 APPROACH/UA TOLERANCE 5.000 %  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 \* INITIAL TEMPERATURE GUESS 105.427 F  
 MINIMUM ALLOWABLE APPROACH 10.000 F  
 ENDPOINT UA 231.622 BTU/HR F  
 PERCENT TOTAL LIQUID IN OUTLET 100.000 %

STREAM CROSS REFERENCE.

STREAM 200 COMES FROM BLOCK 0.00 (INLET )  
 STREAM 202 GOES TO BLOCK 40.00 (CHILLER LCV )

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	110.0	220.2	0.0000E+00	0.0000E+00	0.0000E+00
1	109.6	220.1	-1608.	0.0000E+00	0.0000E+00
2	109.1	220.0	-3216.	0.0000E+00	0.0000E+00
3	108.7	219.9	-4823.	0.0000E+00	0.0000E+00
4	108.2	219.8	-6431.	0.0000E+00	0.0000E+00
5	107.8	219.7	-8039.	0.0000E+00	0.0000E+00
6	107.4	219.6	-9647.	0.0000E+00	0.0000E+00
7	106.9	219.5	-1.1255E+04	0.0000E+00	0.0000E+00
8	106.5	219.4	-1.2862E+04	0.0000E+00	0.0000E+00
9	106.0	219.3	-1.4470E+04	0.0000E+00	0.0000E+00
10	105.6	219.2	-1.6078E+04	0.0000E+00	0.0000E+00

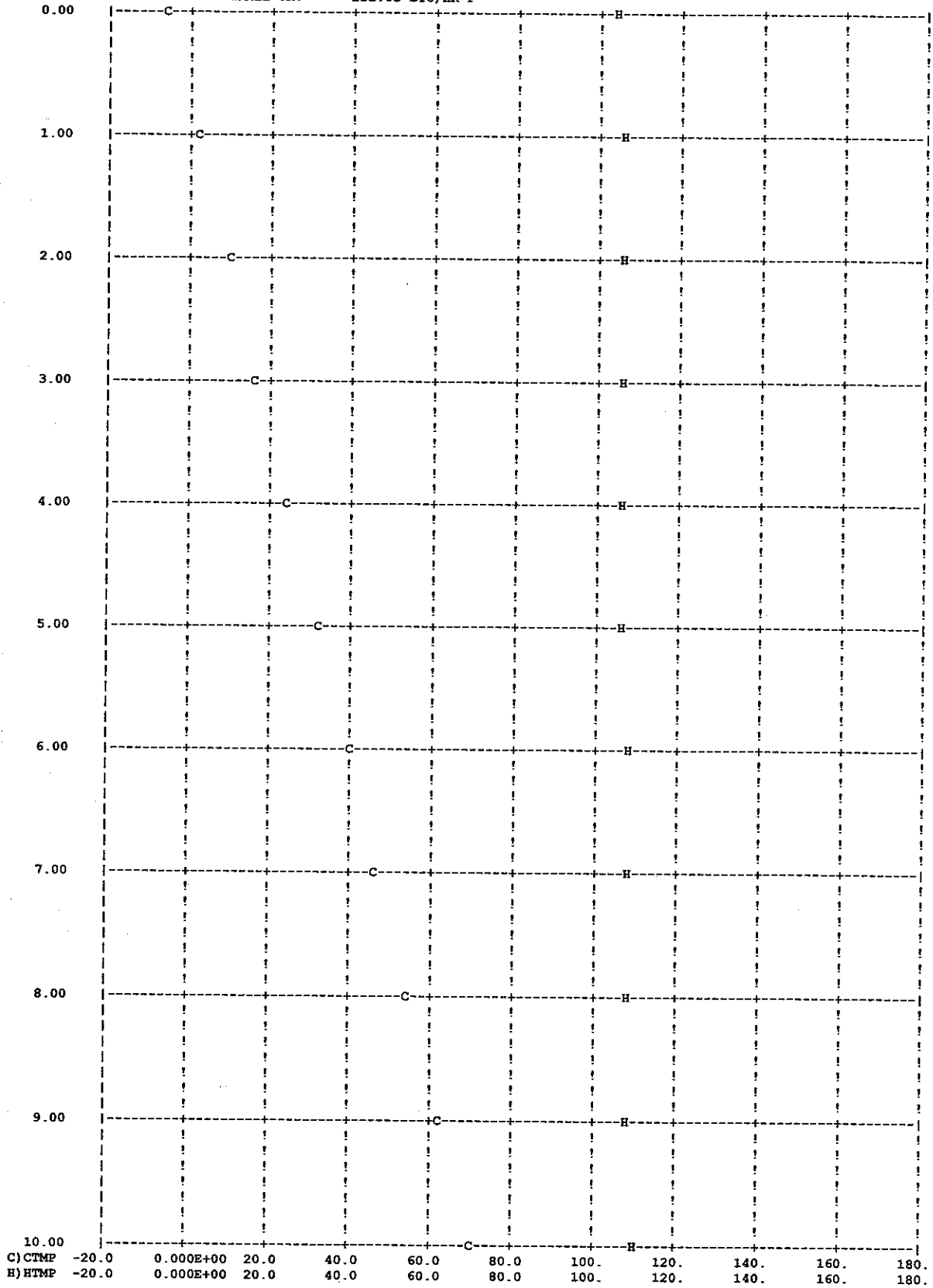
LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	105.9	4670.	20.18	44.09	28.85	0.7910	7.9821E-02	6.1357E-02
1	105.9	4670.	20.16	44.09	28.88	0.7894	8.0044E-02	6.1475E-02
2	105.9	4670.	20.14	44.09	28.91	0.7877	8.0267E-02	6.1592E-02
3	105.9	4670.	20.12	44.09	28.94	0.7861	8.0491E-02	6.1710E-02
4	105.9	4670.	20.10	44.09	28.97	0.7845	8.0716E-02	6.1828E-02
5	105.9	4670.	20.08	44.09	29.00	0.7829	8.0942E-02	6.1946E-02
6	105.9	4670.	20.06	44.09	29.03	0.7813	8.1169E-02	6.2064E-02
7	105.9	4670.	20.04	44.09	29.06	0.7798	8.1396E-02	6.2182E-02
8	105.9	4670.	20.02	44.09	29.09	0.7782	8.1624E-02	6.2300E-02
9	105.9	4670.	20.00	44.09	29.12	0.7767	8.1853E-02	6.2419E-02
10	105.9	4670.	19.98	44.09	29.14	0.7751	8.2082E-02	6.2537E-02

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
0	4.854	4.2717E+04	205.8	616.9
1	4.883	4.1109E+04	205.8	616.9
2	4.912	3.9502E+04	205.8	616.9
3	4.942	3.7894E+04	205.8	616.9
4	4.971	3.6286E+04	205.8	616.9
5	5.000	3.4678E+04	205.8	616.9
6	5.030	3.3071E+04	205.8	616.9
7	5.059	3.1463E+04	205.8	616.9
8	5.089	2.9855E+04	205.8	616.9
9	5.119	2.8247E+04	205.8	616.9
10	5.148	2.6641E+04	205.8	616.9

BLOCK NUMBER: 30.01 TYPE: EXCH NAME: subcoolr-1  
 EFFECTIVE OVERALL DELTA T: 69.29 F  
 EFFECTIVE OVERALL UA: 232.03 BTU/HR F



BLOCK NUMBER: 33.00 TYPE: EXCH NAME: DEC2 COOLER STATUS: CURRENT

\* PRESSURE DROP 5.000 PSI  
 CHANGE IN TEMPERATURE -138.855 F  
 \* OUTLET TEMPERATURE 120.000 F  
 DUTY -23607.184 BTU/HR  
 LOG MEAN VISCOSITY 0.152 CP  
 LOG MEAN THERMAL CONDUCTIVITY 0.061641 BTU/FT HR F  
 MEAN HEAT CAPACITY 0.636 BTU/F LB  
 LOG MEAN DENSITY 35.350 LB/FT^3  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 PERCENT TOTAL LIQUID IN OUTLET 100.000 %

STREAM CROSS REFERENCE.

STREAM 70 COMES FROM BLOCK 32.00 (DEC2 TOWER )  
 STREAM 72 GOES TO BLOCK 0.00 (OUTLET )

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	258.9	201.0	0.0000E+00	1.3886E-02	1.0662E-03
1	246.2	200.5	-2361.	0.0000E+00	0.0000E+00
2	233.3	200.0	-4721.	0.0000E+00	0.0000E+00
3	220.1	199.5	-7082.	0.0000E+00	0.0000E+00
4	206.7	199.0	-9443.	0.0000E+00	0.0000E+00
5	192.9	198.5	-1.1804E+04	0.0000E+00	0.0000E+00
6	178.9	198.0	-1.4164E+04	0.0000E+00	0.0000E+00
7	164.6	197.5	-1.6525E+04	0.0000E+00	0.0000E+00
8	150.0	197.0	-1.8886E+04	0.0000E+00	0.0000E+00
9	135.2	196.5	-2.1246E+04	0.0000E+00	0.0000E+00
10	120.0	196.0	-2.3607E+04	0.0000E+00	0.0000E+00

VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LBMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	3.6243E-05	2.1714E-03	1.1370E-03	59.91	1.910	0.5551	1.0697E-02	1.6638E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
0	0.4523	298.9	527.4

LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	3.399	267.5	1.021	78.69	32.67	0.7081	0.1062	5.3737E-02
1	3.399	267.5	1.003	78.69	33.25	0.6917	0.1131	5.4895E-02
2	3.399	267.5	0.9858	78.69	33.83	0.6765	0.1203	5.6028E-02
3	3.399	267.5	0.9696	78.69	34.39	0.6622	0.1279	5.7365E-02
4	3.399	267.5	0.9542	78.69	34.95	0.6487	0.1359	5.8771E-02
5	3.399	267.5	0.9395	78.69	35.50	0.6357	0.1570	6.0805E-02
6	3.399	267.5	0.9253	78.69	36.04	0.6232	0.1649	6.2624E-02
7	3.399	267.5	0.9117	78.69	36.58	0.6111	0.1739	6.4401E-02
8	3.399	267.5	0.8985	78.69	37.11	0.5993	0.1840	6.6148E-02
9	3.399	267.5	0.8859	78.69	37.64	0.5878	0.1954	6.8045E-02
10	3.399	267.5	0.8736	78.69	38.17	0.5764	0.2085	7.0285E-02

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
0	5.815	2.4731E+04	401.1	454.7
1	6.422	2.2371E+04	401.1	454.7
2	7.057	2.0010E+04	401.1	454.7
3	7.721	1.7649E+04	401.1	454.7
4	8.411	1.5289E+04	401.1	454.7
5	9.128	1.2928E+04	401.1	454.7
6	9.872	1.0567E+04	401.1	454.7
7	10.64	8207.	401.1	454.7
8	11.44	5846.	401.1	454.7
9	12.26	3485.	401.1	454.7
10	13.11	1124.	401.1	454.7

BLOCK NUMBER: 43.00 TYPE: EXCH NAME: C3 COND STATUS: CURRENT

\* PRESSURE DROP 5.000 PSI  
 CHANGE IN TEMPERATURE -55.460 F  
 OUTLET TEMPERATURE 108.158 F  
 \* DUTY -733300.000 BTU/HR  
 \* INCREMENTS ON TRANSFER CURVE 10.000  
 PERCENT TOTAL LIQUID IN OUTLET 98.897 %

STREAM CROSS REFERENCE.  
 STREAM 205 COMES FROM BLOCK 42.00 (C3 COMP )  
 STREAM 206 GOES TO BLOCK 44.00 (C3 ACCUM )

TEMPERATURE/DUTY CURVE:

INCREMENT NUMBER	TEMPERATURE F	PRESSURE PSIA	DUTY BTU/HR	VAPOR VOLUME %	VAPOR MOLE %
0	163.6	220.0	0.0000E+00	100.0	100.0
1	132.9	219.5	-7.3330E+04	100.0	100.0
2	111.2	219.0	-1.4666E+05	99.74	96.48
3	110.8	218.5	-2.1999E+05	98.70	84.50
4	110.5	218.0	-2.9332E+05	97.37	72.53
5	110.1	217.5	-3.6665E+05	95.57	60.57
6	109.8	217.0	-4.3998E+05	93.02	48.63
7	109.4	216.5	-5.1331E+05	89.13	36.70
8	109.0	216.0	-5.8664E+05	82.39	24.80
9	108.6	215.5	-6.5997E+05	67.89	12.93
10	108.2	215.0	-7.3330E+05	13.75	1.103

VAPOR PROPERTIES:

INCREMENT NUMBER	VAPOR FLOW RATE LBMOL/HR	VAPOR FLOW RATE LB/HR	VAPOR FLOW RATE ACFH	MOLECULAR WEIGHT LB/LBMOLE	VAPOR DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	VAPOR VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
0	105.9	4670.	2675.	44.09	1.746	0.5140	1.0202E-02	1.4434E-02
1	105.9	4670.	2440.	44.09	1.914	0.5129	9.8452E-03	1.3368E-02
2	102.2	4505.	2181.	44.09	2.065	0.5185	9.6070E-03	1.2660E-02
3	89.50	3943.	1915.	44.06	2.059	0.5180	9.6003E-03	1.2647E-02
4	76.82	3383.	1647.	44.03	2.054	0.5175	9.5939E-03	1.2634E-02
5	64.15	2823.	1379.	44.01	2.048	0.5171	9.5876E-03	1.2622E-02
6	51.50	2265.	1109.	43.98	2.042	0.5166	9.5814E-03	1.2609E-02
7	38.87	1708.	839.4	43.95	2.035	0.5161	9.5752E-03	1.2597E-02
8	26.27	1154.	568.6	43.91	2.029	0.5156	9.5690E-03	1.2584E-02
9	13.70	600.9	297.2	43.87	2.022	0.5151	9.5628E-03	1.2571E-02
10	1.168	51.19	25.41	43.81	2.015	0.5145	9.5564E-03	1.2557E-02

VAPOR PROPERTIES: (Continued)

INCREMENT NUMBER	VAPOR ENTHALPY BTU/HR	VAPOR PSEUDO Tc F	VAPOR PSEUDO Pc PSIA
0	7.7607E+05	205.8	616.9
1	7.0274E+05	205.8	616.9
2	6.2780E+05	205.7	617.0
3	5.4918E+05	205.5	617.2
4	4.7083E+05	205.4	617.4
5	3.9274E+05	205.2	617.5
6	3.1493E+05	205.0	617.7
7	2.3742E+05	204.8	617.9
8	1.6023E+05	204.5	618.1
9	8.3425E+04	204.1	618.3
10	7103.	203.7	618.6

LIQUID A PROPERTIES:

INCREMENT NUMBER	LIQUID FLOW RATE LBMOL/HR	LIQUID FLOW RATE LB/HR	LIQUID FLOW RATE GPM	MOLECULAR WEIGHT LB/LBMOLE	LIQUID DENSITY LB/FT^3	HEAT CAPACITY BTU/F LB	LIQUID VISCOSITY CP	THERMAL CONDUCTIVITY BTU/FT HR F
2	3.725	165.1	0.7130	44.32	28.87	0.7900	7.9886E-02	6.1085E-02
3	16.41	726.8	3.138	44.28	28.88	0.7896	7.9976E-02	6.1172E-02
4	29.09	1287.	5.557	44.25	28.89	0.7891	8.0071E-02	6.1258E-02
5	41.76	1847.	7.969	44.23	28.90	0.7886	8.0170E-02	6.1344E-02
6	54.41	2405.	10.37	44.20	28.91	0.7880	8.0275E-02	6.1431E-02
7	67.04	2962.	12.77	44.18	28.92	0.7874	8.0385E-02	6.1523E-02
8	79.64	3516.	15.15	44.15	28.93	0.7867	8.0503E-02	6.1621E-02
9	92.21	4069.	17.52	44.13	28.95	0.7860	8.0631E-02	6.1729E-02
10	104.7	4619.	19.88	44.10	28.97	0.7851	8.0773E-02	6.1853E-02

LIQUID A PROPERTIES: (Continued)

INCREMENT NUMBER	SURFACE TENSION DYNES/CM	LIQUID ENTHALPY BTU/HR	LIQUID PSEUDO Tc F	LIQUID PSEUDO Pc PSIA
2	4.852	1608.	207.1	615.4
3	4.866	6901.	206.9	615.6
4	4.880	1.1923E+04	206.8	615.9
5	4.894	1.6675E+04	206.6	616.1



6	4.909	2.1153E+04	206.5	616.2
7	4.924	2.5337E+04	206.3	616.4
8	4.941	2.9196E+04	206.2	616.6
9	4.959	3.2672E+04	206.0	616.7
10	4.978	3.5665E+04	205.8	616.9

BLOCK NUMBER: 32.00 TYPE: STIL NAME: DEC2 TOWER STATUS: CURRENT

\* NUMBER OF IDEAL STAGES 15.000  
 \* PRESSURE 200.000 PSIA  
 \* PRESSURE DROP 1.000 PSI  
 \* PACKING FACTOR 28.000 1/FT  
 \* PERCENT OF FLOOD 70.000 %  
 \* ERROR TOLERANCE 1.0000E-05 %  
 \* REBOILER PRESSURE DROP 0.000 PSI  
 REBOILER DUTY 36871.080 BTU/HR  
 PERCENT OF FEED TO BOTTOMS 53.522 %  
 BOTTOMS FLOW RATE 3.399 LEMOL/HR  
 BOTTOMS TEMPERATURE 258.855 F  
 PERCENTAGE OF FEED TO OVERHEADS 46.478 %  
 OVERHEAD FLOW RATE 2.952 LEMOL/HR  
 OVERHEAD TEMPERATURE 54.973 F  
 \* RECALCULATE INITIAL PROFILES NO  
 \* ALTERNATE INITIAL PROFILES NO  
 \* VAPOR STAGE EFFICIENCY YES  
 \* MAXIMUM NUMBER OF STEPS 150.000  
 \* COLUMN SYSTEM FACTOR 1.000

SPECIFICATION=ETHANE /PROPANE  
 STAGE=BOTTOM ,MOLAR RATIO = 0.020000  
 STREAM CROSS REFERENCE.  
 STREAM 42 COMES FROM BLOCK 31.00 (hclcv ) TO STAGE 1  
 STREAM 80 GOES TO BLOCK 35.00 (DEC2 PCV )  
 STREAM 70 GOES TO BLOCK 33.00 (DEC2 COOLER )  
 INTERNAL STREAM 33 COMES FROM REBOILER AND GOES TO STAGE 14  
 INTERNAL STREAM 34 COMES FROM STAGE 14 AND GOES TO REBOILER

COLUMN INTERNAL INFORMATION							
FROM STAGE	TEMPERATURE F	PRESSURE PSIA	LIQUID LEMOL/HR	VAPOR LEMOL/HR	HEAT DUTY BTU/HR	DIAMETER FT	
1	54.97	200.0	4.189	2.952	0.0000E+00	0.181	
2	78.62	200.1	4.831	0.7900	0.0000E+00	0.144	
3	90.10	200.2	5.186	1.432	0.0000E+00	0.168	
4	93.77	200.2	5.299	1.787	0.0000E+00	0.178	
5	95.56	200.3	5.340	1.900	0.0000E+00	0.181	
6	97.77	200.4	5.374	1.941	0.0000E+00	0.183	
7	101.9	200.5	5.432	1.975	0.0000E+00	0.185	
8	109.3	200.5	5.545	2.033	0.0000E+00	0.189	
9	120.9	200.6	5.744	2.146	0.0000E+00	0.196	
10	135.2	200.7	6.020	2.345	0.0000E+00	0.207	
11	149.5	200.8	6.311	2.621	0.0000E+00	0.218	
12	162.9	200.8	6.538	2.912	0.0000E+00	0.230	
13	178.3	200.9	6.639	3.139	0.0000E+00	0.239	
14	204.2	201.0	6.522	3.240	0.0000E+00	0.248	
15	258.9	201.0	3.399	3.123	3.6871E+04		

LIQUID PHYSICAL PROPERTIES							
FROM STAGE	MOLECULAR WT LB/LBMOLE	DENSITY LB/FT^3	VISCOSITY CP	SURFACE TENS DYNES/CM	THERM COND BTU/FT HR F	FLOW RATE GFM	
1	69.54	38.74	0.2332	13.76	7.7639E-02	0.9376	
2	65.23	37.15	0.1897	11.68	7.3100E-02	1.058	
3	63.32	36.30	0.1732	10.69	7.0463E-02	1.128	
4	62.77	36.02	0.1686	10.38	6.9570E-02	1.152	
5	62.64	35.90	0.1668	10.27	6.9378E-02	1.162	
6	62.65	35.82	0.1655	10.16	6.9200E-02	1.172	
7	62.75	35.68	0.1633	9.993	6.8861E-02	1.191	
8	62.92	35.43	0.1596	9.683	6.8121E-02	1.228	
9	63.13	35.02	0.1541	9.185	6.6613E-02	1.291	
10	63.36	34.48	0.1476	8.551	6.4103E-02	1.379	
11	63.70	33.95	0.1265	7.928	6.2048E-02	1.476	
12	64.37	33.52	0.1202	7.414	6.0655E-02	1.565	
13	65.90	33.20	0.1156	6.990	5.9310E-02	1.643	
14	69.70	32.99	0.1119	6.549	5.7014E-02	1.718	
15	78.69	32.67	0.1062	5.815	5.3737E-02	1.021	

BLOCK NUMBER: 32.00 TYPE: STILL NAME: DEC2 TOWER

VAPOR PHYSICAL PROPERTIES					
FROM	MOLECULAR WT	DENSITY	VISCOSITY	THERM COND	FLOW RATE
STAGE	LB/LBMOLE	LB/FT^3	CP	BTU/FT HR F	ACFH
1	23.96	0.9269	1.0445E-02	1.5734E-02	76.29
2	30.21	1.159	1.0237E-02	1.4013E-02	20.58
3	33.30	1.284	1.0039E-02	1.3350E-02	37.15
4	34.08	1.316	9.9491E-03	1.3230E-02	46.27
5	34.30	1.324	9.9148E-03	1.3236E-02	49.21
6	34.54	1.331	9.9093E-03	1.3276E-02	50.40
7	35.06	1.343	9.9246E-03	1.3351E-02	51.56
8	36.10	1.369	9.9578E-03	1.3473E-02	53.60
9	37.95	1.420	9.9992E-03	1.3640E-02	57.36
10	40.58	1.498	1.0032E-02	1.3820E-02	63.51
11	43.49	1.589	1.0053E-02	1.3994E-02	71.76
12	46.20	1.671	1.0083E-02	1.4194E-02	80.50
13	48.86	1.739	1.0155E-02	1.4509E-02	88.17
14	52.49	1.803	1.0329E-02	1.5171E-02	94.30
15	59.91	1.910	1.0697E-02	1.6638E-02	97.98

BLOCK NUMBER: 32.00 TYPE: STIL NAME: DEC2 TOWER

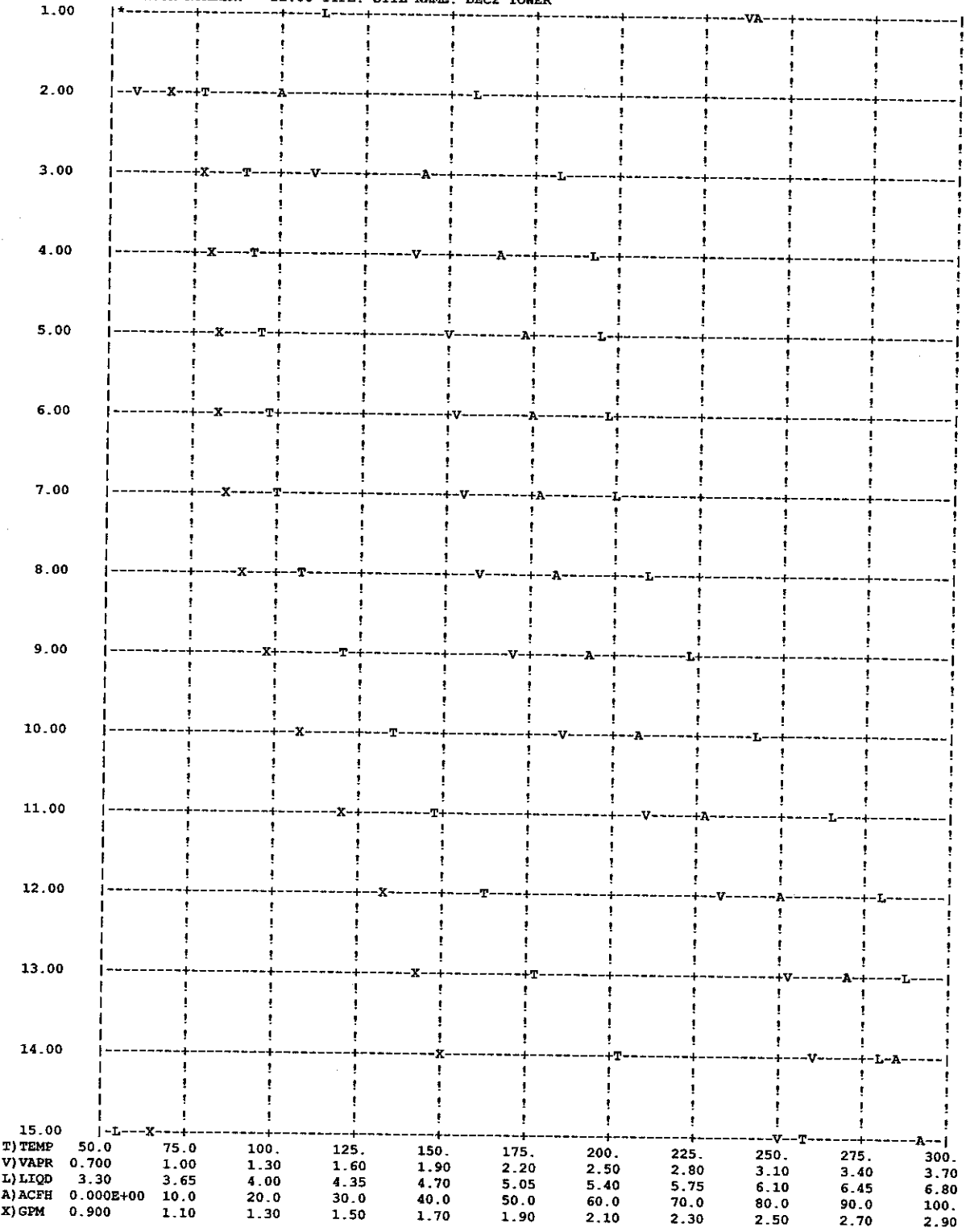
	STAGE # 1			
	COMPOSITION MOLE PERCENT	FLOW RATE LB/MOL/HR	FLOW RATE LB/HR	% OF FEED
WATER	3.5778E-03	1.0561E-04	1.9026E-03	100.00
HELIUM	2.3267E-03	6.8678E-05	2.7492E-04	100.0
NITROGEN	0.2194	6.4757E-03	0.1814	100.0
CARBON DIOXIDE	4.141	0.1222	5.379	100.0
METHANE	64.01	1.890	30.31	100.0
ETHANE	20.72	0.6116	18.39	98.60
PROPANE	6.931	0.2046	9.022	32.04
I-BUTANE	1.387	4.0928E-02	2.379	14.25
N-BUTANE	1.451	4.2832E-02	2.489	10.33
I-PENTANE	0.4793	1.4149E-02	1.021	4.155
N-PENTANE	0.3684	1.0873E-02	0.7845	3.269
N-HEXANE	0.2067	6.1012E-03	0.5258	0.9228
N-HEPTANE	6.5403E-02	1.9306E-03	0.1934	0.2899
N-OCTANE	1.2064E-02	3.5612E-04	4.0676E-02	9.5789E-02
ETHYLENE GLYCOL	1.1809E-05	3.4858E-07	2.1636E-05	3.670
TOTALS FOR PRODUCT	100.0	2.952	70.72	46.48

TEMPERATURE: 54.97 F  
 PRESSURE: 200.0 PSIA  
 MOLECULAR WT: 23.96 LB/LBMOLE  
 DENSITY: 0.9269 LB/FT^3  
 VISCOSITY: 1.0445E-02 CP  
 THERM COND: 1.5734E-02 BTU/FT HR F

	STAGE # 15			
	COMPOSITION MOLE PERCENT	FLOW RATE LB/MOL/HR	FLOW RATE LB/HR	% OF FEED
WATER	3.8148E-09	0.0000E+00	2.3360E-09	1.2278E-04
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
CARBON DIOXIDE	1.6612E-06	5.6468E-08	2.4852E-06	4.6200E-05
METHANE	0.0000E+00	0.0000E+00	0.0000E+00	1.4721E-09
ETHANE	0.2553	8.6789E-03	0.2610	1.399
PROPANE	12.77	0.4339	19.13	67.96
I-BUTANE	7.247	0.2463	14.32	85.75
N-BUTANE	10.93	0.3717	21.60	89.67
I-PENTANE	9.601	0.3263	23.54	95.84
N-PENTANE	9.465	0.3217	23.21	96.73
N-HEXANE	19.27	0.6551	56.45	99.08
N-HEPTANE	19.53	0.6640	66.53	99.71
N-OCTANE	10.93	0.3714	42.42	99.90
ETHYLENE GLYCOL	2.6916E-04	9.1494E-06	5.6788E-04	96.33
TOTALS FOR PRODUCT	100.0	3.399	267.5	53.52

TEMPERATURE: 258.9 F  
 PRESSURE: 201.0 PSIA  
 MOLECULAR WT: 78.69 LB/LBMOLE  
 DENSITY: 32.67 LB/FT^3  
 VISCOSITY: 0.1062 CP  
 THERM COND: 5.3737E-02 BTU/FT HR F  
 SUR TEN 5.815 DYNES/CM

BLOCK NUMBER: 32.00 TYPE: STIL NAME: DEC2 TOWER



BLOCK NUMBER: 54.00 TYPE: STILL NAME: regen STATUS: CURRENT

* NUMBER OF IDEAL STAGES	4.000	
* PRESSURE	14.000	PSIA
* PRESSURE DROP	0.000	PSI
* PACKING FACTOR	48.000	1/FT
* PERCENT OF FLOOD	70.000	%
* ERROR TOLERANCE	1.0000E-05	%
* REBOILER PRESSURE DROP	0.000	PSI
REBOILER DUTY	119942.372	BTU/HR
PERCENT OF FEED TO BOTTOMS	87.980	%
BOTTOMS FLOW RATE	19.317	LBMOL/HR
BOTTOMS TEMPERATURE	252.786	F
* CONDENSER TYPE OR % LIQUID	0.000	%
* CONDENSER PRESSURE DROP	0.000	PSI
CONDENSER HEAT DUTY	-12756.007	BTU/HR
COND COMPLEX EXCH. OR DUTY FROM	50.000	
PERCENTAGE OF FEED TO OVERHEADS	12.020	%
OVERHEAD FLOW RATE	2.639	LBMOL/HR
OVERHEAD TEMPERATURE	213.608	F
CONDENSER MINIMUM APPROACH	1.000	F
CONDENSER APPROACH TEMPERATURE	218.723	F
CONDENSER LMTD	217.238	F
* REFLUX RATIO	0.250	
* TOP TEMPERATURE ESTIMATE	200.000	F
* BOTTOM TEMPERATURE ESTIMATE	255.000	F
* RECALCULATE INITIAL PROFILES	NO	
* ALTERNATE INITIAL PROFILES	NO	
* T AT SECOND STAGE GUESS	210.000	F
CONDENSER ENDPPOINT UA	58.719	BTU/HR F
* VAPOR STAGE EFFICIENCY	YES	
* MAXIMUM NUMBER OF STEPS	150.000	
* COLUMN SYSTEM FACTOR	1.000	

SPECIFICATION=ETHYLENE GLYCOL,STAGE=BOTTOM,COMA= 80.000000  
 STREAM CROSS REFERENCE.

STREAM 317	COMES FROM BLOCK	53.00 (flashlv	)	TO STAGE	2
STREAM 320	GOES TO BLOCK	0.00 (OUTLET	)		
STREAM 330	GOES TO BLOCK	51.00 (leanrich	)		
INTERNAL STREAM	38	COMES FROM CONDENSER	AND GOES TO STAGE	2	
INTERNAL STREAM	47	COMES FROM REBOILER	AND GOES TO STAGE	3	
INTERNAL STREAM	37	COMES FROM STAGE	2 AND GOES TO CONDENSER		
INTERNAL STREAM	39	COMES FROM STAGE	3 AND GOES TO REBOILER		

COLUMN INTERNAL INFORMATION

FROM STAGE	TEMPERATURE F	PRESSURE PSIA	LIQUID LBMOL/HR	VAPOR LBMOL/HR	HEAT DUTY BTU/HR	DIAMETER FT
1	213.6	14.00	0.6598	2.639	-1.2756E+04	
2 F	238.0	14.00	25.68	3.299	0.0000E+00	0.323
3	238.8	14.00	25.62	6.363	0.0000E+00	0.399
4	252.8	14.00	19.32	6.300	1.1994E+05	

LIQUID PHYSICAL PROPERTIES

FROM STAGE	MOLECULAR WT LB/LBMOLE	DENSITY LB/FT^3	VISCOSITY CP	SURFACE TENS DYNES/CM	TENS BTU/FT HR F	COND	FLOW RATE GPM
1	21.65	60.53	0.3852	53.00	0.3194		2.9418E-02
2	36.02	62.75	0.7823	44.47	0.2025		1.838
3	36.25	62.75	0.7847	44.37	0.2016		1.845
4	41.68	62.94	0.8616	42.47	0.1831		1.595

BLOCK NUMBER: 54.00 TYPE: STIL NAME: regen

VAPOR PHYSICAL PROPERTIES					
FROM	MOLECULAR WT	DENSITY	VISCOSITY	THERM COND	FLOW RATE
STAGE	LB/LBMOLE	LB/FT^3	CP	BTU/FT HR F	ACFH
1	18.25	3.5639E-02	1.2901E-02	1.4552E-02	1351.
2	18.93	3.5657E-02	1.3354E-02	1.5027E-02	1751.
3	18.83	3.5431E-02	1.3307E-02	1.5043E-02	3381.
4	19.57	3.6109E-02	1.3561E-02	1.5243E-02	3415.

BLOCK NUMBER: 54.00 TYPE: STILL NAME: regen

	STAGE # 1			
	COMPOSITION MOLE PERCENT	FLOW RATE LBMOL/HR	FLOW RATE LB/HR	% OF FEED
WATER	99.12	2.616	47.13	22.64
HELIUM	6.3961E-07	1.6881E-08	6.7573E-08	100.0
NITROGEN	9.5272E-04	2.5144E-05	7.0444E-04	100.0
CARBON DIOXIDE	0.6105	1.6114E-02	0.7092	100.0
METHANE	8.8836E-02	2.3446E-03	3.7612E-02	100.0
ETHANE	1.1606E-02	3.0631E-04	9.2102E-03	100.0
PROPANE	2.5258E-03	6.6661E-05	2.9393E-03	100.0
I-BUTANE	1.3543E-04	3.5744E-06	2.0774E-04	100.0
N-BUTANE	4.8011E-04	1.2671E-05	7.3645E-04	100.0
I-PENTANE	8.5872E-05	2.2663E-06	1.6351E-04	100.0
N-PENTANE	1.3320E-04	3.5154E-06	2.5362E-04	100.0
N-HEXANE	1.0727E-04	2.8310E-06	2.4396E-04	100.0
N-HEPTANE	5.6071E-05	1.4798E-06	1.4828E-04	100.0
N-OCTANE	2.3716E-05	6.2592E-07	7.1493E-05	100.0
ETHYLENE GLYCOL	0.1664	4.3926E-03	0.2726	4.2307E-02
TOTALS FOR PRODUCT	100.0	2.639	48.16	12.02

TEMPERATURE: 213.6 F  
 PRESSURE: 14.00 PSIA  
 MOLECULAR WT: 18.25 LB/LBMOLE  
 DENSITY: 3.5639E-02 LB/FT^3  
 VISCOSITY: 1.2901E-02 CP  
 THERM COND: 1.4552E-02 BTU/FT HR F

	STAGE # 4			
	COMPOSITION MOLE PERCENT	FLOW RATE LBMOL/HR	FLOW RATE LB/HR	% OF FEED
WATER	46.27	8.939	161.0	77.36
HELIUM	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
NITROGEN	0.0000E+00	0.0000E+00	0.0000E+00	2.4779E-09
CARBON DIOXIDE	0.0000E+00	0.0000E+00	2.5562E-09	3.6046E-07
METHANE	0.0000E+00	0.0000E+00	0.0000E+00	1.4434E-09
ETHANE	0.0000E+00	0.0000E+00	0.0000E+00	3.5987E-09
PROPANE	0.0000E+00	0.0000E+00	0.0000E+00	2.9465E-09
I-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00	1.1990E-09
N-BUTANE	0.0000E+00	0.0000E+00	0.0000E+00	5.2871E-09
I-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	2.2456E-09
N-PENTANE	0.0000E+00	0.0000E+00	0.0000E+00	3.2068E-09
N-HEXANE	0.0000E+00	0.0000E+00	0.0000E+00	9.0913E-09
N-HEPTANE	0.0000E+00	0.0000E+00	0.0000E+00	6.3890E-09
N-OCTANE	0.0000E+00	0.0000E+00	0.0000E+00	2.7300E-08
ETHYLENE GLYCOL	53.73	10.38	644.2	99.96
TOTALS FOR PRODUCT	100.0	19.32	805.2	87.98

TEMPERATURE: 252.8 F  
 PRESSURE: 14.00 PSIA  
 MOLECULAR WT: 41.68 LB/LBMOLE  
 DENSITY: 62.94 LB/FT^3  
 VISCOSITY: 0.8616 CP  
 THERM COND: 0.1831 BTU/FT HR F  
 SUR TEN 42.47 DYNES/CM





X) GPM 0.000E+00 0.200 0.400 0.600 0.800 1.00 1.20 1.40 1.60 1.80 2.00

BLOCK NUMBER: 38.00 TYPE: TEST NAME: TEST38.0 STATUS: CURRENT

* Type of Test	PHASE	
* Number of Test Stages		1.000
* Type of stages	RATIO	
* Lowest Pressure	200.000	PSIA
* Final Temperature	-40.000	F
* Start Vapor Quality	100.000	%
Cricondenbar Temperature	-44.746	F
Cricondenbar Pressure	1071.964	PSIA
Cricondenthern Temperature	-1.218	F
Cricondenthern Pressure	483.805	PSIA
Critical Temperature	-81.116	F
Critical Pressure	913.043	PSIA
* Dry basis used in calculations?	YES	
* Number of points on Solids Line	0.000	

STREAM CROSS REFERENCE.

STREAM 54 COMES FROM BLOCK 17.00 (COMP CLR3 )

PHASE TEST: TEST38.0                      NUMBER:    38.00 (Continued)

Temperature F	Pressure PSIA	Percent Vapor %
-58.94	14.70	100.0
-58.76	14.84	100.0
-57.75	15.71	100.0
-56.00	17.31	100.0
-52.68	20.77	100.0
-49.47	24.71	100.0
-46.00	29.74	100.0
-42.66	35.46	100.0
-39.45	41.91	100.0
-36.00	50.10	100.0
-32.71	59.35	100.0
-29.19	71.11	100.0
-25.87	84.42	100.0
-23.07	97.59	100.0
-20.45	112.0	100.0
-18.26	125.9	100.0
-16.43	139.0	100.0
-14.73	152.8	100.0
-13.15	167.2	100.0
-11.84	180.4	100.0
-10.62	194.1	100.0
-9.505	208.0	100.0
-8.477	222.1	100.0
-7.537	236.5	100.0
-6.680	251.0	100.0
-5.980	264.1	100.0
-5.345	277.2	100.0
-4.769	290.3	100.0
-4.250	303.3	100.0
-3.734	317.7	100.0
-3.277	332.1	100.0
-2.877	346.4	100.0
-2.528	360.5	100.0
-2.229	374.5	100.0
-1.976	388.3	100.0
-1.765	401.8	100.0
-1.593	415.2	100.0
-1.457	428.3	100.0
-1.344	442.6	100.0
-1.269	456.6	100.0
-1.228	470.4	100.0
-1.218	483.8	100.0
-1.236	496.9	100.0
-1.286	511.2	100.0
-1.366	525.1	100.0
-1.471	538.6	100.0
-1.599	551.8	100.0
-1.766	566.0	100.0
-1.957	579.8	100.0
-2.168	593.2	100.0
-2.425	607.7	100.0
-2.702	621.7	100.0
-2.997	635.3	100.0
-3.340	649.7	100.0
-3.692	663.4	100.0
-4.090	677.7	100.0
-4.492	691.2	100.0
-4.941	705.2	100.0
-5.391	718.4	100.0
-5.889	732.2	100.0
-6.440	746.6	100.0
-6.986	760.0	100.0
-7.587	774.0	100.0
-8.244	788.4	100.0
-8.893	801.8	100.0
-9.599	815.7	100.0
-10.37	830.0	100.0
-11.12	843.3	100.0
-11.94	856.9	100.0
-12.82	870.8	100.0
-13.77	884.9	100.0
-14.79	899.3	100.0
-15.90	913.7	100.0
-17.08	928.2	100.0
-18.35	942.7	100.0
-19.70	957.0	100.0
-21.14	971.0	100.0
-22.67	984.7	100.0
-24.45	999.1	100.0
-26.34	1013.	100.0
-28.51	1026.	100.0
-31.26	1041.	100.0

-34.67	1055.	100.0
-38.08	1064.	100.0
-41.46	1070.	100.0
-44.75	1072.	100.0
-48.21	1071.	100.0
-51.75	1066.	100.0
-55.28	1057.	100.0
-58.71	1046.	100.0
-61.72	1034.	100.0
-64.61	1020.	100.0
-67.19	1006.	100.0
-69.57	992.7	100.0
-71.85	978.7	100.0
-74.09	964.0	100.0
-76.19	949.6	100.0
-78.18	935.2	100.0

**Fort Energy 8B Refrigeration Unit - Fort Assinibone, Alberta**

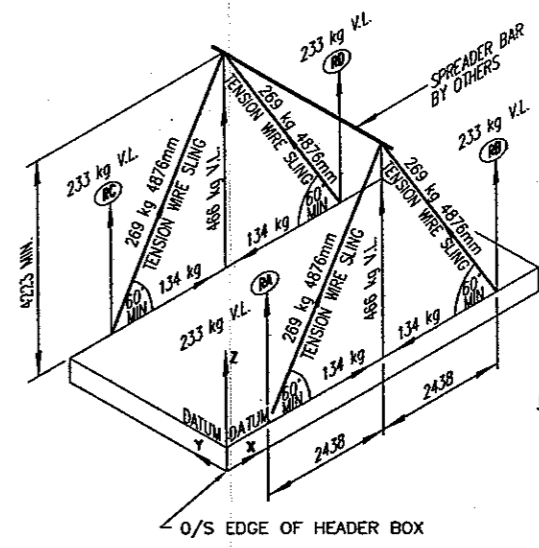
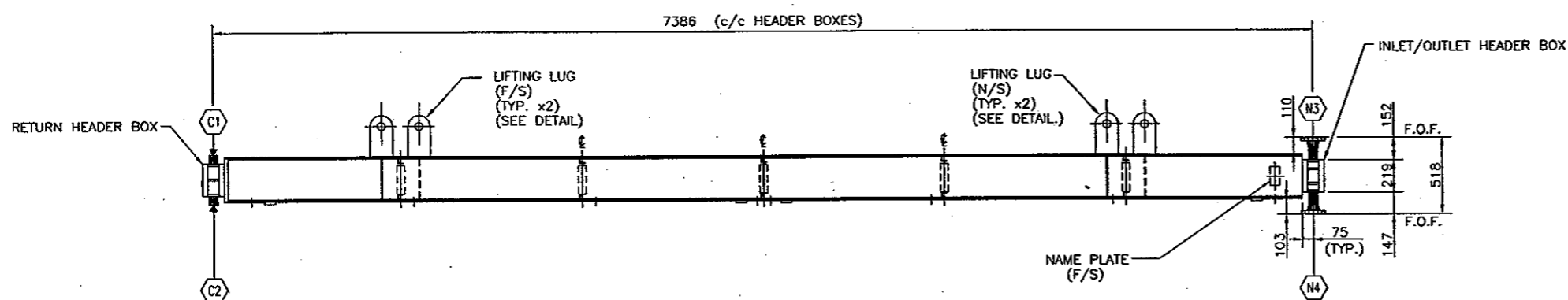
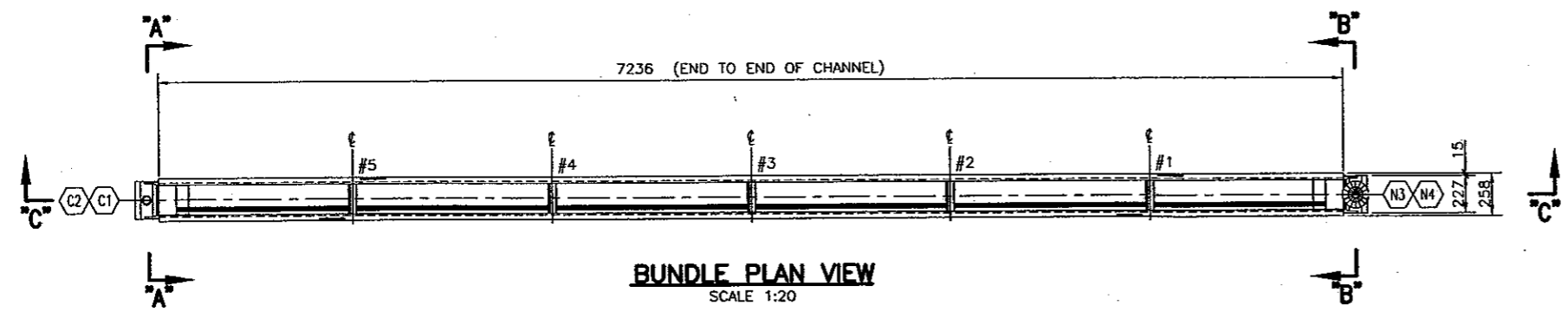
**Equipment List - Propak Job #054468**

REV	0	1											
DATE	16-Aug-05												
REV #	MFS #	SKID #	TAG #	NEW TAG #	ENG	DESCRIPTION	SIZE (MODEL)	MAKE	POWER KW	DESIGN P (kPag)	DESIGN T (°C)	REMARKS (e.g. SHELLSIDE MAWP)	
0	104		AC-610			PRODUCT COOLER	1H2-93-288	PROPAK		3792	204/-28	COMMON FRAME w/ AC-620	
0	105		AC-620			REFRIG. CONDENSER	1H2-93-288	PROPAK	2X11.2	2068	93/-28	COMMON FRAME w/ AC-610	
0	103		E-600			GAS/GAS EXCHANGER	324mm O.D. x 12186mm TS/TS x 2 PASS	PROPAK		TS/SS 8963	TS/SS: 66/-28		
0	103		E-610			GAS CHILLER	406mm O.D. x762mm O.D. x 6090mm S/TS	PROPAK		TS: 8963 SS: 1724	TS: 66/-28 SS: 66/-28		
0	103		E-615			REFRIGERANT SUBCOOLER	168mm O.D. x 6090mm TS/TS	PROPAK		TS: 8963 SS:1724	TS: 66/-28		
0	104		E-625			OVERHEAD/C3 SUBCOOLER EXCHANGER	48mm O.D. x 89mm O.D. x 6096 mm	PROPAK		TS: 3792 SS:1724	TS: 204/-28 SS: 204/-28		
0	106		F-601			GLYCOL FILTER	3000L2	CUNO		9653	66/-28	CAPACITY: 5 L/MIN@10 MICRON	
0	106		F-602			CARBON FILTER	PSL STD. 324mm O.D.x 780mm HIGH	PROPAK		1000	-28/93	C/W ONE(1) 1120C ELEMENT	
0	103		F-603			REFRIGERANT FILTER/DRYER	MODEL C-19212 P	SPORLAN					
0	104		H-633			DEETHANIZER REBOILER	914mm O.D. x 3668mm lg.	PROPAK		TS: 3792 SS:ATM	TS: 232/-28 SS: 287/-28		
0	106		H-650			GLYCOL REGENERATOR	SHELL: 610mm DIA x 3010mm LG. SURGE: 610mm DIA x 2400mm LG	MODIFIED PROPAK	100	SS: ATM	SS: 204		
0	106		H-400 A/B			UNIT HEATERS	XL-416-480360-15.0	RUFFNECK	15			480/3/60	
0	105		K-670			REFRIGERANT COMPRESSOR	P8WB	MYCOM				38USTR@109HP,1200RPM	
0	105		KD-670			COMPRESSOR DRIVER	150 Hp ELECTRIC MOTOR, XP	MARATHON	112			1200 RPM, 460/3/60	
0	106		P-655A/B			GLYCOL INJECTION PUMP	2S-1M	NAT. OIL	1.5	8274		5.7 L/min	
0	104		T-630			DEETHANIZER	356mm O.D. x 14583 mm S/S	PROPAK		3792	204/-28	PACKING: 38mm C.S. PALL RINGS	
0	103		V-610			PROPANE SUCTION SCRUBBER	610mm O.D. x 3048mm S/S	PROPAK		1724	66/-28		
0	103		V-620			LOW TEMP. SEPARATOR	914mm O.D. x 4572mm S/S BOOT: 324mm x 543mm L.G.	PROPAK		8963	66/-28		
0	106		V-640			GLYCOL FLASH TANK	324mm O.D. x 2286mm S/S	PROPAK		1724	-28/93		
0	105		V-660			DISCHARGE OIL SCRUBBER	356mm O.D. x 610mm S/S	PROPAK		1724	-28/93		
0	105		V-680			REFRIGERANT ACCUMULATOR	762mm O.D. x3048mm S/S	PROPAK		1724	66/-28		
0	106		V-690			FUEL GAS SCRUBBER	324 mm O.D. x 1524mm S/S	PROPAK		1724	66/-28		

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				AIR COOLER		SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIGERATION PLANT 8B SERVICE : LPG PRODUCT COOLER JOB NO. : TAG NO: AC-610 MFR. : PROPAK MODEL NO: 1H2-93-288				REV	BY	DATE	REVISION DESCRIPTION
1	SIZE & TYPE	FORCED DRAFT	NO. OF BAYS	1			
2	HEAT EXCHANGED (kW)	73.3	EFFECTIVE MTD	55.3			
3	TRANSFER RATE - FINNED (W/m2 C)	10.6	SURFACE AREA - FINNED (m2)	125.6			
4	TRANSFER RATE - BARE (W/m2 C)	227.0	SURFACE AREA - BARE (m2)	5.8			
5	TRANSFER RATE - CLEAN (W/m2 C)	402.9					
6	PERFORMANCE DATA - TUBE SIDE						
7	FLUID NAME	LPG	PHYSICAL PROPERTIES	INLET		OUTLET	
8	TOTAL FLOW (kg/h)	687.7	OF FLUID	LIQUID	VAPOR	LIQUID	VAPOR
9	FOULING FACTOR (m2 C/W)	0.00018	TEMPERATURE ° C	180		49	
10	ALLOW PRESS DROP (kPa)	34.5	PRESSURE (kPag)	1956			
11	CALC PRESS DROP (kPa)	1.48	MASS FLOW (kg/s)	0.191		0.191	
12			NONCOND. (kg/s)				
13	COOLING CURVE		STEAM (kg/s)				
14	T0 (C) / Q0 (kW)		WATER (kg/s)				
15	T1 (C) / Q1 (kW)		DENSITY (kg/cu.m)	460.8		626.3	
16	T2 (C) / Q2 (kW)		SPEC. HEAT (J/kg C)	3515		2337	
17	T3 (C) / Q3 (kW)		TH. COND. (W/m C)	0.080		0.125	
18	T4 (C) / Q4 (kW)		VISCOSITY (cP)	0.070		0.224	
19							
20	PERFORMANCE DATA - AIR SIDE						
21	AIR FLOW (kg/s)	4.557	AIR FLOW (Acum/s)		ALTITUDE (m)	914	
22	AIR FLOW/FAN (kg/s)		MASS VELOCITY (kg/s/m2)	7.8	TEMP : INLET / OUTLET ° C	32.2/48.2	
23	STATIC PRESS (mmH2O)	17.78	FACE VELOCITY (m/s)	3.56	MIN. DES AMB. TEMP ° C	-40	
24	DESIGN - MATERIALS - CONSTRUCTION						
25	DES PRESS (kPag)	3792	TEST PRESS (kPag)	5688	DESIGN TEMP ° C	204	
26	SIZE	7385	HEADER TYPE	PLUG	TUBE MATERIAL	SA-179	
27	NO. / BAY	1	MATERIAL	SA-516-70N	TUBE TYPE	SEAMLESS	
28	TUBE ROW	4	PASSES	4	OD X THK (mm x ga)	25.4 X 16 GA	
29	NO. BUNDLES	1	SLOPE (mm/m)	0	NO. / LENGTH (m)	10 / 7315	
30	NO. BAYS	1	PLUG MATERIAL	SA-105	TUBE PITCH (mm)	57.15	
31	FRAME	WELDED STEEL	GASKET MATERIAL	C1010/20	FIN TYPE	L-TYPE	
32	BUG SCREEN	YES	CORR. ALLOWANCE (mm)	1.59	FIN MATERIAL	ALUMINUM	
33	HAIL SCREEN	YES	INLET NOZZLE OD (mm)	60	FIN OD X THK (mm x ga)	57.1 X 0.4 mm	
34	VIB SWITCH	YES	OUTLET NOZZLE OD (mm)	60	FIN PITCH (F/mm)	0.394	
35	SURFACE PREP	SSPC-SP6	FLANGE RATING & FACE	300# RF	ASME CODE	VIII, DIV.1	
36	STEAM COIL	NO	TEMP CONN.	NO	TEMA		
37	FAN GUARD	YES	PRESS CONN.	NO	API	661 MODEIFIED	
38	LOUVERS (MAN / AUTO)	MANUAL	CLEAN CONN.	NO	OTHER SPEC		
39	HANDRAIL / WALKWAY	NO	LADDERS	NO	WINDLOAD (km/h)		
40							
41	MECHANICAL EQUIPMENT						
42	FAN MANUFACTURER	MOORE	DRIVER	WESTINGHOUSE	SPEED REDUCER TYPE	BELT	
43	FAN MODEL	5000-40	MFR MODEL	254T	MFR	GATES	
44	NO. / BAY	2	KW RATING	11.19	MODEL	3VX	
45	DIAMETER (m)	2.134	RPM	1750	AGMA RATING		
46	RPM	392	ENCLOSURE	TEFC	RATIO	4.464	
47	KW / FAN	7.46	SERVICE FACTOR	1.15	SUPPORT		
48	TIP SPEED (m/s)	43.79	VOLT/PH/Hz	480/3/60			
49	NO. BLADE	5			STRESS RELIEVE REQ'D	NO	
50	BLADE MATERIAL	ALUMINUM	RECIRCULATION	NO	BUNDLE WEIGHT (kg)	600	
51	HUB MATERIAL	ALUMINUM	STRUCT COAT PREP	SSPC-SP6	SHIPPING WEIGHT (kg)		
52	PITCH	1.3	STRUCT COAT PRIMER	PNT-12	PLOT AREA	2362X7620	
53			STRUCT COAT FINISH	PNT-12	LSD		
54	REMARKS: COMMON FRAME WITH AC-620						
55							

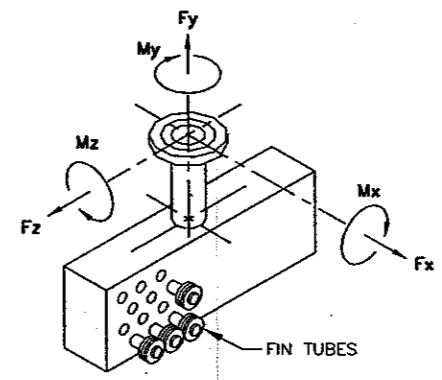
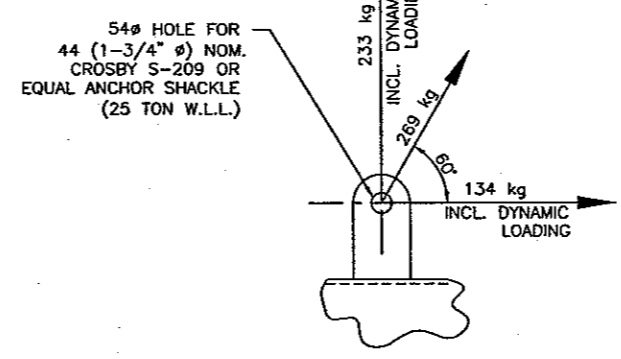
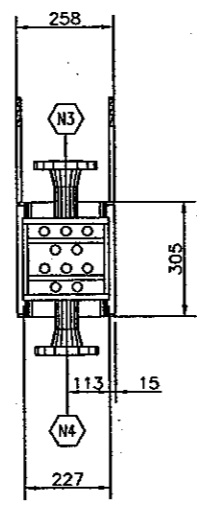
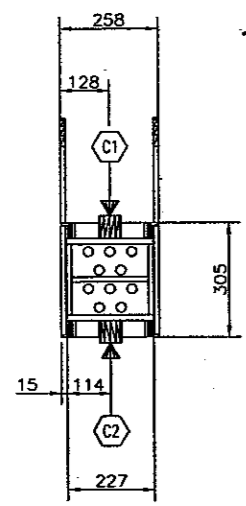
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NOZZLE SCHEDULE							EXT. PROJ	WELD
MK	SIZE	RATING	FACING	SCH	SERVICE			
N3	2 NPS	300#	RFWN	XXH	LPG PRODUCT INLET		152	
N4	2 NPS	300#	RFWN	XXH	LPG PRODUCT OUTLET		147	
C1	1 NPS	6000#	NPT	-	VENT c/w PLUG		-	
C2	1 NPS	6000#	NPT	-	DRAIN c/w PLUG		-	



**C.O.G.**  
DIMS FROM DATUM  
X = 3766mm  
Y = 129mm  
Z = 153mm

- NOTE:**
- WEIGHTS SHOWN ON DIAGRAM INCLUDE 50% EXCESS FOR DYNAMIC LOADING
  - CALCULATED SHIPPING WT.: 621 kg (DYNAMIC LOADING NOT INCLUDED)



MAXIMUM ALLOWABLE NOZZLE LOADS	
Fx	460 lb
Fy	600 lb
Fz	460 lb
Mx	220 ft-lb
My	360 ft-lb
Mz	220 ft-lb

**MAXIMUM ALLOWABLE NOZZLE LOADS**  
FOR AC-610

SERVICE: LPG	SERIAL NO: 054468-210	CRN: P4080.21
LOADINGS PER UG-22(e)	YEAR BUILT: 2005	
GOVERNS: NO	LSO #:	
PRODUCTION IMPACT TEST REQ'D: NO	CODE:	ASME SECT. VIII DIV I, '01, ADDENDA '03
IMPACT TESTING: NO-PER UG20(f)(1-5)	DESIGN PRESSURE:	3792 kPag
-PER UCS-66(a)		NOTE: DES. PRESS. IS MAWP
-PER UCS-66(c)	DESIGN TEMPERATURE:	204.4°C
CAPACITY: 0.032 m <sup>3</sup>	M.D.M.T.:	-28.8°C @ 3792 kPag
WEIGHT EMPTY: 621 kg	HYDROTEST PRESSURE:	5688 kPag
WEIGHT FULL OF WATER: 653 kg	MATERIAL: TUBES:	SA-179 (SMLS)
WEIGHT ACCOUNTS FOR POSSIBLE CHANGE TO 14 B.W.G. TUBES	HEADER:	SA-516-70N
TUBE S.A. INCL. FINS: 123.64 m <sup>2</sup>	RADIOGRAPHY:	N/A
PAINT SPEC: PNT-12	PWHT: MIN TEMP/TIME	NO
INSULATION: NONE	CORR. ALLOWANCE:	1.59mm
SHIP LOOSE: NO	TAG NO: <b>AC-610</b>	

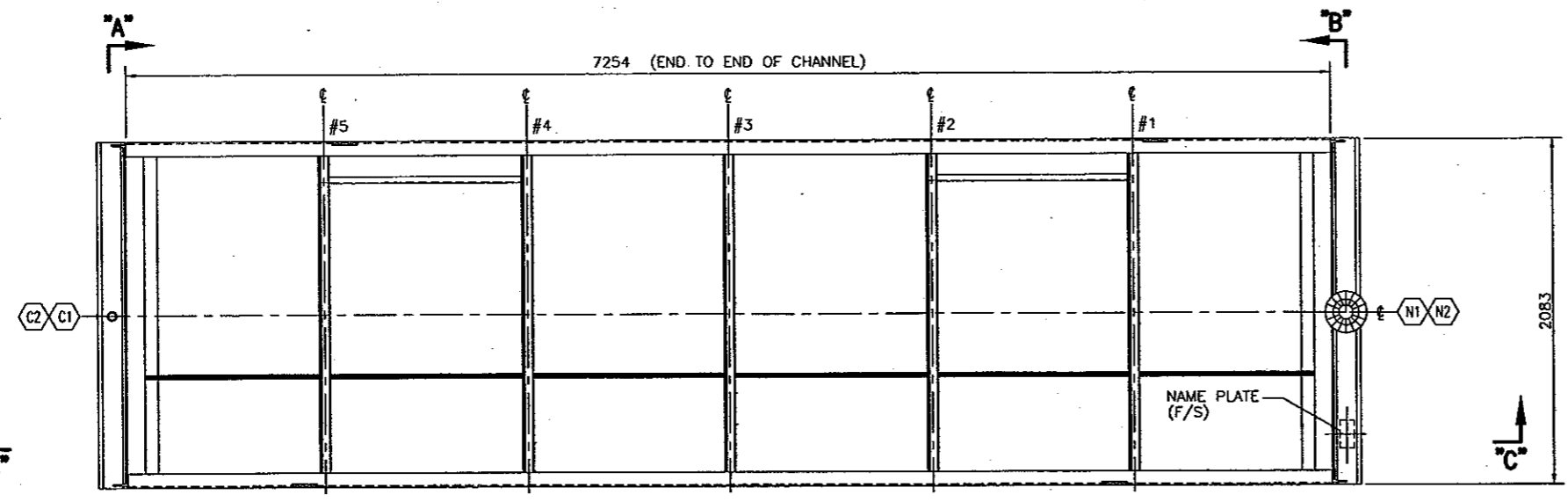
GENERAL NOTES		GENERAL NOTES		SKT		ISSUED FOR DOCUMENTATION		C. YU		05/09/30		VK		MZ		
DATE	BY	DATE	BY	No.	REVISION	BY	DATE	CKD	ENG	DATE	BY	DATE	BY	DATE	REV.	
2005/09/30	J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\BDL-054468-210-SKT-01.DWG	hmeng														

APPROVED		DRAWN		FORT ENERGY CORP.	
MECH/STRUCT.	BY	DATE	DATE	440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
ELECTRICAL	CHECKED			8B REFRIGERATION UNIT LPG PRODUCT COOLER AC-610	
PROJECT	DATE			Dwg. No.: D-BDL-054468-210-SKT SHT. 1 OF 1	
DATE	SCALE	AS NOTED		REV. SKT	

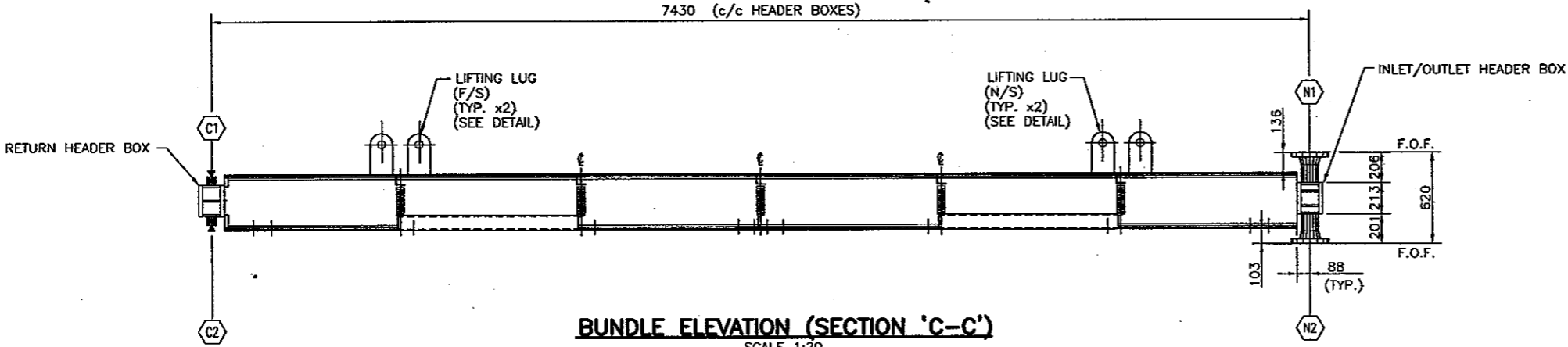


PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				AIR COOLER		SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIGERATION PLANT 8B SERVICE : PROPANE CONDENSER JOB NO. : TAG NO: AC-620 MFR. : PROPAK MODEL NO: 1H2-93-288				REV	BY	DATE	REVISION DESCRIPTION
1	SIZE & TYPE	FORCED DRAFT	NO. OF BAYS	1			
2	HEAT EXCHANGED (kW)	303.7	EFFECTIVE MTD	7.9			
3	TRANSFER RATE - FINNED (W/m2 C)	21.6	SURFACE AREA - FINNED (m2)	1783			
4	TRANSFER RATE - BARE (W/m2 C)	464.6	SURFACE AREA - BARE (m2)	83			
5	TRANSFER RATE - CLEAN (W/m2 C)	757.3					
6	PERFORMANCE DATA - TUBE SIDE						
7	FLUID NAME	PROPANE	PHYSICAL PROPERTIES	INLET		OUTLET	
8	TOTAL FLOW (kg/h)	3102.6	OF FLUID	LIQUID	VAPOR	LIQUID	VAPOR
9	FOULING FACTOR (m2 C/W)	0.00018	TEMPERATURE ° C	66.7		43.3	
10	ALLOW PRESS DROP (kPa)	34.5	PRESSURE (kPag)	1458			
11	CALC PRESS DROP (kPa)	2.5	MASS FLOW (kg/s)		0.862	0.862	
12			NONCOND. (kg/s)				
13	COOLING CURVE		STEAM (kg/s)				
14	T0 (C) / Q0 (kW)		WATER (kg/s)				
15	T1 (C) / Q1 (kW)		DENSITY (kg/cu.m)	28.9		462.5	
16	T2 (C) / Q2 (kW)		SPEC. HEAT (J/kg C)	2148		3308	
17	T3 (C) / Q3 (kW)		TH. COND. (W/m C)	0.024		0.106	
18	T4 (C) / Q4 (kW)		VISCOSITY (cP)	0.01		0.08	
19							
20	PERFORMANCE DATA - AIR SIDE						
21	AIR FLOW (kg/s)	47.71	AIR FLOW (Acum/s)		ALTITUDE (m)	914	
22	AIR FLOW/FAN (kg/s)		MASS VELOCITY (kg/s/m2)	6.8	TEMP : INLET / OUTLET ° C	32.2/38.6	
23	STATIC PRESS (mmH2O)	17.78	FACE VELOCITY (m/s)	3.11	MIN. DES AMB. TEMP ° C	-40	
24	DESIGN - MATERIALS - CONSTRUCTION						
25	DES PRESS (kPag)	2069	TEST PRESS (kPag)	3104	DESIGN TEMP ° C	93	
26	SIZE	7430	HEADER TYPE	PLUG	TUBE MATERIAL	SA-179	
27	NO. / BAY	1	MATERIAL	SA-516-70N	TUBE TYPE	SEAMLESS	
28	TUBE ROW	4	PASSES	4	OD X THK (mm x ga)	25.4 X 16 GA	
29	NO. BUNDLES	1	SLOPE (mm/m)	0	NO. / LENGTH (m)	142 / 7315	
30	NO. BAYS	1	PLUG MATERIAL	SA-105	TUBE PITCH (mm)	57.15	
31	FRAME	WELDED STEEL	GASKET MATERIAL	C1010/20	FIN TYPE	L-TYPE	
32	BUG SCREEN	YES	CORR. ALLOWANCE (mm)	1.59	FIN MATERIAL	ALUMINUM	
33	HAIL SCREEN	YES	INLET NOZZLE OD (mm)	114	FIN OD X THK (mm x ga)	57.1 X 0.41 mm	
34	VIB SWITCH	YES	OUTLET NOZZLE OD (mm)	114	FIN PITCH (F/mm)	0.394	
35	SURFACE PREP	SSPC-SP6	FLANGE RATING & FACE	300# RF	ASME CODE	VIII, DIV.1	
36	STEAM COIL	NO	TEMP CONN.	NO	TEMA		
37	FAN GUARD	YES	PRESS CONN.	NO	API	661 MODEIFIED	
38	LOUVERS (MAN / AUTO)	MANUAL	CLEAN CONN.	NO	OTHER SPEC		
39	HANDRAIL / WALKWAY	NO	LADDERS	NO	WINDLOAD (km/h)		
40							
41	MECHANICAL EQUIPMENT						
42	FAN MANUFACTURER		DRIVER		SPEED REDUCER TYPE		
43	FAN MODEL		MFR MODEL		MFR		
44	NO. / BAY		KW RATING		MODEL		
45	DIAMETER (m)		RPM		AGMA RATING		
46	RPM		ENCLOSURE		RATIO		
47	KW / FAN		SERVICE FACTOR		SUPPORT		
48	TIP SPEED (m/s)		VOLT/PH/Hz				
49	NO. BLADE				STRESS RELIEVE REQ'D	NO	
50	BLADE MATERIAL		RECIRCULATION	NO	BUNDLE WEIGHT (kg)	4160	
51	HUB MATERIAL		STRUCT COAT PREP	SSPC-SP6	SHIPPING WEIGHT (kg)		
52	PITCH		STRUCT COAT PRIMER	PNT-11	PLOT AREA	2362 X 7620	
53			STRUCT COAT FINISH	PNT-11	LSD		
54	REMARKS: COMMON FRAME WITH AC-610 (SEE AC-610 FOR MECHANICAL EQUIPMENT DETAILS)						
55							

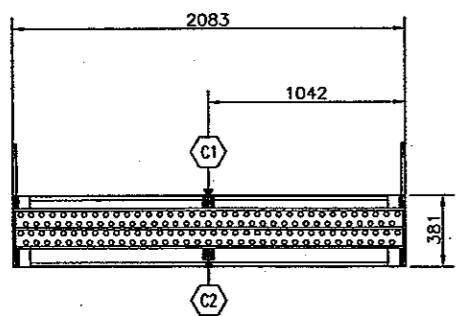
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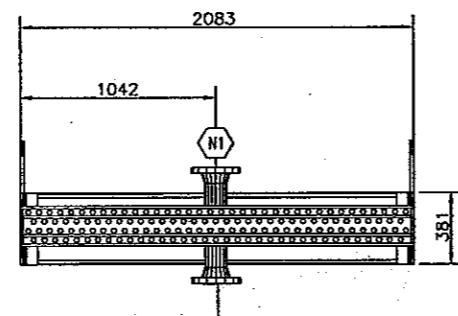
**BUNDLE PLAN VIEW**  
SCALE 1:20



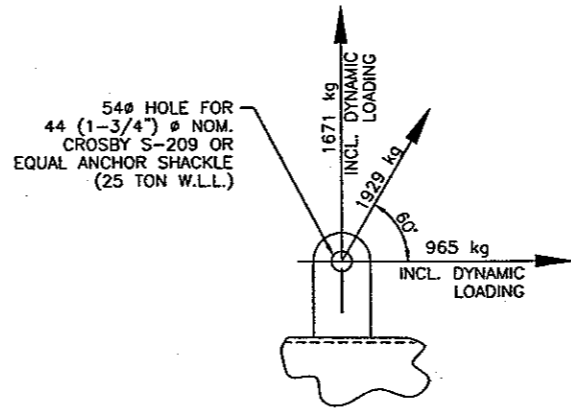
**BUNDLE ELEVATION (SECTION 'C-C')**  
SCALE 1:20



**SECTION 'A-A'**  
SCALE 1:20

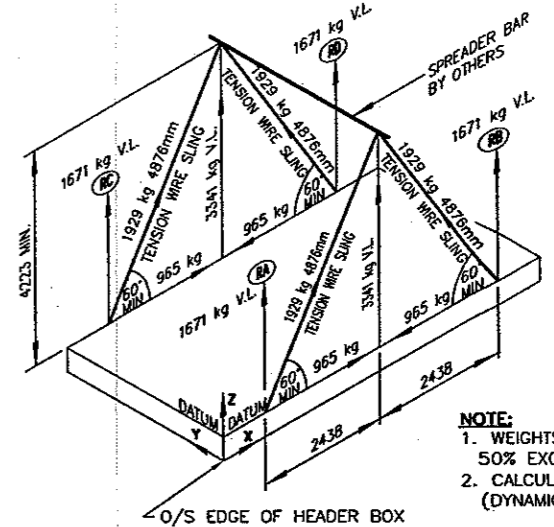


**SECTION 'B-B'**  
SCALE 1:20



**LIFTING LUG DETAIL**  
SCALE 1:10  
(4) - REQ'D

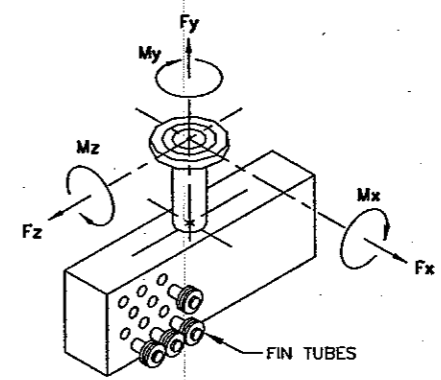
NOZZLE SCHEDULE						
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ WELD
N1	4 NPS	300#	RFWN	160	PROPANE CONDENSER INLET	206
N2	4 NPS	300#	RFWN	160	PROPANE CONDENSER OUTLET	201
C1	1 NPS	6000#	NPT	-	VENT c/w PLUG	-
C2	1 NPS	6000#	NPT	-	DRAIN c/w PLUG	-



**C. OF G.**  
DIMS FROM DATUM  
X = 3801mm  
Y = 1042mm  
Z = 191mm

- NOTE:**
- WEIGHTS SHOWN ON DIAGRAM INCLUDE 50% EXCESS FOR DYNAMIC LOADING
  - CALCULATED SHIPPING WT.: 4455 kg (DYNAMIC LOADING NOT INCLUDED)

**LIFTING DIAGRAM**  
FOR AC-620



MAXIMUM ALLOWABLE NOZZLE LOADS	
Fx	1500 lb
Fy	1200 lb
Fz	1500 lb
Mx	1200 ft-lb
My	1800 ft-lb
Mz	1200 ft-lb

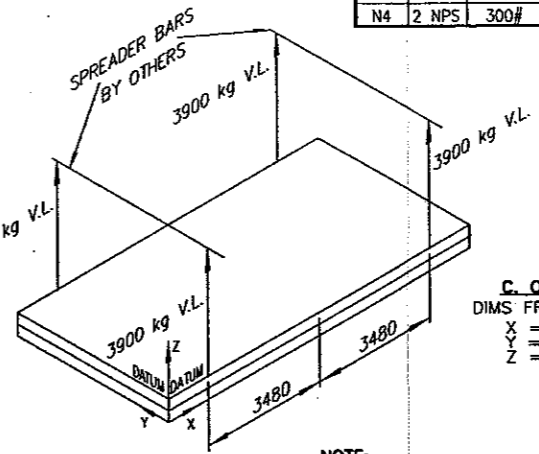
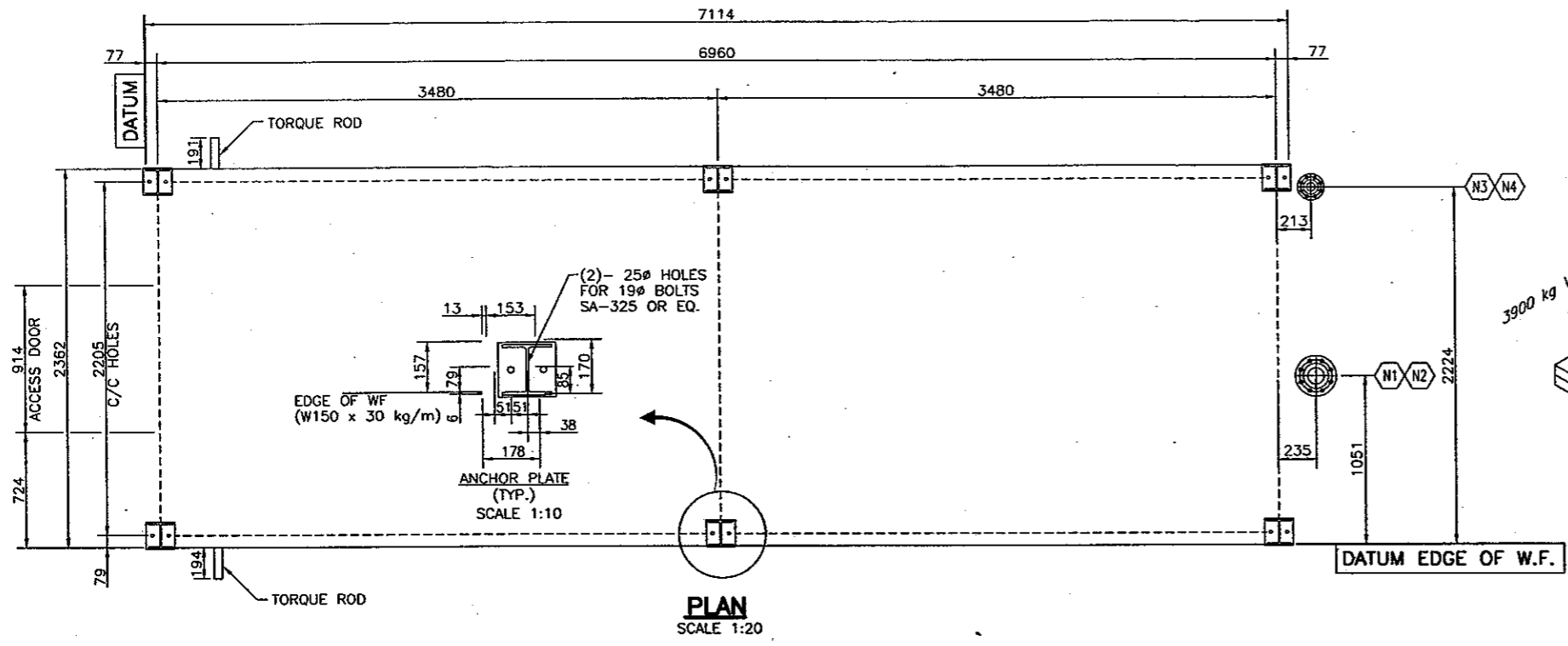
**MAXIMUM ALLOWABLE NOZZLE LOADS**  
FOR AC-620

SERVICE: PROPANE	SERIAL NO: 054468-211	CRN: P4082.21
LOADINGS PER UG-22(e) CONSIDERED	YEAR BUILT: 2005	
GOVERNS: NO	LSD #: -	
PRODUCTION IMPACT TEST REQ'D: NO	CODE:	ASME SECT. VIII DIV I, '01, ADDENDA '03
IMPACT TESTING: NO -PER UG20(f)(1-5) -PER UCS-66(c)	DESIGN PRESSURE:	2069 kPag
CAPACITY: 0.482 m <sup>3</sup>	NOTE: DES. PRESS. IS MAWP	
WEIGHT EMPTY: 4455 kg	DESIGN TEMPERATURE:	93.3 °C
WEIGHT FULL OF WATER: 4937 kg	M.D.M.T.:	-28.8°C @ 2069 kPag
WEIGHT ACCOUNTS FOR POSSIBLE CHANGE TO 14 B.W.G. TUBES	HYDROTEST PRESSURE:	3104 kPag
TUBE S.A. INCL. FIN: 1760.4 m <sup>2</sup>	MATERIAL:	TUBES: SA-179 SMLS HEADER: SA-516-70N
PAINT SPEC: PNT-11	RADIOGRAPHY:	N/A
INSULATION: NONE	PWHT: MIN TEMP/TIME	NO
SHIP LOOSE: NO	CORR. ALLOWANCE:	1.59 mm
	TAG NO: <b>AC-620</b>	

APPROVED		DRAWN		FORT ENERGY CORP.	
MECH/STRUCT.	BY	BY	BY	88 REFRIGERATION UNIT	
DATE	DATE	DATE	DATE	PROPANE CONDENSER	
ELECTRICAL	CHECKED	AC-620			
DATE	BY				
PROJECT	DATE				
DATE	SCALE	AS NOTED			
DWG. No.: D-BDL-054468-211-SKT		SHT. 1 OF 1		REV. SKT	
<b>GENERAL NOTES</b> DATE: 2005/09/30 10:08 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\BDL-054468-211-SKT-01.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION		C. YU 05/09/30 VK NZ BY DATE CKD ENG	
		REVISION			

**PROPAC**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

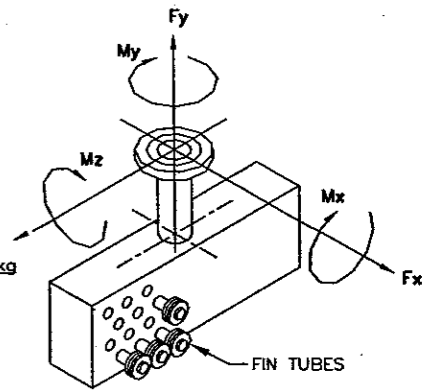
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NOZZLE SCHEDULE						
MK	SIZE	RATING	FACING	SERVICE	€	ELEVATION
N1	4 NPS	300#	RFWN	PROPANE CONDENSER INLET AC-620		SPEC.
N2	4 NPS	300#	RFWN	PROPANE CONDENSER OUTLET AC-620		SPEC.
N3	2 NPS	300#	RFWN	LPG PRODUCT INLET AC-610		SPEC.
N4	2 NPS	300#	RFWN	LPG PRODUCT OUTLET AC-610		SPEC.

MAXIMUM ALLOWABLE 114 O/D NOZZLE LOADS		MAXIMUM ALLOWABLE 60 O/D NOZZLE LOADS	
Fx	1500 lb	Fx	460 lb
Fy	1200 lb	Fy	600 lb
Fz	1500 lb	Fz	460 lb
Mx	1200 ft-lb	Mx	220 ft-lb
My	1800 ft-lb	My	360 ft-lb
Mz	1200 ft-lb	Mz	220 ft-lb

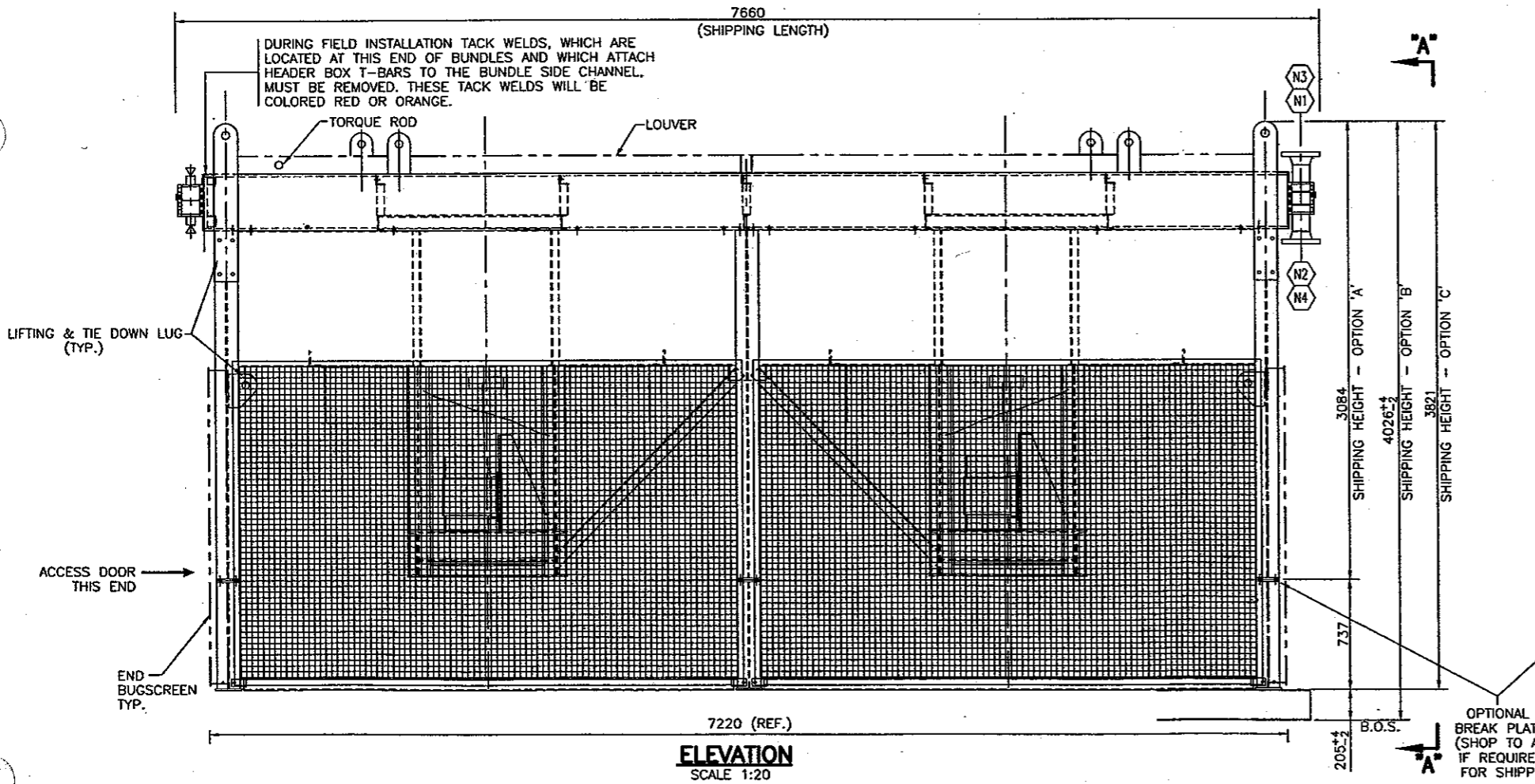
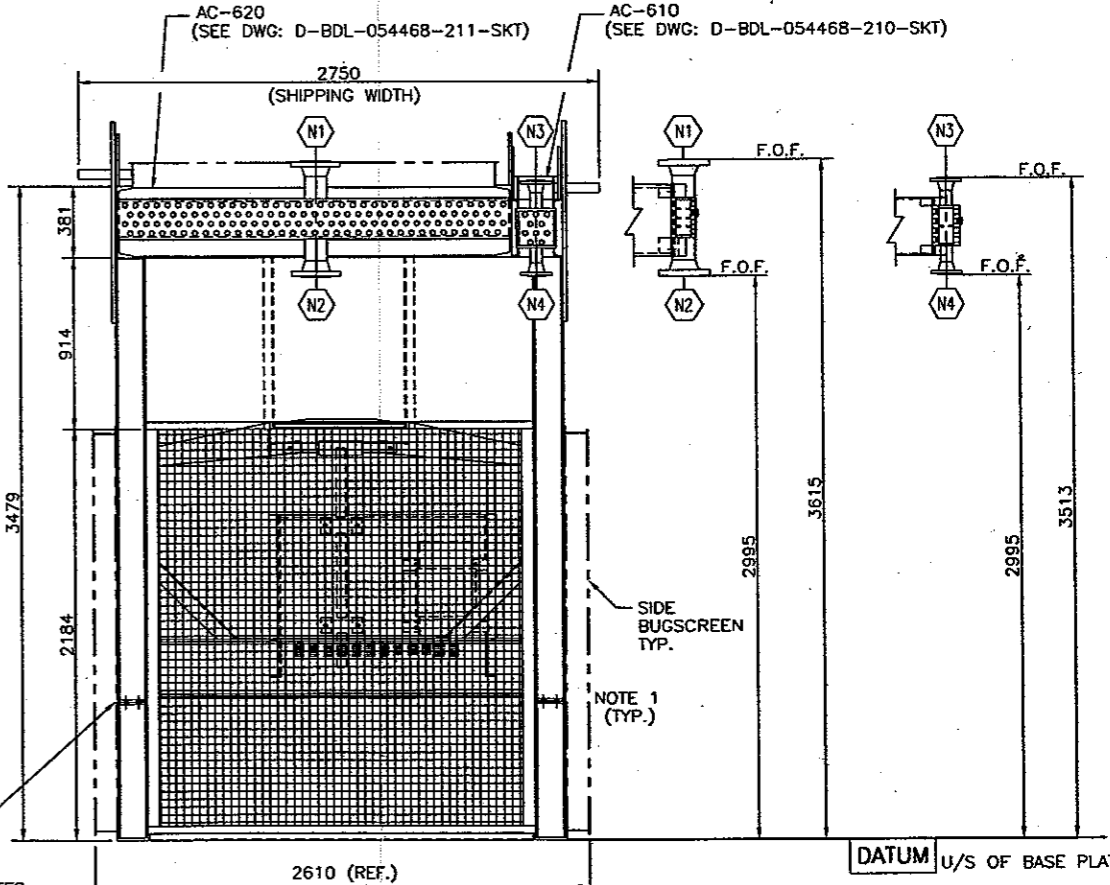
C. OF G.  
DIMS FROM € DATUM  
X = 1/2 ON €  
Z = 3120mm



NOTE: WEIGHTS SHOWN IN DIAGRAM INCLUDE 50% EXCESS FOR DYNAMIC LOADING  
TOTAL SHIPPING WT. WITHOUT DYNAMIC LOADING: 10,400 kg INCLUDING: STRUCTURAL STEEL, BUNDLES (AC-610/AC-620) & LOUVERS  
NOTE: FOR SHIPPING OPTION 'B' FOR SKID MOUNTED COOLER, SEE COOLER SKID ASSY. FOR LIFTING DIAGRAM.

**LIFTING DIAGRAM**  
FOR COOLER ASSEMBLY

**MAXIMUM ALLOWABLE NOZZLE LOADS**  
FOR COOLER ASSEMBLY



APPROVED		DRAWN		FORT ENERGY CORP.	
MECH/STRUCT.	BY	BY	BY	88 REFRIGERATION UNIT	
DATE	DATE	DATE	DATE	AERIAL COOLER-LAYOUT (AC-610/AC-620)	
ELECTRICAL	BY	CHECKED		MDL: 1HH2-84-288-F	
DATE	DATE			DWG. No.: D-LYT-054468-214-SKT SHT. 1 OF 1	
PROJECT	BY			REV. SKT	
DATE	DATE			SCALE AS NOTED	

GENERAL NOTES		GENERAL NOTES		SKT	
DATE: 2005/09/30 10:09 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\LYT-054468-214-SKT-01.DWG hmeng		ISSUED FOR DOCUMENTATION		C. YU 05/09/30 VK MZ	
		REVISION		BY DATE CKD ENG	

**PROPAC**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				BUILDING			SHEET 1 OF 1		
CUSTOMER : PROPAK SYSTEMS LTD. PLANT : 8B STOCK REFRIGERATION PLANT SERVICE : BUILDING JOB NO. : 054468 TAG NO: MFR. : MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	RDD	07/06/05	FOR PURCHASE		
				1	RDD	07/14/05	ROOF IS PERFORMED		
				2	RDD	07/27/05	INNER LINING IS 20 GA		
1									
2	RIGID FRAMED	NO	SELF FRAMED	YES	INSTALLED BY	PSL			
3	LENGTH	mm	14326	WIDTH	mm	4267	EAVE	mm	3658
4									
5	WALL		ROOF			STRUCTURAL STEEL			
6	THICKNESS	mm		THICKNESS	mm		COLUMN		
7	OUTER LINING	mm	22GA	OUTER LINING	mm	22 GA	GIRTS		
8	MATERIAL	GALVANIZED STEEL		MATERIAL	GALVANIZED STEEL		PERLINS		
9	COLOR	STONE GREY		COLOR	STONE GREY		CROSS BRACING		
10	INSULATION	m C/W	R-12	INSULATION	m C/W	R-20	SURFACE PREP		
11	VAPOR BARRIER	YES		VAPOR BARRIER	YES		PRIMER		
12	INNER LINING	mm	20 GA	INNER LINING	mm	20 GA	OVERCOAT		
13	MATERIAL	FLUTED ALUMINUM		MATERIAL	FLUTED ALUMINUM				
14	COLOR	WHITE		COLOR			CRANE		
15	PERFORATED	YES - ABOVE 3FT		PERFORATED	YES		CAPACITY	kg	
16	TRANSLUCENT PANEL	%	N/A	TRANSLUCENT PANEL	%	N/A	HOOK HEIGHT	mm	
17				DOUBLE	N/A		MAN / ELECTRIC		
18				ROOF (GABLE/SHED)	GABLE		ACCESS LADDER		
19				SLOPE	4.0 / 12				
20	WINDOWS		MAIN DOOR			MAINTENANCE DOOR			
21	QUANTITY			QUANTITY	TWO (2)		QUANTITY	ONE (1)	
22	SIZE	mm X mm		SIZE	mm X mm	914 X 2134	SIZE	mm X mm	1828W X 2134 HIGH
23	HORIZONTAL			STEEL	YES		STEEL	YES	
24	SLIDING			INSULATED	YES		ROLL UP	NOTE 3	
25	DOUBLE GLAZE			PANIC HARDWARE	YES		MAN / AUTO		
26	SCREEN			CLOSER	HYDRAULIC		WALL MOUNT		
27				CANOPY	NO		GUIDES		
28				LOCKSET	YES				
29									
30	RIDGE		LOUVERS			EXHAUST FAN			
31	VENT THROATS	mm	152	QUANTITY	THREE (3)		SIZE	mm Xmm	BY VENDOR
32	CHAIN OPERATED	YES		SIZE	mm x mm	610x610	CLASSIFICATION	CLASS 1, DIV 1, GR D	
33	BIRD SCREEN	YES		MAN / AUTO	MANUAL		MOTOR	kw	BY VENDOR
34	AIR CHANGE	/HR		BIRD SCREEN	YES		VOLTS/PHASE/CYCLE	120/1/60	
35	LENGTH	mm	FULL LENGTH	WIND SPEED	km/h		FORCE AIR CHANGE /HR	12	
36									
37	UNIT HEATER		MISC.			MISC.			
38	DUTY	kw		LIGHTING SERV ACCESS			STEPS		
39	CLASSIFICATION			MONORAIL			PLATFORMS		
40	MOTOR	kw		EAVES TROUGH	YES		COOLER DORMER		
41	VOLTS/PHASE/CYCLES			DOWN SPOUTS	YES		CANOPY		
42				LADDERS					
43	REMARKS:								
44	1) REFERENCE LAYOUT DRAWING D-ASY-054468-152								
45	REMOVABLE 1524mm WIDE X 2483mm HIGH WALL PANELS REQUIRED AS INDICATED ON LAYOUT DRAWING								
46	2) BUILDING VENDOR TO SIZE EXHAUST FANS AND ADVISE ON NUMBER OF FANS REQUIRED, SIZE & HP								
47	3) MAINTENANCE DOOR = INSULATED DOUBLE DOOR C/W PANIC HARDWARE & CLOSURE ON ONE SIDE,								
48	PLAIN STEEL WITH BARREL BOLT & LOCKSET ON OTHER SIDE.								
49	4) ALL OPENINGS FLASHED, CAULKED AND SEALED								
50									
51									
52									
53									
54									
55									

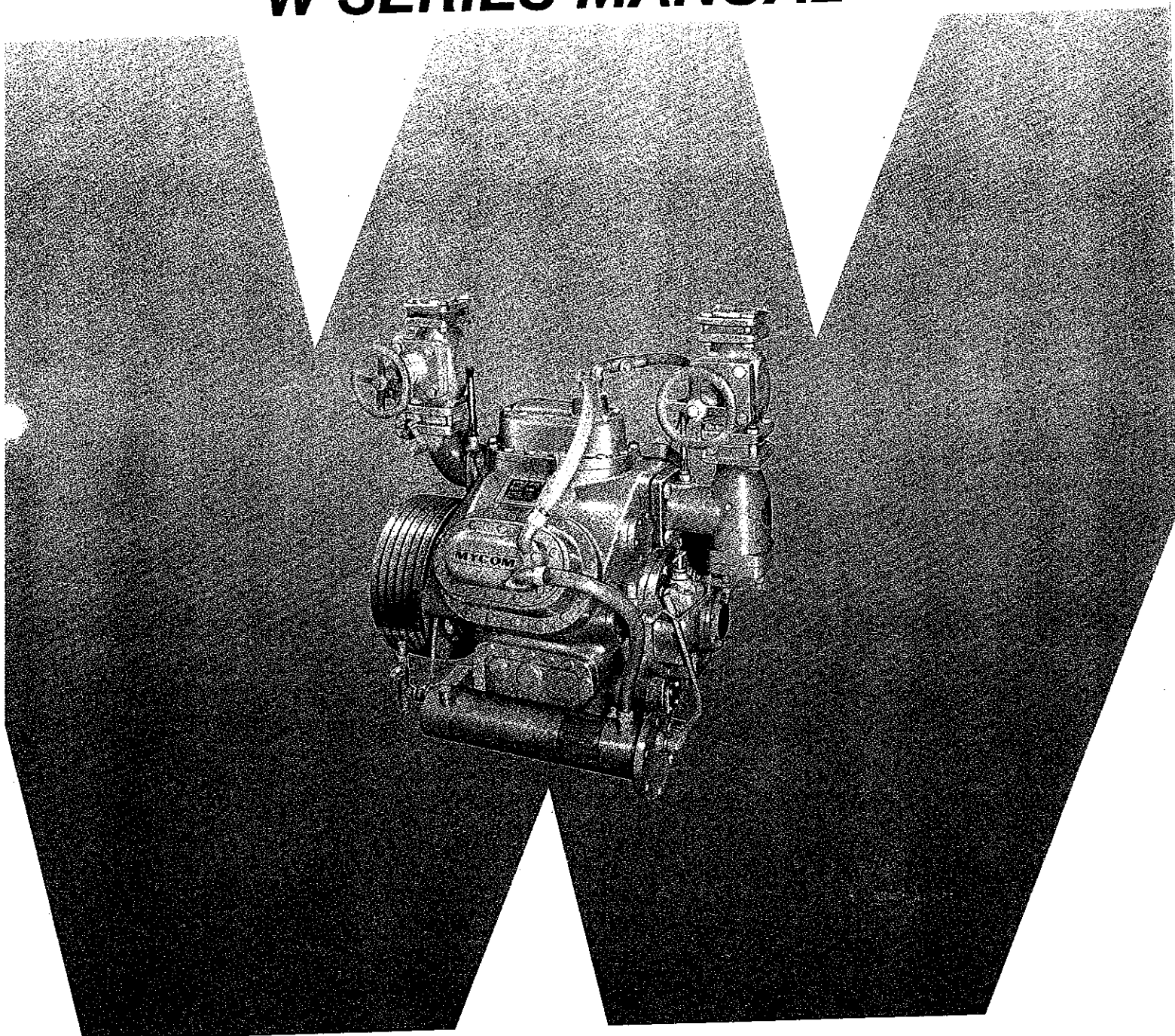
K-670

# MYCOM

## W SERIES

*New, Premium Industrial Reciprocating Compressors*

## W SERIES MANUAL



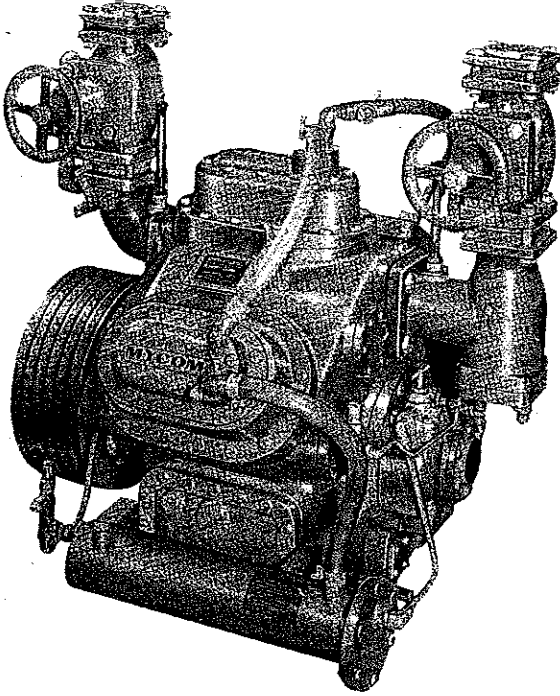
**MAYEKAWA MFG. CO., LTD.**

Tokyo-Japan

● MYCOM W Series Multi-cylinder Refrigeration Compressors

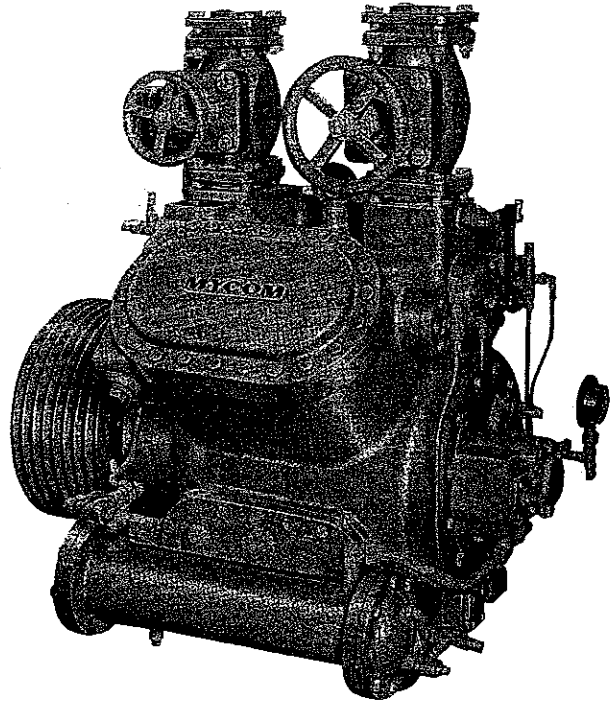
Watercooled headcovers

6WA Watercooled oil cooler



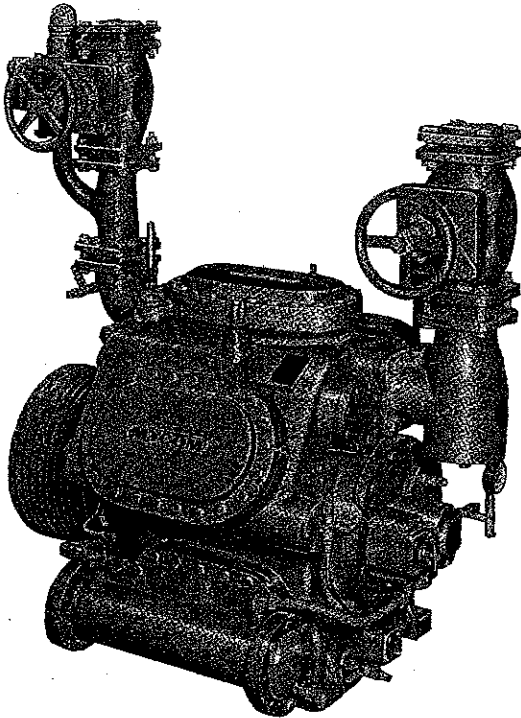
Aircooled headcovers

4WB DX cooled oil cooler



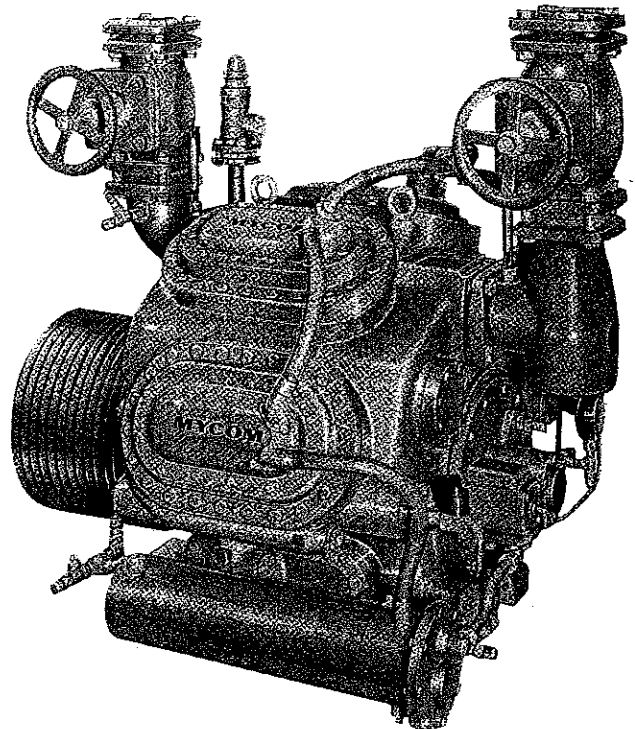
Aircooled headcovers

6WB DX cooled oil cooler



Watercooled headcovers

8WB Watercooled oil cooler





# SPECIFICATIONS (BARE COMPRESSOR)

Item	Single-stage compressor									Compound compressor				
	2WA	4WA	6WA	8WA	4WB	6WB	8WB	12WB	42WA	62WA	42WB	62WB	12.4WB	
Refrigerant	R717, R22, R502, R12, Propane													
Type	Reciprocating, open type													
No. of cylinders	2	4	6	8	4	6	8	12	L-4/H-2	L-6/H-2	L-4/H-2	L-6/H-2	L-12/H-4	
Bore	3-3/4 (95)				5-1/8 (130)				3-3/4 (95)		5-1/8 (130)			
Stroke	3 (76)				3-15/16 (100)				3 (76)		3-15/16 (100)			
Max. speed	1,100			1,450			1,200			1,450			1,200	
Displacement at max. speed	CFM	42	110	165	220	224	337	450	674	L-110 (187)	L-165 (281)	L-224 (381)	L-337 (573)	L-674 (1,145)
	(m <sup>3</sup> /h)	(71)	(187)	(281)	(374)	(381)	(573)	(764)	(1,145)	H-55 (94)	H-55 (94)	H-112 (191)	H-112 (191)	H-224 (381)
Driving method*	Belt drive or Direct drive													
Capacity control steps	%	100	100, 50	100, 66, 33	100, 75, 50, 25	100, 50	100, 66, 33	100, 75, 50, 25	100, 66, 33	100, 50	100, 66, 33	100, 50	100, 66, 33	100, 66, 33
Refrigeration oil	ISO VG68 or equivalent													
Oil charge quantity	U.S. gal. (l)	1.32 (5)	3.17 (12)	3.70 (14)	4.49 (17)	5.29 (20)	6.61 (25)	6.87 (26)	13.74 (52)	3.70 (14)	4.49 (17)	6.61 (25)	7.00 (26.5)	14.53 (55)
Connections	Suction	R717	1-1/2" (40A)	2" (50A)	2-1/2" (65A)	3" (80A)	3-1/2" (90A)	4" (100A)	5" (125A)	L-2" (50A)	L-2-1/2" (65A)	L-3" (80A)	L-3-1/2" (90A)	L-5" (125A)
		R22, R502	1-1/2" (40A)	2-1/2" (65A)	3" (80A)	3-1/2" (90A)	4" (100A)	5" (125A)	H-1-1/2" (40A)	H-1-1/2" (40A)	H-2-1/2" (65A)	H-2-1/2" (65A)	H-3" (80A)	H-3" (80A)
	Discharge	R717	1-1/2" (40A)	2" (50A)	2-1/2" (65A)	3" (80A)	3-1/2" (90A)	4" (100A)	5" (125A)	L-2" (50A)	L-2" (50A)	L-2-1/2" (65A)	L-2-1/2" (65A)	L-3" (80A) x 2
		R22, R502	1-1/2" (40A)	2" (50A)	2-1/2" (65A)	3" (80A)	3-1/2" (90A)	4" (100A)	5" (125A)	H-1-1/2" (40A)	H-1-1/2" (40A)	H-2" (50A)	H-2" (50A)	H-2" (50A) x 2
Net weight	lb. (kg)	810 (370)	1,280 (580)	1,540 (700)	1,800 (820)	2,420 (1,100)	3,100 (1,410)	3,410 (1,550)	5,500 (2,500)	1,580 (720)	1,850 (840)	3,170 (1,440)	3,430 (1,560)	6,820 (3,100)

NOTE: \*L": Low stage, \*H": High stage • Model 12.4WB - Direct drive only

## ITEMS INCLUDED

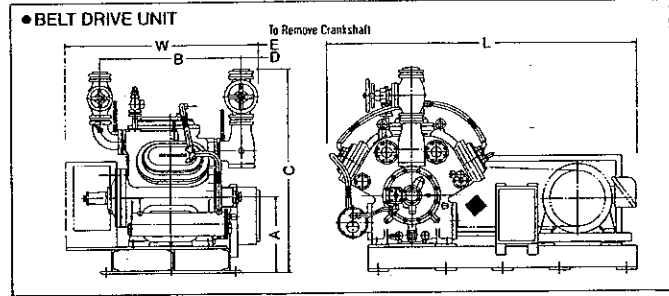
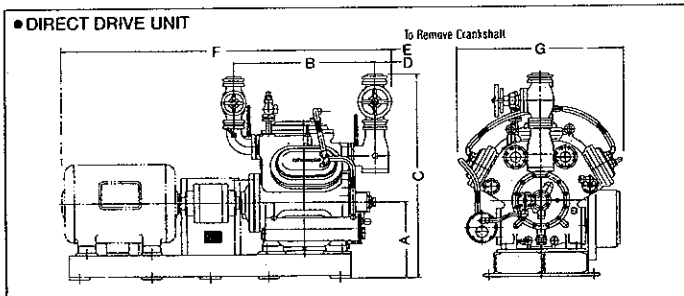
- Suction shut-off valve ..... 1 pc. (Single-stage), 2 pcs. (Compound)
- Discharge shut-off valve ..... 1 pc. (Single-stage), 2 pcs. (Compound)
- Oil cooler ..... 1 pc.
- Safety valve ..... 1 pc.
- Capacity control solenoid valve\* ..... 1 pc.\*\*
- Excludes compressors for chemical plants. \*\*
- Discharge side thermometer ..... 1 pc. Excludes Model 2WA.
- Suction side thermometer ..... 1 pc. (Single-stage), 2 pcs. (Compound)
- Service tools ..... 1 set
- Gasket (Asbestos-free)

## OPTIONAL ACCESSORIES

- Driving method (Belt drive, Direct drive)
- Control panel (Mechanical type, Microprocessor type)
- Head cover (Air-cooled, DX-cooling)
- Oil cooler (DX-cooling)
- Oil filter (External)
- High pressure cut-out switch
- Low pressure control switch
- Oil pressure failure protection switch
- High pressure side pressure gauge
- Low pressure side pressure gauge
- Micro-WI, WI, Micro processor control panel
- Oil pressure gauge
- Gauge board
- Oil heater with thermo-switch
- Oil separator

## OUTER DIMENSIONS (COMPRESSOR UNIT)

Unit: in.(mm)

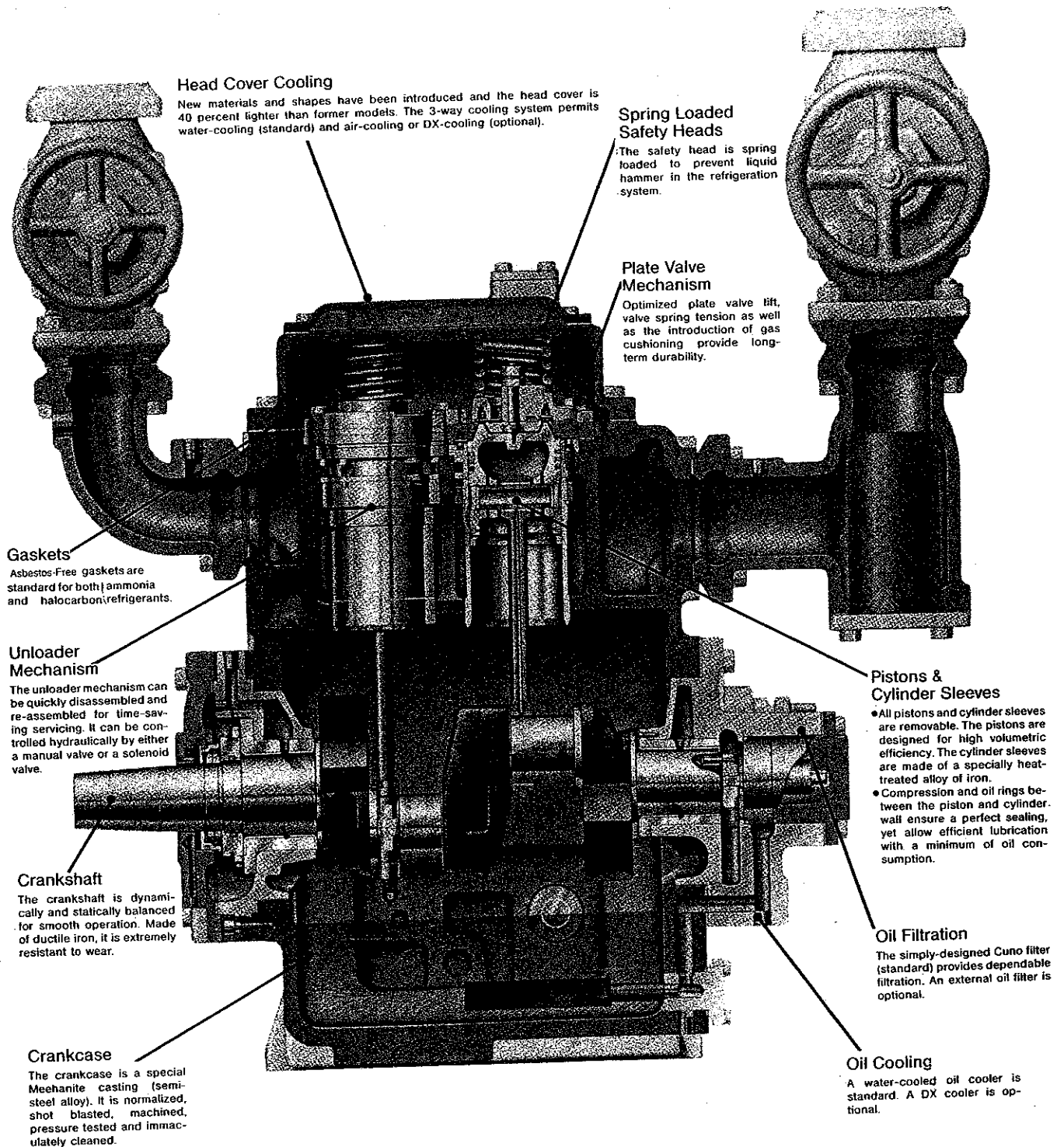


Model	Dimensions (inch)										Flywheel Pitch dia.	Flywheel No. of grooves	Weight less motor lb. (kg)	
	A	B	C	D		E	F	G	L*	W				
2WA	12-5/8(321)	-	37-1/2(955)	17(432)	-	21(533)	-	-	58(1,475)	34(865)	13-1/4(336)	SPC x 4	975(442)	
4WA	17-3/4(451)	12-1/16(306)	45-7/8(1,165)	15(381)	11(279)	25(635)	66-1/2(1,690)	38(965)	67(1,705)	42(1,070)	15-7/16(392)	SPC x 4	2,005(909)	
6WA	17-3/4(451)	32-1/16(814)	47-7/8(1,220)	4(102)	4(102)	25(635)	73-3/4(1,875)	41(1,045)	69-1/2(1,765)	43-1/2(1,105)	15-7/16(392)	SPC x 6	2,280(1,034)	
8WA	18-15/16(481)	32-7/16(824)	50-1/16(1,290)	4-1/2(114)	4-1/2(114)	25(635)	78(1,985)	41-1/2(1,055)	71(1,805)	44-1/8(1,125)	15-7/16(392)	SPC x 8	2,605(1,181)	
4WB	20-1/2(521)	15-13/16(402)	55-1/2(1,410)	20(508)	12-1/2(318)	27(686)	82(2,085)	44-1/2(1,130)	81(2,060)	55(1,400)	17-9/16(446)	SPC x 8	3,430(1,556)	
6WB	21-5/16(541)	40-3/8(1,026)	58-5/16(1,485)	5(127)	5(127)	26(711)	92(2,340)	50(1,270)	82-3/4(2,105)	55(1,400)	17-9/16(446)	SPC x 10	3,980(1,805)	
8WB	21-1/4(540)	39-11/16(1,008)	60-13/16(1,545)	6-1/2(165)	5-1/2(140)	30(762)	95(2,415)	46-1/2(1,235)	83-3/4(2,130)	55-1/4(1,405)	17-9/16(446)	SPC x 10 SPC x (12)*	4,420(2,005)	
12WB	B.D.	23-1/4(591)	63-1/2(1,613)	61-1/2(1,565)	5(127)	5(127)	72(1,829)	122-1/4(3,120)	55-3/16(1,355)	88(2,235)	79(2,010)	17-9/16(446)	SPC x 12	7,740(3,510)
	D.D.	25-1/4(631)												

Note: - "B.D.": Belt drive, "D.D.": Direct drive  
 • Dimension L given is less motor. Motor junction box may extend beyond frame especially on larger motor sizes.  
 • Figures in bracket ( ): m/m

• Design and specifications subject to change without notice.

# Sectional View of W Series Compressor



### Head Cover Cooling

New materials and shapes have been introduced and the head cover is 40 percent lighter than former models. The 3-way cooling system permits water-cooling (standard) and air-cooling or DX-cooling (optional).

### Spring Loaded Safety Heads

The safety head is spring loaded to prevent liquid hammer in the refrigeration system.

### Plate Valve Mechanism

Optimized plate valve lift, valve spring tension as well as the introduction of gas cushioning provide long-term durability.

### Gaskets

Asbestos-Free gaskets are standard for both ammonia and halocarbon refrigerants.

### Unloader Mechanism

The unloader mechanism can be quickly disassembled and re-assembled for time-saving servicing. It can be controlled hydraulically by either a manual valve or a solenoid valve.

### Crankshaft

The crankshaft is dynamically and statically balanced for smooth operation. Made of ductile iron, it is extremely resistant to wear.

### Crankcase

The crankcase is a special Meehanite casting (semi-steel alloy). It is normalized, shot blasted, machined, pressure tested and immaculately cleaned.

### Pistons & Cylinder Sleeves

- All pistons and cylinder sleeves are removable. The pistons are designed for high volumetric efficiency. The cylinder sleeves are made of a specially heat-treated alloy of iron.
- Compression and oil rings between the piston and cylinder wall ensure a perfect sealing, yet allow efficient lubrication with a minimum of oil consumption.

### Oil Filtration

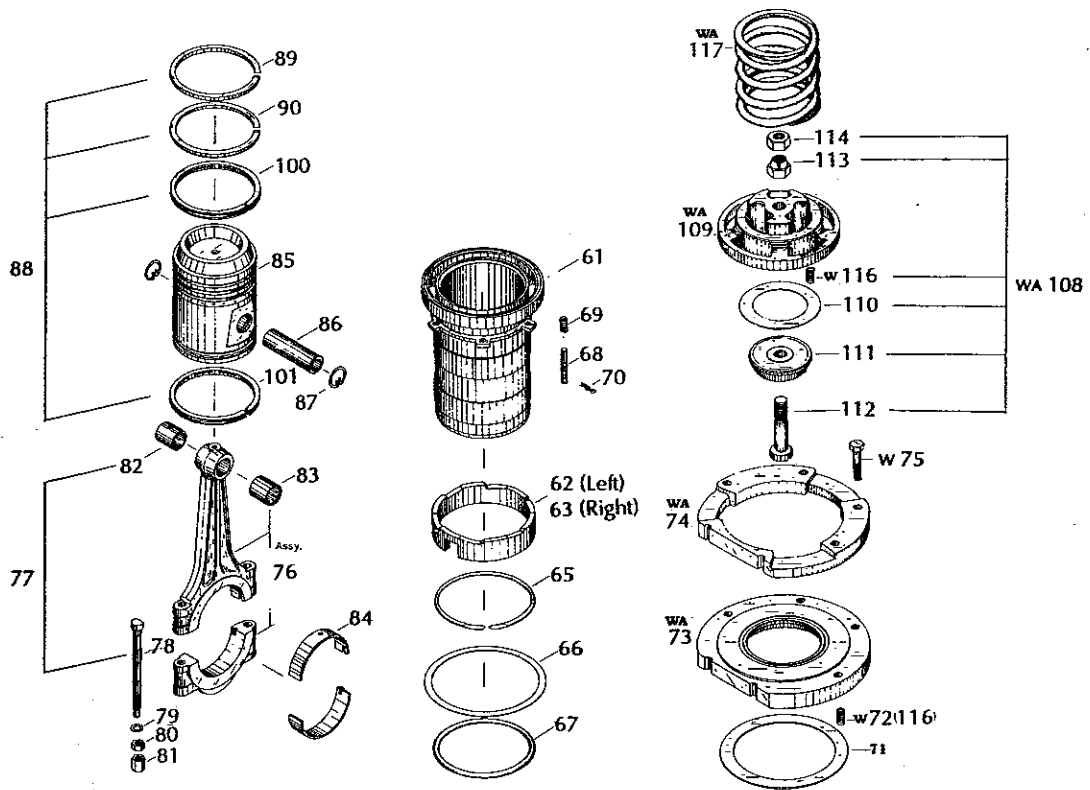
The simply-designed Cuno filter (standard) provides dependable filtration. An external oil filter is optional.

### Oil Cooling

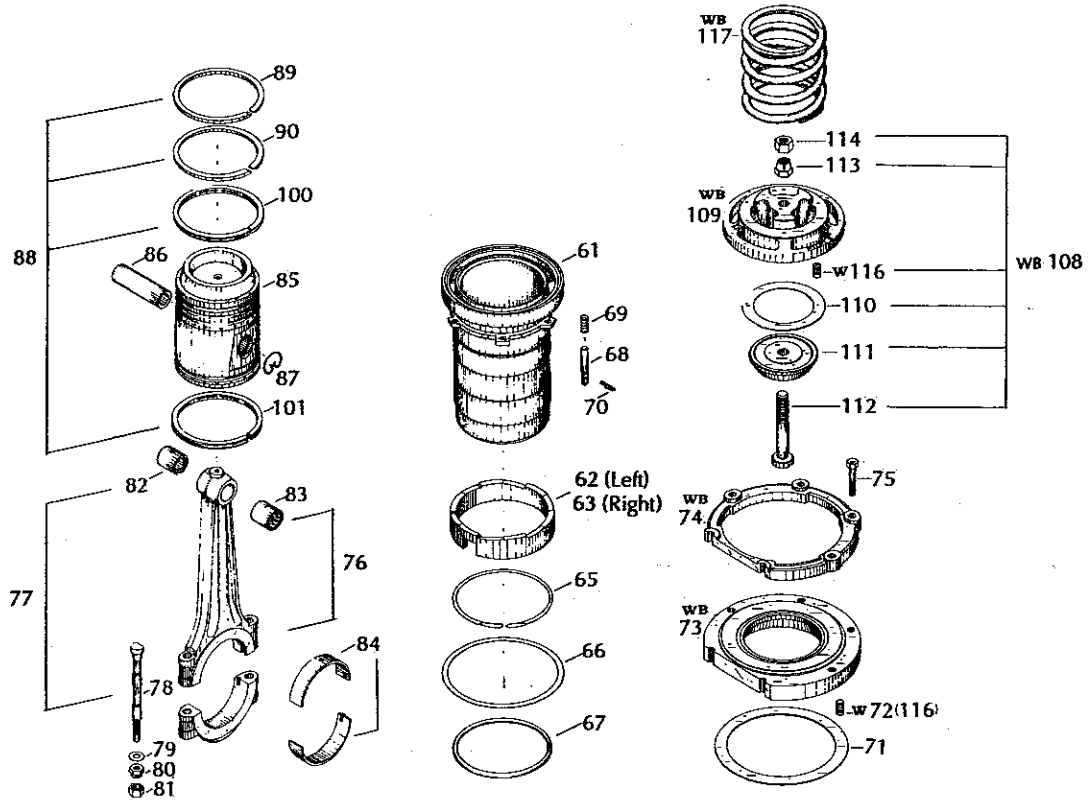
A water-cooled oil cooler is standard. A DX cooler is optional.



# WA · WB Cylinder Assembly, Exploded View



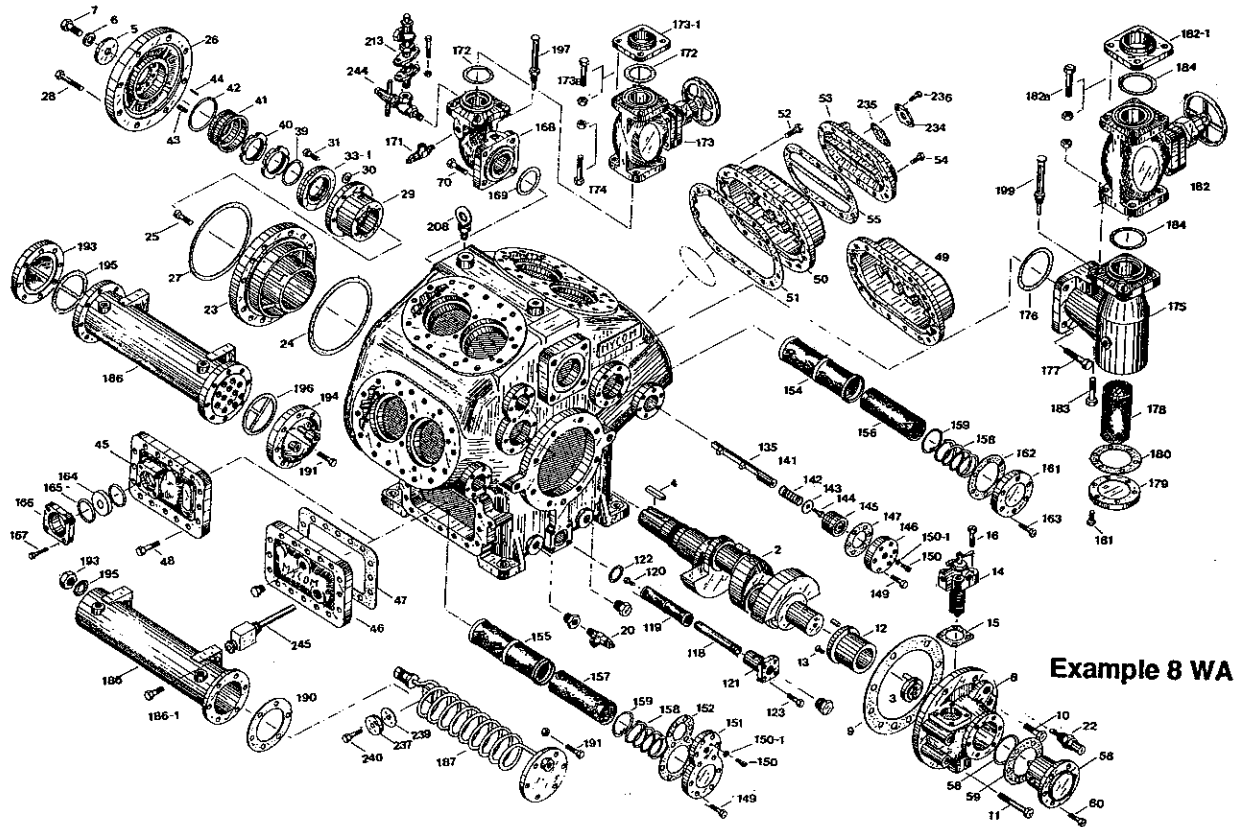
**WA series**



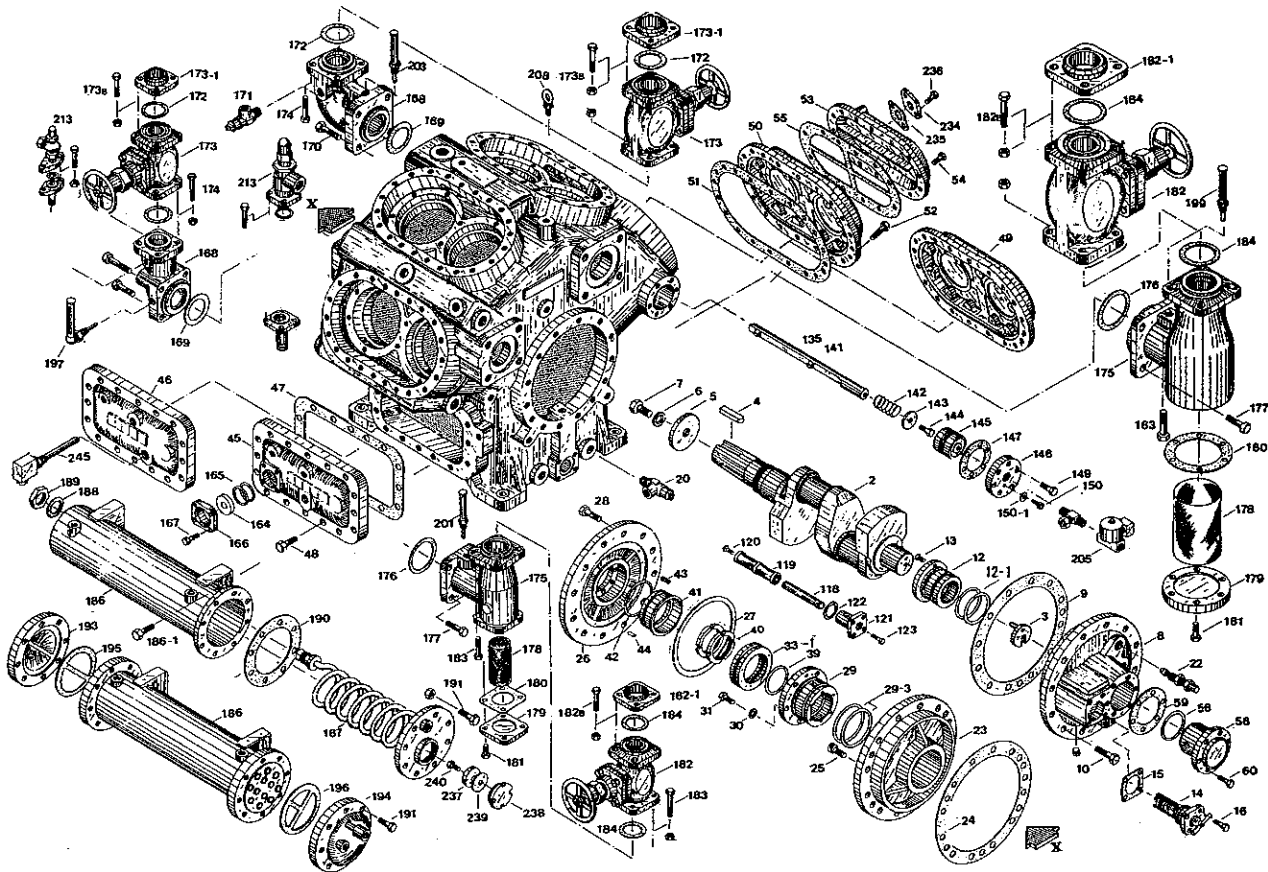
**WB series**

# Exploded View of Compressor

## WA · WB Compressor Assembly, Exploded View



Example 8 WA



Example 62 WB

## MYCOM RECIPROCATING COMPRESSOR PARTS LIST

Index No.	Description	Index No.	Description
1	Crankcase	34/38 *	Assembly parts, double seal collar
2	Crankshaft	34 *	Fixing ring
3	Drag crank	35 *	Floating seat
4	Key, pulley	36 *	Stop pin
5	Flat washer, pulley	37 *	"O" ring, Double seal collar
6	Lock washer, pulley	38 *	Spring
7	Set bolt, pulley hub	39	"O" ring, shaft seal collar
8	Main bearing head	40	Locknuts (2 p'cs)
9	Gasket, main bearing head	41	Shaft seal ring
10	Screw, hex. head cap (short)	42	"O" ring, shaft seal ring
11	Screw, hex. head cap (long)	43	Helical springs
12	Main bearing	44	Roll pin
12-1(225)	"O" ring, main brg (WB Compound Comp. Omly)	45	Handhole cover , with fittings and oil sight glass
13	Pin, main bearing	46	Handhole cover , without oil sight glass
14	Assembly, cuno-filter	47	Gasket, handhole cover
15	Gasket, cuno-filter cover	48	Bolt, handhole cover
16	Bolt, cuno-filter cover	49	Head cover (air cooled)
17 *	Cuno-filter case for Models 12WB & 12-4WB only	50	Head cover (water cooled)
18 *	Gasket, cuno-filter case for Models 12WB & 12-4WB only	51	Gasket, head cover
19 *	Bolt, cuno-filter for Models 12WB & 12-4WB only	52	Bolt, head cover
20	Drain valve	53	Jacket cover, head cover
22	Regulating valve, oil pressure/oil relief valve	54	Bolt, Jacket cover
23	Bearing head	55	Gasket, Jacket cover
24	Gasket, bearing head	56	Oil pump assembly, consisting of 56, 57 & 60
25	Bolt, bearing head	57	(discontinued numbers)
26	Cover plate	58	"O" ring, oil pump
27	Gasket, cover plate	59	Gasket, oil pump
28	Bolt, cover plate	60	Bolts (6 p'cs), oil pump
29	Thrust bearing	61	Cylinder sleeve
29-3 (226)	"O" ring, thrust brg (WB Compound only)	62	Cam ring, leftward sloped
30	Washers (6 p'cs), thrust bearing	63	Cam ring, rightward sloped
31	Bolts (6 p'cs), thrust bearing	64	(discontinued numbers)
32 *	Assembly, shaft mechanical seal (including No.33-1, 39, 41 & 42)	65	Retaining ring
33-1	Double shaft seal collar	66	Gasket, cylinder sleeve
		67	"O" ring, cylinder sleeve for compound compressor high-stage side only

68	Lift pin	123	Bolt, oil strainer cover
69	Spring, lift pin	125/134 *	Intermediate bearing, for Models 12WB & 12-4WB only
70	Split pin, lift pin		
71	Suction plate valve	135/141	Push rod, unloader device
72	Spring, suction plate valve	142	Spring, unloader device
73	Valve plate	143	Washer, push rod
74	Cage guide, discharge valve	144	Screw, push rod
75	Bolt, discharge valve cage guide	145	Unloader piston
76	Assembly, connecting rod (high stage)	146	Cover, unloader piston
77	Assembly, connecting rod (standard)	147	Gasket, unloader piston cover
78	Bolt, connecting rod	149	Bolt, unloader piston cover
79	Washer, connecting rod	150	Allen screw, unloader piston cover
80	Nut, connecting rod (No.1)	150-1	Washer allen screw
81	Nut, connecting rod (No.2)	151	Unloader & suction end cover 8WA
82	Bushing, connecting rod (standard)	152	Gasket, 8WA
83	Bushing, connecting rod (needle bearing)	153	(discontinued numbers)
84	Bearing halves	154	Suction strainer (filter)
85	Piston	155	Suction strainer (filter)
86	Piston pin	156	Fine screen, suction strainer
87	Lock spring, piston pin	157	Fine screen, suction strainer
88	Piston ring set	158	Spring, suction strainer
89	Piston ring, FC-PC-BF	159	Lock spring, suction strainer
90	Piston ring, FC-UC	160	Lock spring, suction strainer (see fig 57)
91/99	(discontinued numbers)	161	Suction end cover
100	Oil ring, FC-PC-BC3P	162	Gasket, suction end cover
101	Oil ring, FC-PC-BC3	163	Bolt, suction end cover
100/107	(discontinued numbers)	164	Oil sight glass
108	Assembly, discharge plate valve	165	"O" ring, oil sight glass
109	Discharge valve cage	166	Gland, oil sight glass
110	Discharge plate valve	167	Bolt, oil sight glass gland
111	Valve seat, discharge	168	Elbow, discharge
112	Bolt, discharge valve seat	169	Gasket, discharge elbow
113	Nut, discharge valve seat (No.1)	170	Bolt, discharge elbow
114	Nut, discharge valve seat (No.2)	171	Purge valve
116	Spring, discharge plate valve	172	Gasket, discharge shut-off valve inlow
117	Spring, safety head	173	Discharge shut-off valve
118	Screen supporter, oil strainer	174	Bolt & nut, discharge stop valve
119	Screen, oil strainer	175	Scale trap
120	Bolt, oil strainer	176	Gasket, scale trap faucet crankcase side
121	Cover, oil strainer	177	Bolt, scale trap
122	Gasket, oil strainer cover	178	Screen, scale trap

179	Cover, scale trap
180	Gasket, scale trap cover
181	Bolt, scale trap cover
182	Suction shut-off valve
183	Bolt & nut, suction shut-off valve
184	Gasket, suction shut-off valve
185 *	Assembly, oil cooler (water cooled)
186	Shell, oil cooler
186-1	Bolt, shell fitting
187	Coil assy, Watercooled oil cooler
188	Gasket, Coil assy
189	Nut, Coil assy
190	Gasket, oil cover shel and flange
191	Bolt, oil cover shel and flange
192	Assembly, oil cooler (refrigerant cooled)
193	End cover B
194	End cover A
195	Gasket, endcover A
196	Gasket, endcover B
197	Assembly, thermometer (high-stage side)
199 *	Assembly, thermometer (low-stage side)
201 *	Assembly, thermometer, high-stage suction side
203 *	Thermometer assembly, low-stage discharge side
205 *	Solenoid valve
206 *	Fitting, oil piping (12WB & 12-4WB)
207 *	Manual valve, unloader
208	Hanger eye bolt
210 *	Oil pressure gauge, 75 mm dia.
211 *	Oil pressure gauge, 100 mm dia.
212 *	Nipple, oil gauge
213 *	Safety valve (external mounting)
214 *	Safety valve (internal mounting)
225 (12-1)	"O" ring, main bearing (Compound only)
226 (29-3)	"O" ring, thrust bearing (Compound only)
227 *	Oil tank
234	Oval flange, water cooled head cover jacket piping
235	Oval flange gasket, water cooled head cover jacket piping
237	Zinc plate, Water cooled oil cooler

238	Plug, Zinc plate
239	Gasket, Zinc plate
240	Bolt, Zinc plate
236	Bolt, water cooled head cover jacket piping
245	Electric oil heater

Remarks:

1. State serial number of compressor for which replacement parts are being ordered.
2. If serial number is not available, it is necessary to indicate compressor model number, type of refrigerant used, and invoice number for compressor.
3. Nos.76/77 connecting rod and Nos.185/192 oil cooler are supplied as assemblies.
4. Parts numbers marked \* in index column are not shown in exploded drawing. These parts are for special application depending on type of refrigerant used or other non-standard conditions.

"W" Series

Care must be exercised when ordering spare parts.

Spare parts for reciprocating compressors are classified by type, i.e., those for the WA, WJ and WB models as well as the conventional A, J and B models. Some compressor parts have no interchangeability whatsoever while others may be fitted with common parts. When ordering spare parts for "W" Series compressors, note that the following parts are exclusive to the series.

Index No.	Name
49, 50, 53	Head and jacket covers
52	Screw, head cover
72	Spring, suction valve
73	Valve plate
74	Discharge valve cage guide
75	Screw, discharge valve cage guide
108	Discharge valve assembly
109	Discharge valve cage
116	Spring, discharge plate valve
117	Spring, safty head

**SERVICE MANUAL, MYCOM MULTI-CYLINDER  
REFRIGERATION COMPRESSORS**

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# SERVICE MANUAL FOR WA, WB, WJ MYCOM MULTI-CYLINDER REFRIGERATION COMPRESSORS

## CHAPTER 1. CONSTRUCTION

### 1. General Design

The Mycom multi-cylinder compressor is small and light-weight, maximizing use of floor space and weight per unit of refrigerating capacity. It is so designed that capacity control is achieved automatically by an unloader mechanism which is operated by regulating the suction pressure. When starting, load is automatically reduced by this mechanism, enabling the compressor to start with minimum torque. Load is applied only after the compressor attains working speed, thus reducing load on the motor. This means that it can be operated by a motor of smaller capacity than competing makes.

Compressor speed is max. 1200 rpm to 1450 rpm but operation is comparatively noiseless thanks to the dynamic balancing system employed. Various refrigerants can be used simply by changing a few parts.

Mycom compressors are divided into two series. One is Model WA, having 3.75" (95mm) bore and 3" (76mm) stroke, and the other is Model WB having 5.125" (130mm) bore and 3.9375" (100mm) stroke. These are also divided into two types: single stage and two stage (compound). The construction of the compound compressor is the same as that of the single stage compressor except that the compound type has two discharge and suction sections.

All parts are fabricated by the limited gauge system and are interchangeable. Replacement of parts can be achieved in a matter of minutes during periodic inspection or when repairs are necessary. All products are shipped only after extensive factory performance tests.

Please note, however, that the compressor's superior characteristics cannot be displayed if it is not properly handled. Careful reading of this manual will insure correct operation and maintenance of your Mycom compressor.

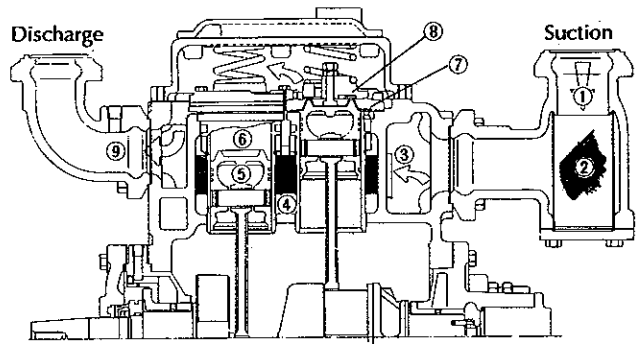
### 2. Mechanisms

#### 2.1. Gas compression mechanism

##### 2.1.1. Single stage compression (Ref. Fig. 1)

The refrigerant vaporized in the evaporator, enters the scale trap (2) through the suction stop valve (1) of the compressor, where scale is removed by a screen installed inside the trap. It then passes through the suction strainer (3) and enters the crankcase suction chamber (4). When the piston (5) starts a suction stroke, the pressure in the cylinder sleeve (6) drops, allowing the gas in the suction chamber to enter the cylinder after pushing up the suction valve (7). When the piston begins its upstroke, the suction valve is closed and the gas is compressed. When the gas pressure becomes higher than the pressure in the discharge section,

it pushes up the discharge valve (8) and the compressed gas is sent into the discharge section. It is then discharged through the discharge elbow (9) to the condenser.



**Fig. 1 Compression Mechanism**

Models WA & WB are of the same construction

- |                       |                         |
|-----------------------|-------------------------|
| ① Gas from stop valve | ⑥ Cylinder sleeve       |
| ② Scale Trap          | ⑦ Suction plate valve   |
| ③ Suction strainer    | ⑧ Discharge plate valve |
| ④ Suction chamber     | ⑨ Discharge elbow       |
| ⑤ Piston              |                         |

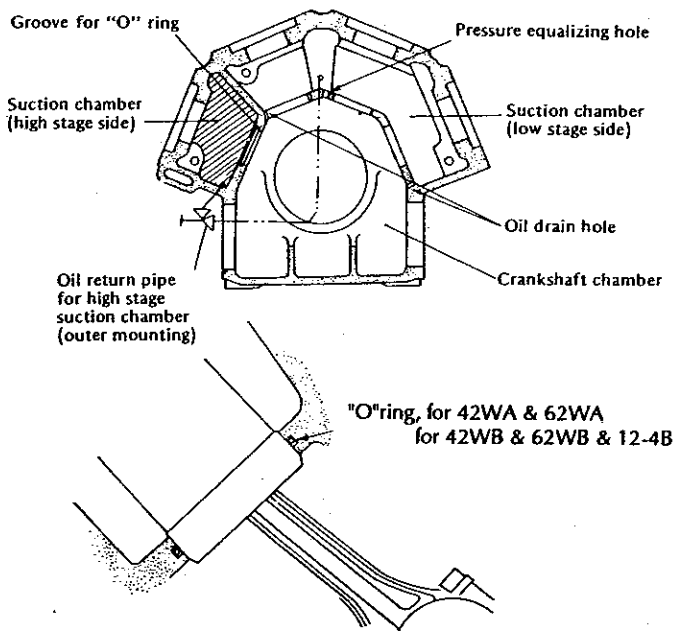
##### 2.1.2. Compound compression

(Two-stage compression by a single compressor)

The compound compressor is constructed with two suction chambers and two discharge ports and the interior is divided into two sections in order to perform the functions of two single-stage compressors.

Two cylinders of the compressor function as the high stage while, depending on the size of the compressor, the other four or six cylinders work as the low stage. Viewed from the oil pump side, the low stage cylinders are on the right side of the compressor. (Ref. Fig. 2) The suction chamber and the crankshaft chamber are connected by a pressure equalizing hole of 12mm dia. and another 5mm dia. hole is found between the bottom of the suction gas chamber and the crankshaft chamber which serves as a drain for oil returned from the evaporator and to prevent foaming.

The high stage side is located on the same side as the oil cooler. The high side suction chamber is separated from the low side suction chamber by a wall and airtightness is maintained by the use of an "O" ring in the lower end of the cylinder sleeve. The cylinder is thus sealed off from the crankshaft chamber as this suction chamber reaches a mediate evaporative pressure during operation.



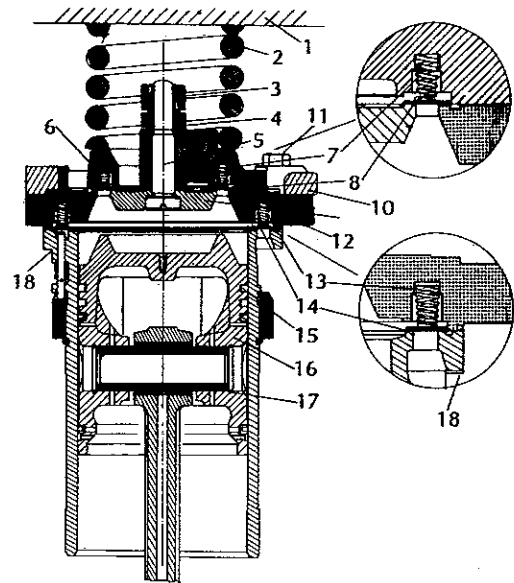
**Fig. 2 Sectional view of compound type crankcase**

From the oil drain in the high side suction chamber, piping is led to the low stage suction chamber for the purpose of cycling any oil which collects in the high side chamber. This flow is regulated by a manually operated stop valve. Oil from the high side passes to the low side and then to the crankcase through the oil drain at the bottom of the low side suction chamber. The pressure differential between high and low sides pushes the oil through the pipe. Care should be taken not to open the stop valve more than a quarter turn as this may result in gas of medium pressure flowing into the low side. Please note, however, that if the valve is completely closed, the high side suction chamber will fill with oil and oil hammering will occur.

Special note should be taken that when a compound compressor is being used for single stage operation it is necessary to reduce the pressure in the low stage suction chamber periodically in order to permit accumulated oil in the high side to flow to the low side.

## 2.2. Safety head and valve mechanism

The safety head spring is compressed between the head cover and the discharge valve assembly. It serves to prevent damage resulting from liquid hammer caused by refrigerant, oil, or foreign matter entering the cylinder by absorbing abnormal pressure.

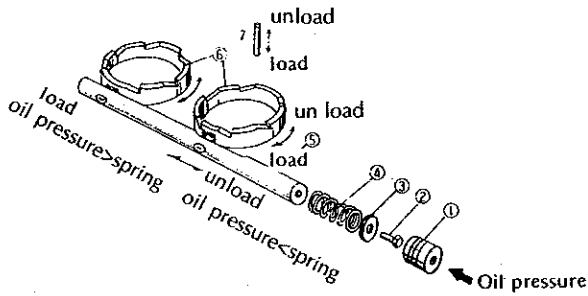


**Fig. 3 Sectional view of valve mechanism**

1. Head cover
2. Spring, safty head
3. No. 2 nut, discharge valve
4. No. 1 nut, discharge valve
5. Bolt, discharge valve seat fastening
6. Discharge valve cage
7. Spring, discharge plate valve
8. Discharge plate valve
9. Valve seat, discharge
10. Cage guide, discharge valve
11. Bolt, discharge valve cage guide fastening
12. Valve plate
13. Spring, suction valve
14. Suction plate valve
15. Piston ring
16. Piston
17. C ylinder sleeve
18. Gasket, cylinder sleeve

## 2.3. Unloader mechanism

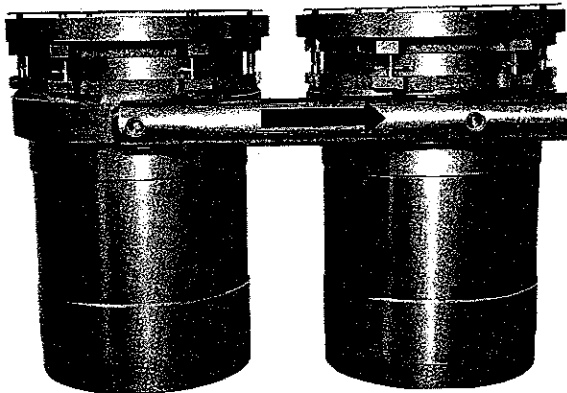
Operation of the mechanism is controlled hydraulically by means of either a manual valve or a solenoid valve. Fig. 6 shows the unloader mechanism in a loaded condition, oil pressure being applied to its unloader piston. Figure 4 shows the unloaded condition of the mechanism where no oil pressure is applied and the unloder piston is pushed back by spring force. The push rod then begins to operate, rotating the cam ring counterclockwise.



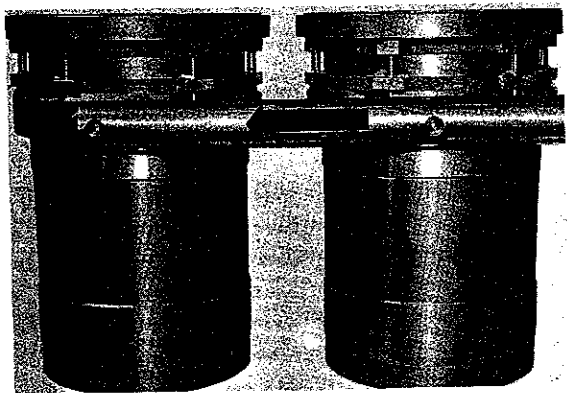
**Fig. 4 Unloader mechanism**

- |                            |                      |
|----------------------------|----------------------|
| 1. Unloader piston         | 5. Unloader push rod |
| 2. Screw, push rod         | 6. Cam ring          |
| 3. Washer, push rod        | 7. Lift pin          |
| 4. Spring, unloader device |                      |

The cam ring has a slant cut and the lift pin produces vertical movement along the slant face. The lift pin pushes up the suction valve on the upper surface of the sleeve.



**Fig. 5 Unloader mechanism in unloaded condition**



**Fig. 6 Unloader mechanism in loaded condition**

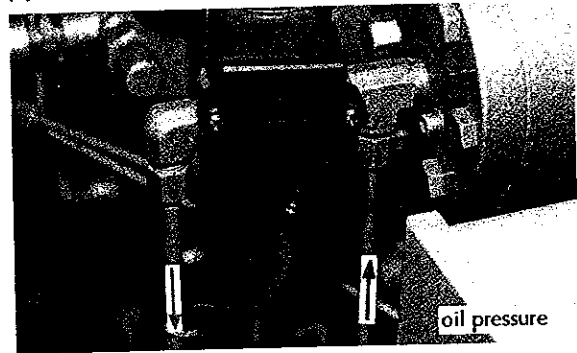
Consequently, gas escapes to the suction side even if the piston starts compression strokes. This indicates that the unloader mechanism is in an unloaded condition (Ref. Fig. 5).

On the contrary, when the lift pin is lowered and the valve is operating on the seat surface, the unloaded mechanism is in a loaded condition (ref. Fig. 6).

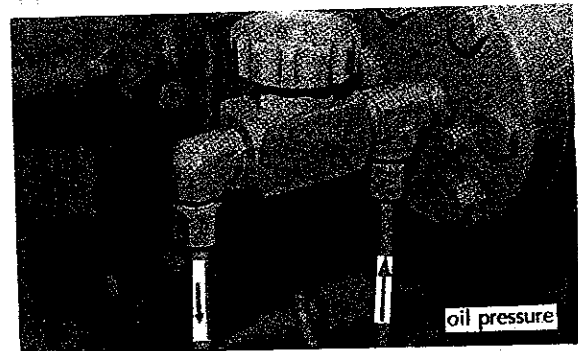
As oil pressure from the oil pump is applied to the unloader mechanism through a throttle nozzle, the unloader mechanism returns to the unloaded position if the oil pressure is released by opening the manual valve or opening the solenoid valve while it is operating.

The unloader piston cover (Ref. Fig. 7) has a solenoid valve or a manual valve mounted externally.

(1) Solenoid valve



(2) Manual valve



- |                              |                            |
|------------------------------|----------------------------|
| (1) Solenoid valve operation | (2) Manual valve operation |
| load .....by closing         | load .....by closing       |
| unload .....by opening       | unload .....by opening     |

**Fig. 7 Standard type unloader cover and manual valve**

The unloader piping of models 12WB and 12-4WB is internal and a special piston cover is utilized. Unloading is achieved by opening the manual valve or solenoid valve, while loading is achieved by closing of the valve.

Capacity control for single stage operation is directly proportionate to the displacement volume, while for compound or two-stage operation it is reduced by the displacement volume of the low stage side. The ratio of displacement volumes of the high and low stages change as follows.

62WA, 62WB L:H = 3:1 / 2:1 / 1:1

42WA, 42WB L:H = 2:1 / 1:1

12.4WA L:H = 3:1 / 2:1 / 1:1

## 2.4. Lubrication mechanism

Lube oil is pressure-fed and circulated by means of an oil pump (Fig. 8) employing a trochoid gear. The pump is driven directly off the crankshaft. An arrow on the outer rim of the pump assembly indicates the direction of rotation.

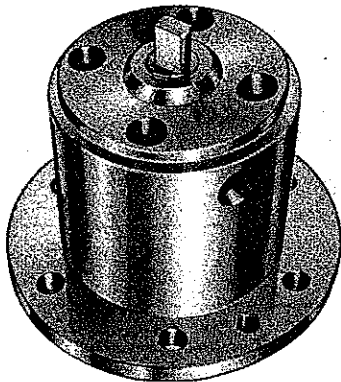


Fig. 8 Oil pump assembly

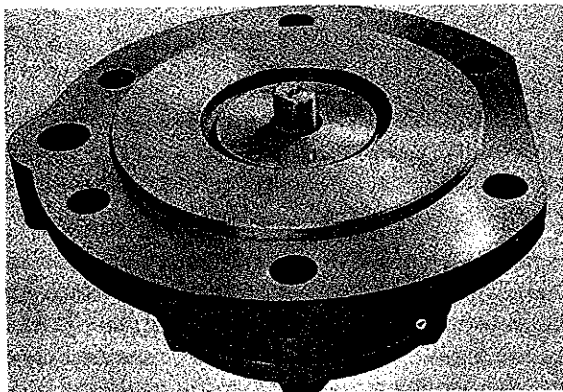


Fig. 9 Oil pump assembly for 12WB & 12-4WB



Fig. 10 Compressor rotation direction plate

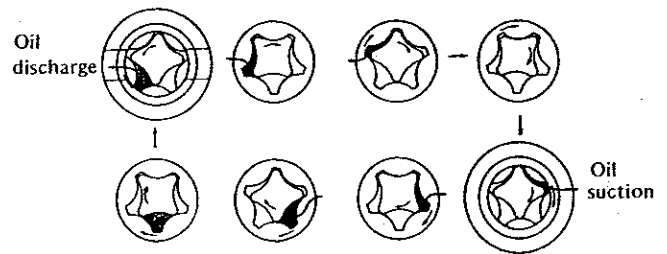


Fig. 11 Oil pumping sequence

### 2.4.1. Oil Flow for Model WA

Lube oil from the crankcase is drawn through the oil strainer by the pump and then force-fed to a multi-plate type cuno-filter. Compressors for marine use are equipped with an oil tank which feeds the oil except for model 2WA, which functions in the same manner as the standard compressor.

Oil from the cuno-filter follows two paths; one for lubricating the compressor, and the other for operating the unloader mechanism. Lubricating oil passes through the oil cooler and then to the crankshaft, the oil passes through the thrust bearing and crankshaft where it lubricates the connecting rod bearings and main bearings.

The oil pressure regulating valve is mounted at the extreme end of the lubricating path. Thus the oil pressure gauge indicates a pressure slightly lower than that at the main lubricating points along the path.

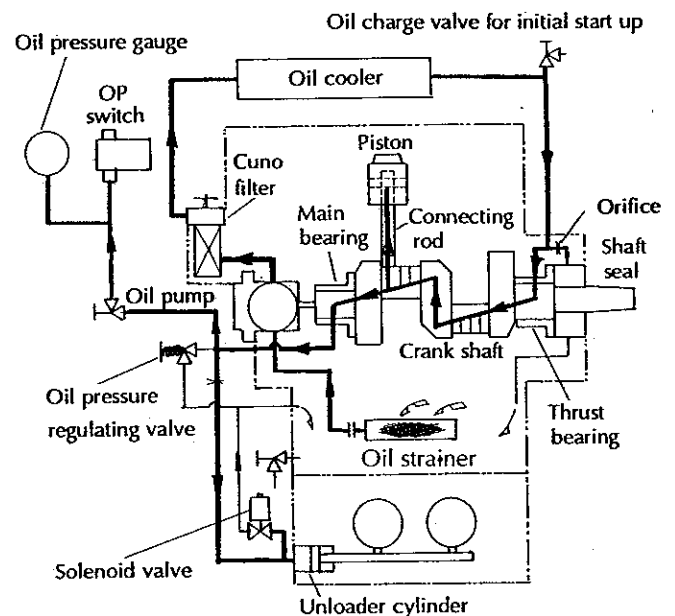
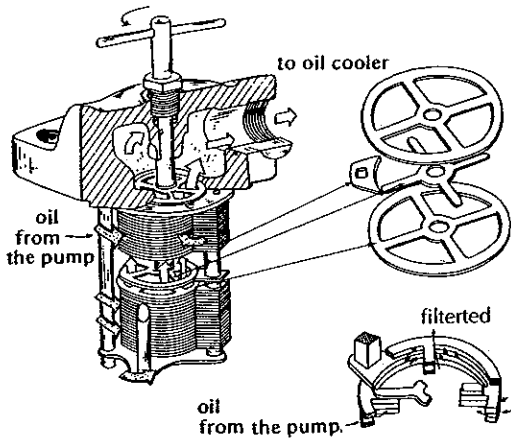
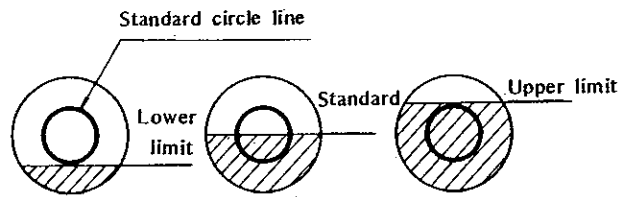


Fig. 12 Oil flow chart for Model WA



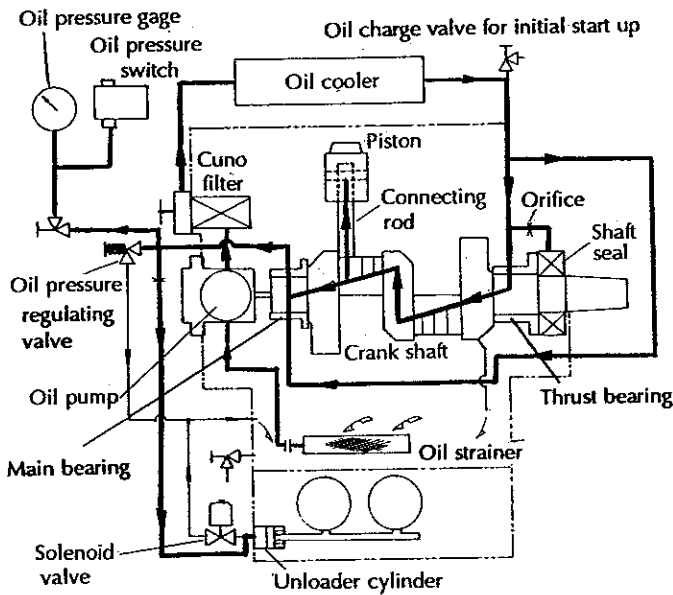
**Fig. 13 Cuno-filter mechanism**

a) Oil level in the crankcase may be checked through the oil sight glass mounted on the handhole cover.



**Fig. 16 Oil level on the sight glass**

**2.4.2. Oil flow for Model WB**



**Fig. 14 Oil flow chart for Model WB**

Initial oil quantity

UNIT : l

Model	2WA	4WA	6WA	42WA	8WA	62WA
Upper limit	6.5	16.0	16.6	16.6	19.8	20.6
Normal	5.0	13.5	11.9	11.9	16.3	16.9
Lower limit	3.5	11.5	7.5	7.5	13.0	13.4
Oil tank volume	-	30.0	30.0	30.0	35.0	35.0

4WB	6WB	42WB	8WB	62WB	12WB	124WB
24.9	29.8	30.7	31.2	32.1	59.5	62.5
19.8	24.0	25.4	25.6	26.2	48.0	50.5
15.4	19.4	19.7	20.3	20.9	38.8	40.5
40.0	45.0	46.0	50.0	50.0		

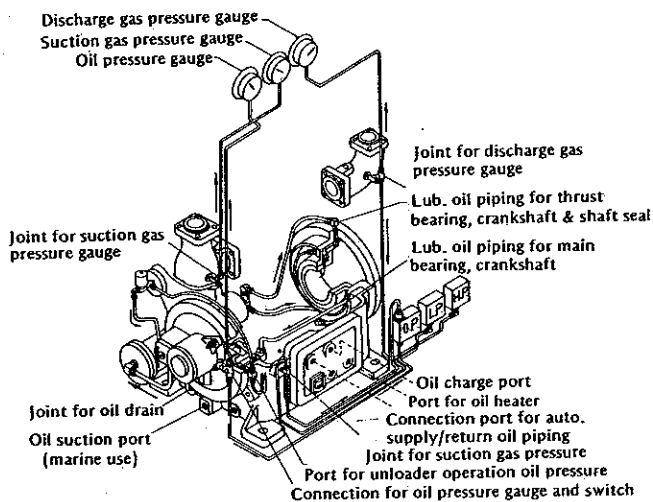
b) Oil can be easily charged from the charging mouth, even while the compressor is in operation, if the internal pressure of the crankcase is lower than the atmospheric pressure.

In case of Gas flowback at work, close the suction stop valve slightly and, after checking that the pressure in the crankcase has dropped below the atmospheric pressure, charge the oil. Put the oil charging hose deep enough into the oil tank to prevent air being sucked in.

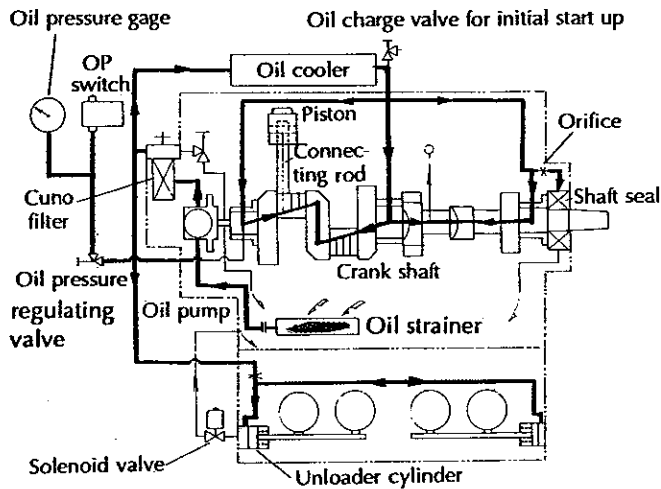
The container used for charging oil must be kept clean. If residue of other oil type remains in the container, it may cause a future trouble.

**2.4.3. Oil flow for Models 12WB and 12-4WB**

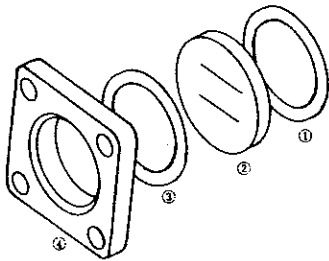
The oil flow system is similar to the Model WB system, but an intermediate bearing on the crankshaft is also lubricated. Therefore, the oil flows from the center to the ends of the crankshaft through internal paths and holes inside the crankcase (refer to Fig. 17).



**Fig. 15 Oil piping of Model WB**



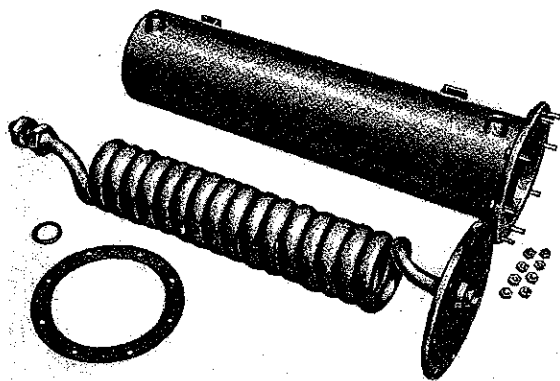
**Fig. 17 Oil flow chart for Models 12WB & 12-4WB**



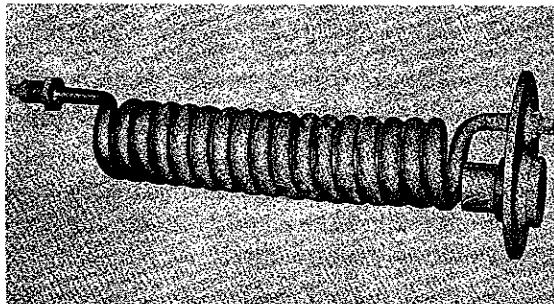
**Fig. 18 Exploded view of oil sight glass**

- (1) "O" ring
- (2) Oil sight glass
- (3) "O" ring
- (4) Gland, oil sight glass

**2.5 Oil cooler**



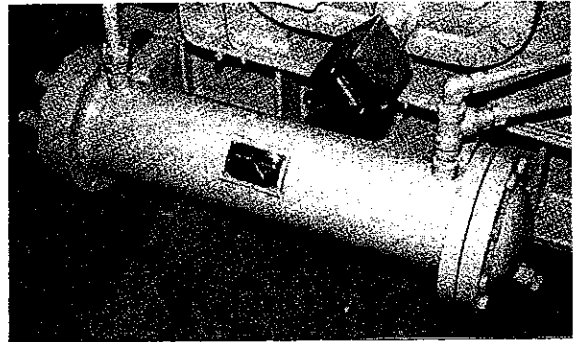
**Fig. 19 Oil cooler, Type WA**



**Fig. 20 Oil cooler, Type WB**

Both Type WA and Type WB employ a shell & coil type oil cooler, as shown on Figs. 19 and 20.

The quantity of cooling water required varies upwards of 30 L/min. (the quantity is determined by the water temperature). Keep the oil temperature under 45°C at the oil cooler outlet. The oil coolers of 12WB and 12-4WB employ a shell & tube system with 4 passes and have high cooling capacity even though small in size.

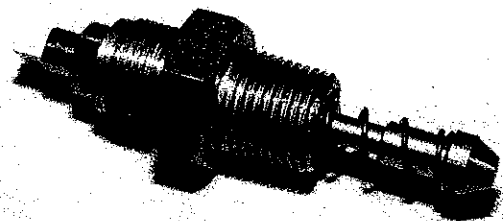


**Fig. 21 DX oil cooler**

**2.6. Abnormal oil pressure protection**

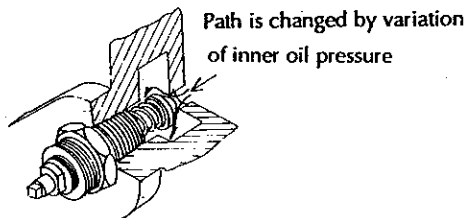
All models are equipped with an oil pressure regulating valve for abnormal oil pressure protection on the rear side of the cuno-filter chamber. It vents any abnormally high oil pressure resulting from high viscosity at start up.

If the oil pressure cannot be raised dust may have clogged the valve seat. In this case, check valve operation once again or remove the valve and clean.



**Fig. 22 Oil pressure regulating valve**

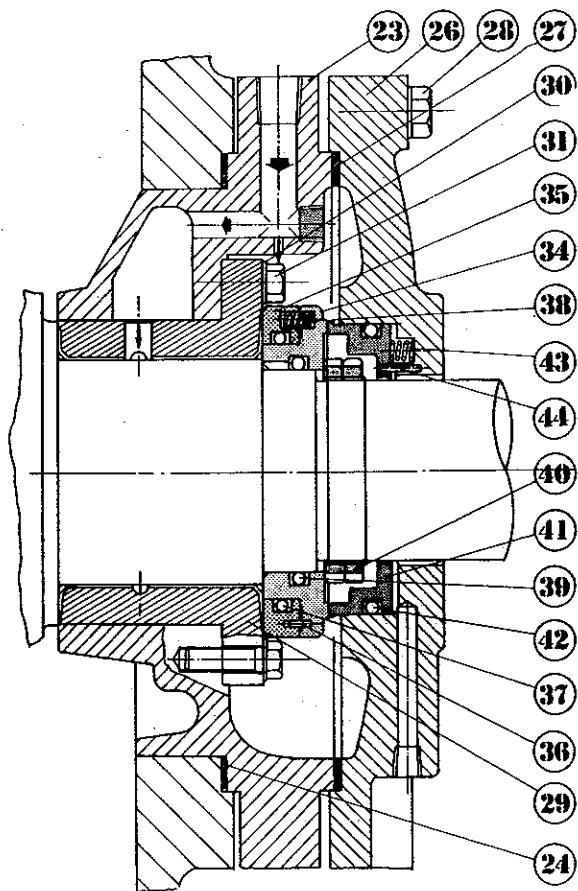
(with relief for abnormal high pressure)



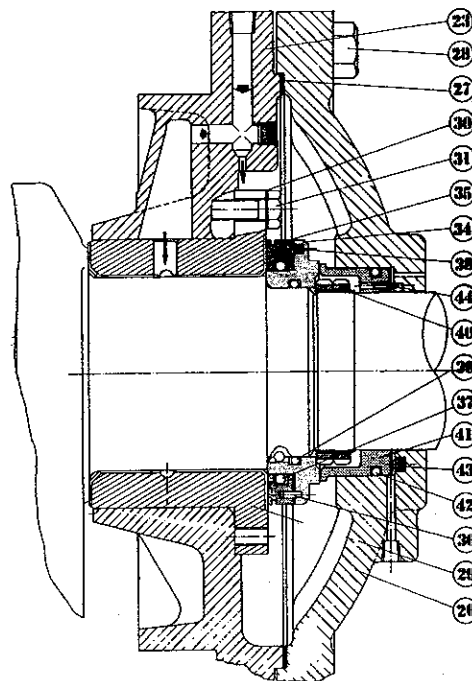
**Fig. 23 Oil pressure regulating valve**

### 2.7. Shaft seal mechanism

The shaft seal mechanism (Figs. 24 & 25) is a simple and efficient sealing device consisting of a shaft seal collar (33-1), shaft seal ring (41) and "O" rings (37, 39 & 42). The shaft seal collar is fixed to the shaft by a locking ball and thus rotates with the crankshaft. The seal ring is locked to the cover plate by a roll pin (44) and alignment of the friction surfaces of these two parts is assured by the installation of a helical spring (43). The seal is pressure-fed with oil from the pump and is sealed by "O" rings and a lapped friction surface. Leakage of refrigerant and oil is completely eliminated.



**Fig. 24 Sectional view of shaft seal, Type WA**



**Fig. 25 Sectional view of shaft seal, Type WB**

- 23. Bearing head
- 24. Gasket, bearing head
- 26. Cover plate
- 27. Gasket, cover plate
- 28. Bolt, cover plate
- 29. Thrust bearing
- 30. Washer, thrust
- 31. Screw, thrust bearing
- (32). Mechanical shaft seal assembly (33-1, 39, 41, 42)
- (33-1). Collar assembly, double shaft seal (34, 35, 36, 37, 38)
- 39. "O" ring shaft seal collar
- 40. Lock nut
- 41. Shaft seal ring
- 42. "O" ring, shaft seal ring
- 43. Helical spring
- 44. Roll pin

### 2.8. Safety valve

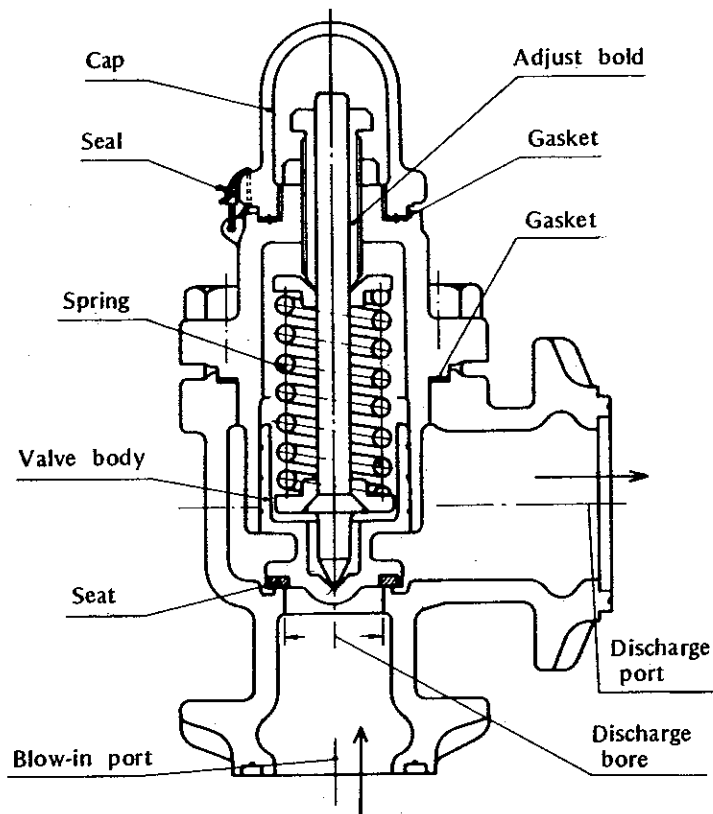
The valve is set at the following discharge pressures:

	psig	(kg)
Ammonia	275	19.5
R-22	275	19.5
R-12	275	19.5

The valve should be tested at least once a year (minimum pressure test). Test apparatus and standard pressure gauges are necessary for adjustment.

The above are our standard pressure settings for safety valves. If any other pressure setting is required, please contact us at the time of your order.

A spring type safety valve is employed as shown in Figure 26.



**Fig. 26 Safety valve**



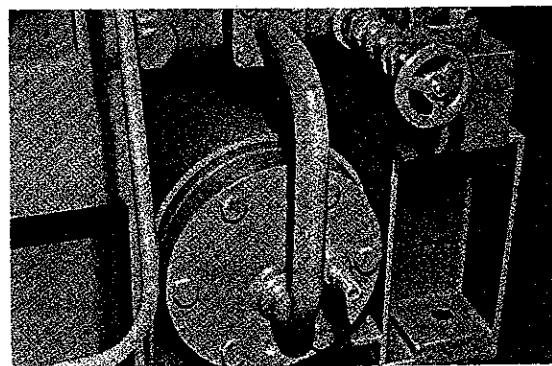
### 2.9. Oil tank for marine use

We manufacture special compressors and oil tank units for marine use. These units are designed to eliminate oil pressure drop resulting from rolling and pitching at sea.

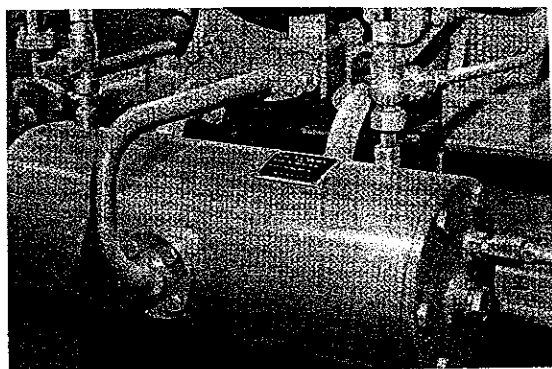
Oil tanks for 4WA to 8WB have two shapes. Fig. 27 shows a tank mounted under the compressor and Fig. 28 shows a side mounted tank. The former type has no pressure equalizing piping, and is connected with flange at the lower center part of the crankcase. The other type has two oil flow pipes and one pressure equalizing pipe for purging gas and is connected to the handhole cover. There is a stop valve in the middle of this pipe. It should not be closed during operation.

The tank cover has a valve for draining oil. The inside of the oil tank must be cleaned after each voyage.

The normal oil level is the same as for land use. Adjust to keep the level in the middle of the sight glass.



**Fig. 27 Oil tank, bottom mounting type for marine use**



**Fig. 28 Oil tank, side mounting type for marine use**



## CHAPTER 2. DISASSEMBLY AND REASSEMBLY

### 1. Disassembly

#### 1.1. Stopping operation

There are two reasons for disassembly of the compressor. One is for routine checking and the other is for repairs.

##### 1.1.1. Routine checking

In general, routine checking is planned so as to limit the downtime of the compressor, and is for maintenance and safety control. It must guarantee smooth operation at least until the next routine check, so may include replacement or repair of parts.

First, the compressor must be stopped and the refrigerant in the low pressure side collected into the liquid receiver. If each unit in a multi-compressor system can be checked alternately, it is equal to temporary stopping, i.e., close the suction stop valve of the compressor, and exhaust refrigerant from the crankcase.

After stopping the compressor, close the discharge stop valve to allow refrigerant gas in the discharge assembly to escape to the low pressure side through the by-pass piping. If the compressor has an automatic control circuit which works by suction pressure for load reduction and stopping, this electric circuit must be changed over to the manual circuit or shorted.

If ammonia remains, it gives off a strong odor. Purge as soon as possible.

In case of Freon, reduce pressure gradually until it becomes 0 kg/cm<sup>2</sup>G, then stop the compressor. The pressure will rise after a while, so repeat this handling until the pressure does not rise again.

Care must have taken not to reduce pressure too quickly. If roughly handled, refrigerant in the oil evaporates, foams and causes oil pumping or oil hammer.

##### 1.1.2. Repairs

When disassembly and repair is required due to trouble, the compressor must be stopped with the same handling as described above if the necessary time for stopping is available. In many cases, there is no time for gradual stopping when abnormal conditions are found, however. Even so, do not forget the correct handling of valves, otherwise it may further endanger the equipment.

##### 1.1.3. Purging refrigerant

Ammonia gas must be discharged into water. Water absorbs ammonia gas up to 600 times its own volume so even if a small amount is used it is able to absorb a fairly large quantity of gas. In this case, care should be taken to ensure

that the water is not sucked into the compressor.

In case of Halocarbon refrigerant, close the liquid outlet valve on the liquid receiver and collect as much refrigerant as possible into the receiver and the condenser by operating the compressor. When the suction pressure reaches close to vacuum, close the suction and discharge valves and all valves on the high pressure line, then stop operation (care must be taken not to exhaust excessive gas into the air). Halocarbon gas stays close to the floor and care must be taken to exhaust the gas outdoors using a pipe or hose to protect potential suffocation.

Should liquid flow-back occur, it is advisable to bleed both refrigerant and compressor oil into a container.

#### 1.2. Preparation for disassembly

- a) The crankcase is in a vacuum state when the compressor is stopped. It should be brought to atmospheric pressure.

Drain the oil from the crankcase through the oil drain valve by removing the oil plug through the hand hole. Also drain through the piping of the low pressure gauge.

If the compressor is equipped with an automatic oil supply system, do not forget to close all valves of the system. This must also be done for the automatic oil return type oil separator.

- b) During disassembly work, cut off all power switches not in use.
- c) Drain water from the jacket heads and block. Drain cocks are provided on the side of the crankcase and the bottom of the oil cooler.
- d) Remove belts or coupling and take off the flange and flywheel as shown in Figures 29 & 30.
- e) Both flywheel and coupling flange are tapered on the compressor side so that they are easily removed by loosening them slightly. Handle the components with care.

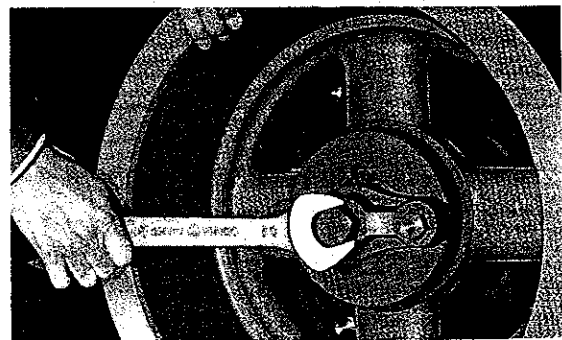
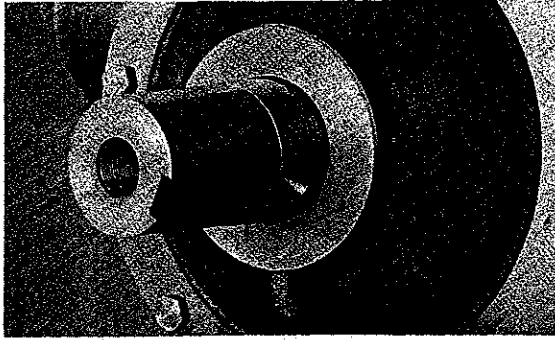


Fig. 29 Dismantling flywheel



**Fig. 30 Crankshaft without flywheel**

**1.3. Notes on disassembly**

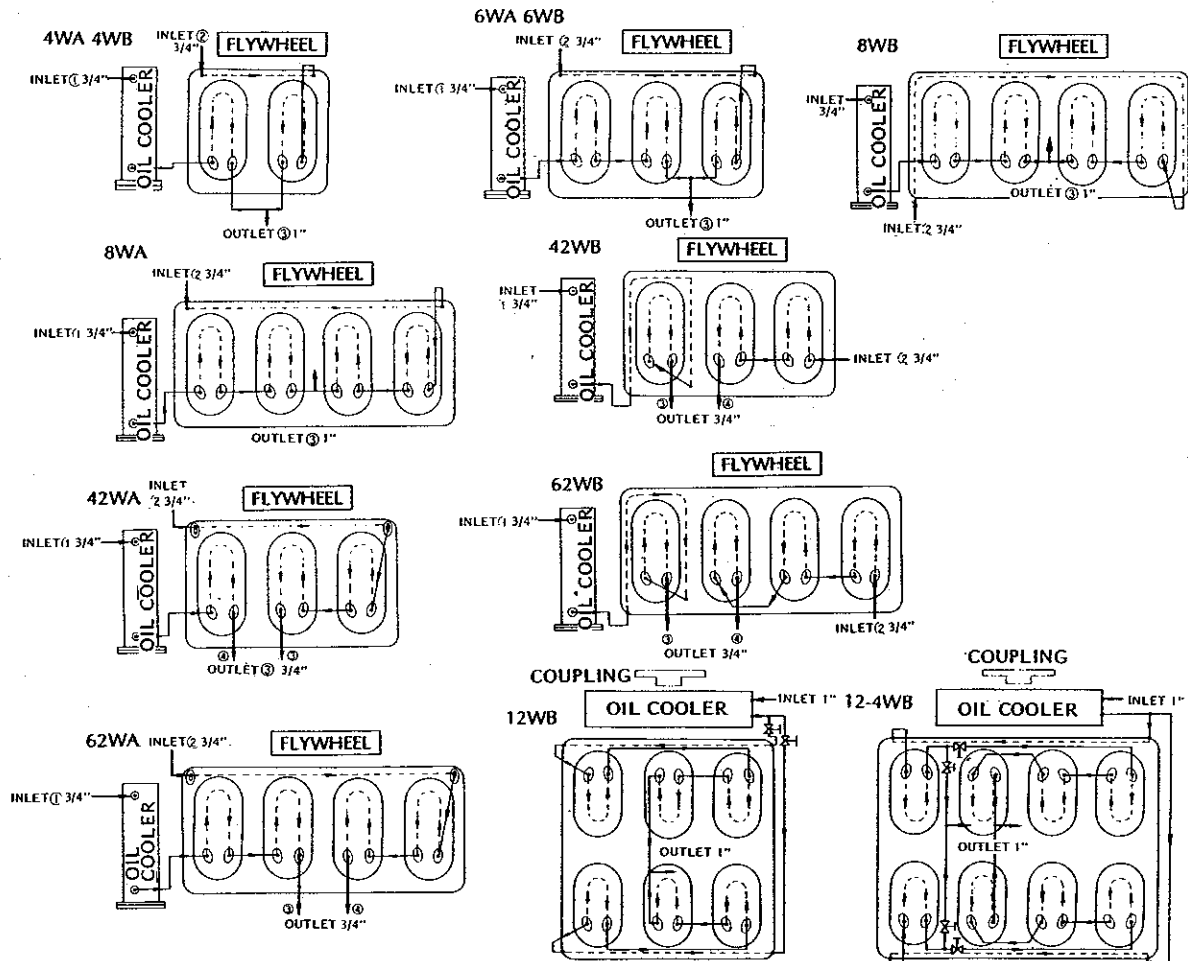
- a) Tools must always be kept clean (refer to Supplement II).
- b) Neatly arrange disassembled parts in order on a table or a surface which is clean, free of moisture and nonabrasive.
- c) To clean parts, use pure alcohol, carbon tetrachloride, trichlore-ethylene or light oil. Warmed (45 to 50°C) compressor oil may also be used.

After washing, coat surfaces with lubricating oil. Parts will become rusty if left without an oil film.

- d) Before assembling, clean the parts with compressed air, a sponge or clean cloth and coat with clean lubricating oil. Avoid using rags which shed fibers as these will cause clogging of the oil piping.
- e) When mounting gaskets, it is advisable that graphite-mixed oil or nondrying packing be applied on one side of the gasket to make future disassembly easier.
- f) When cylinders are disassembled, component parts should be arranged neatly in order of each cylinder. In particular, take special care not to mix connecting rods.

**1.4. Removal of water piping**

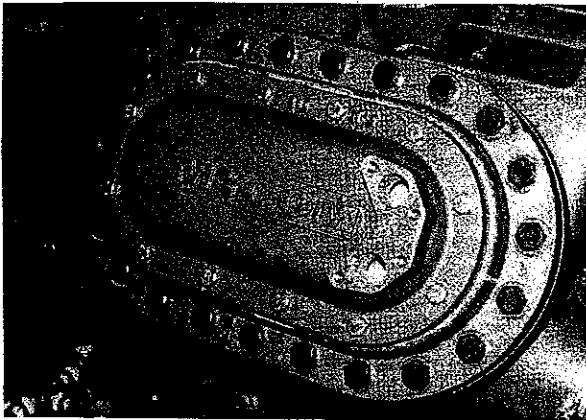
- a) The standard cooling water flow is as illustrated in Figure 31.
- b) Land standard models employ vinyl hose, so loosen the hose bands.
- c) Marine standard models employ steel pipe, so remove the flange connections.



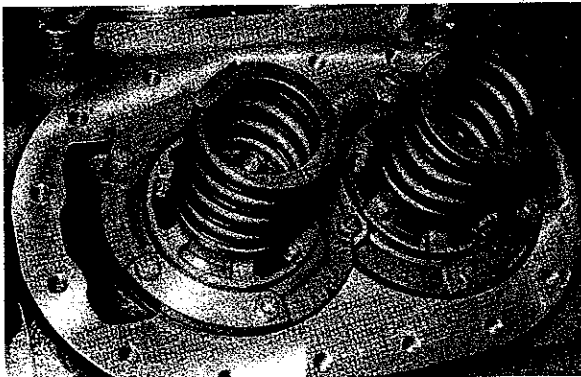
**Fig. 31 Standard cooling water flow chart (Jacket head cover)**

### 1.5. Removal of head cover

- a) Two types of head cover exist, those with and those without water jackets.
- b) In the case of Model WB compressors, first replace any two symmetrically opposite screws with the long ones provided in the hand tool kit. Now, remove all screws other than these two long ones from the head cover. Finally loosen these two gradually until the head springs break the gasket free.
- c) If the gasket adheres to the main body or to the head cover, tap the head cover on the side with a mallet after loosening the two screws, or peel the gasket off carefully with a felt chisel or screwdriver. Be careful not to damage the gasket.



**Fig. 32 Jacket head cover, Model WB**

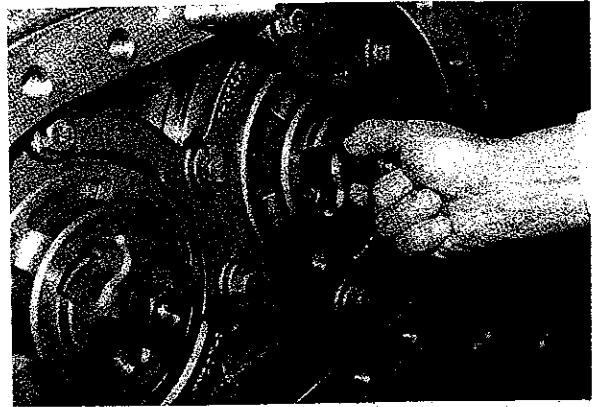


**Fig. 33 View after head cover removed**

### 1.6. Removal of head springs

The safety head springs shown in Figure 33 are pressure-attached between the head cover and discharge valve assembly and their position is determined by the seat of the cage. They can be taken off easily by hand. When carbonized oil, slag and the like adhere to them, the discharge valve assembly occasionally comes off with the spring.

Remove the springs only, taking care that no carbonized oil or slag falls into the cylinder.



**Fig. 34 Removing discharge valve assembly**

### 1.7. Discharge valve (assembly)

- a) As the assembly is kept in position by the cage guide only, the valve assemblies can easily be removed by hand (Fig. 34). However, when carbonized oil and slag adhere to them remove carefully taking care not to allow any foreign matter to drop into the cylinder.
- b) Avoid disassembly if the parts appear to be in good condition, i.e., no abrasion of valves, damage to spring or presence of carbonized oil or slag. When disassembly is necessary, do it with care using the tools in the hand tool kit. (ref. 3-16).
- c) Sequence of disassembly

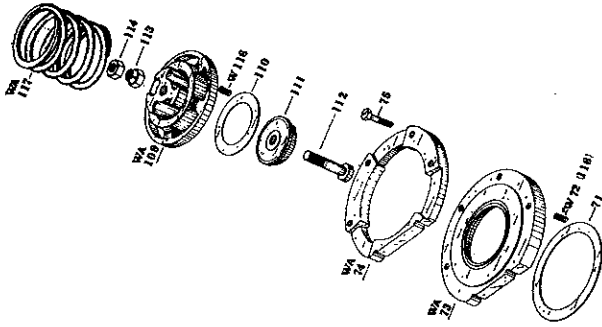
- 1) Unscrew and remove both parts of locknut assembly.

#### NOTE

The discharge valve assembly must be firmly held in order to prevent the assembly turning when the locknuts are slackened-off, and again when tightening the nuts on reassembly. The valve assembly must NOT be held in a vice as this practice may distort the discharge valve seat, forming 'high spots' which will prevent the valve seating correctly. Instead, hold the valve assembly using the special tool provided in the compressor tool kit, illustrated in fig. 86

- 2) Pull out bolt (112).

- 3) When the bolt has been pulled out, the discharge valve seat (111), discharge valve (110) and discharge valve spring (116) will come loose. Be careful not to lose the springs as they are very small.



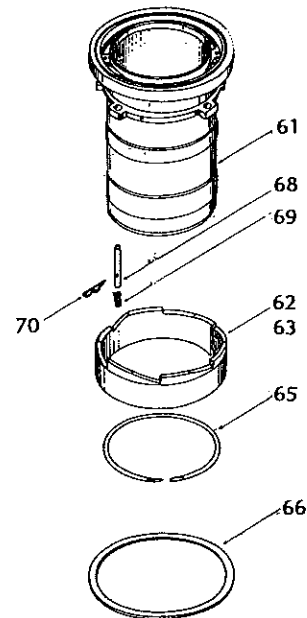
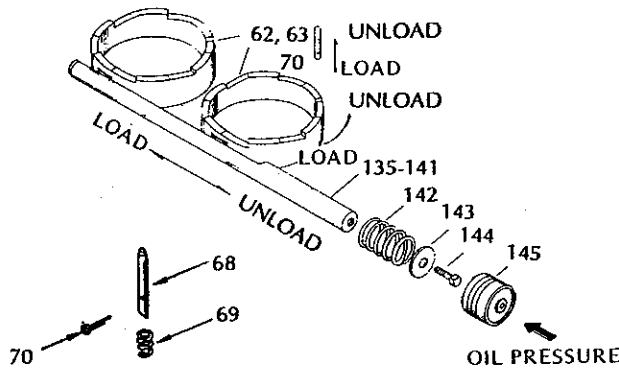
**Fig. 35 Discharge and suction valve assemblies, Model WA**

**1.8. Suction valve (assembly) (refer to Fig. 49).**

- a) Loosen screws (W75) and take off.
- b) The cage guide (W74) and valve plate (W73) can be removed together by pulling out by hand.
- c) The springs (W72) for the suction valve (W71) are generally tightly fixed in the holes of the valve plate (W73) but handle them with care as some may be loose.
- d) The suction valve remains on the seat surface of the cylinder sleeve. Do not separate the valve plate and cage guide. Place them with the spring side upwards to protect the seat surface from scratches.

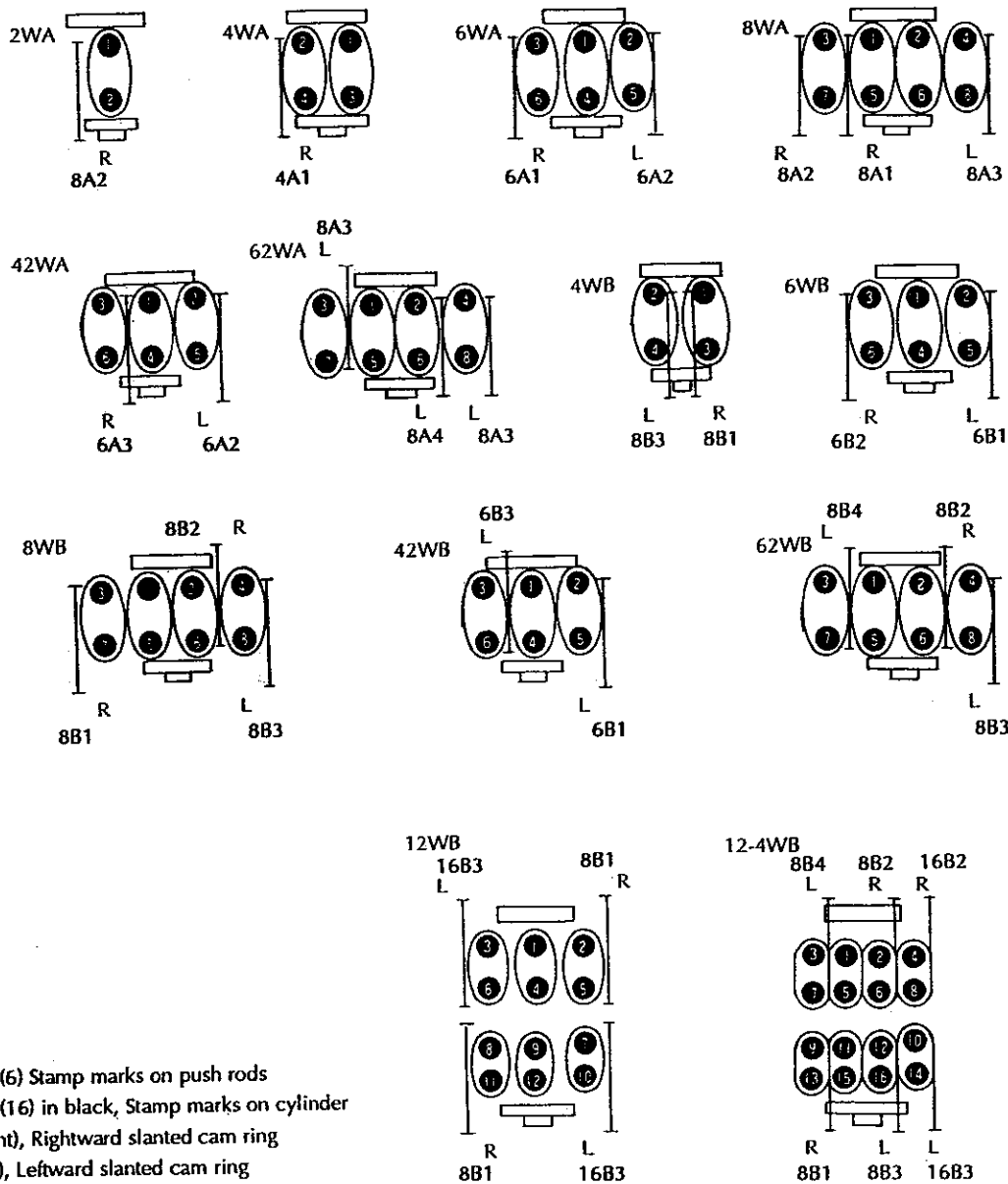
**1.9. Unloader mechanism**

- a) Take off oil piping. It is not necessary to take off the screwed fitting on the unloader piston cover except on Model 12WB.
- b) When electric wiring is connected to the solenoid valve, disconnect this first.
- c) Remove the unloader piston cover together with the solenoid valve.
- d) Pull out the unloader piston (145) using the eyebolt supplied in the hand tool kit, or push in the unloader piston with your thumb and release it quickly so that it is pushed out by the elastic power of the spring (142).
- e) Pull out push rod (135-141) as shown in Figs. 36 & 38. Spring (142) and washer (143) are attached to the push rod with a screw (2); do not separate.
- f) The size of the push rod varies depending on the position. Do not forget to record the original position for these push rods so they can be reinstalled correctly later (Fig. 39-1).



- |                              |                             |
|------------------------------|-----------------------------|
| 145. Unloader piston         | 66. Gasket, cylinder sleeve |
| 144. Screw, push rod         | 65. Retaining ring          |
| 143. Washer, push rod        | 61. Cylinder sleeve         |
| 142. Spring, unloader device | 69. Spring, lift pin        |
| 135-141. Push rod            | 68. Lift pin                |
| 62,63. Cam ring              | 70. Slit pin, lift pin      |

**Fig. 36 Cylinder sleeve and unloader mechanism**



Remarks: (1) to (6) Stamp marks on push rods  
 (1) to (16) in black, Stamp marks on cylinder  
 R (right), Rightward slanted cam ring  
 L (left), Leftward slanted cam ring

**Fig. 37 Unloader and cylinder sleeves**

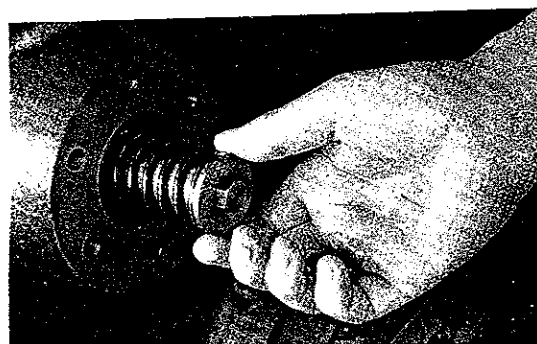
### 1.10. Oil cooler

a) The cylinder section is disassembled after removing the hand hole cover. Take off the oil cooler before removing the hand hole cover (not necessary to take off if marine type). The oil cooler is attached by two screws on the right and left sides. Loosen slightly, slide the oil cooler upwards and remove from the slot (ref. Fig. 40).

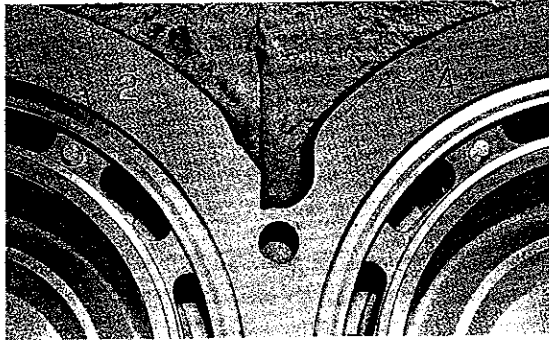
b) Disassembly of the oil cooler is done in the following order.

- 1) Take off oil piping and bolts.
- 2) Pull out flange after loosening bolts and nuts.

3) Pull out coil simultaneously with flange (ref. to Figs. 19 & 20).



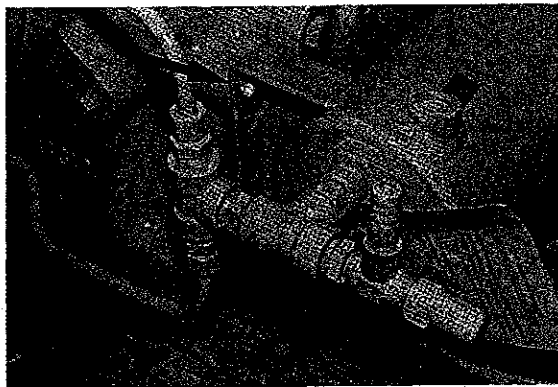
**Fig. 38 Removal of push rod**



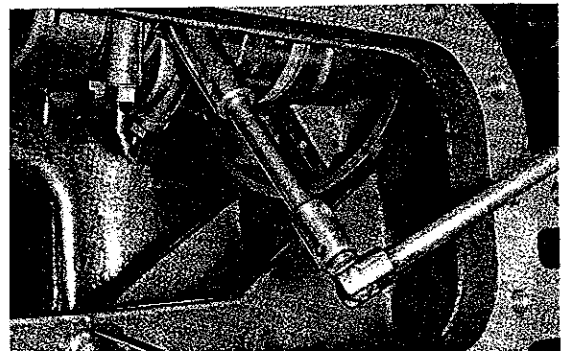
**Fig. 39 Cylinder number mark (case side)**

No.	Compressor model	2WA	4WA	6WA	8WA	42WA	62WA	4WB	6WB	8WB	42WB	62WB	12WB	12-4WB
1	Art. No.		4AU8	6AU8	8AU8			8BU8	6BU8	8BU8	6BU8		8BU8	8BU8
	Mark		4A1	6A1	8A1			8B1	6B1	8B1	6B1		8B1	8B1
	Full length (mm)		275	264	324			397	412.5	397	412.5		397	397
2	Art. No.	8AU9		6AU9	8AU9	6AU9			6BU9	8BU9		8BU9		8BU9
	Mark	8A2		6A2	8A2	6A2			6B2	8B2		8B2		8B2
	Full length (mm)	280		286	280	286			381.5	372		372	428	372
3	Art. No.				8AU10	6AU8	8AU10	8BU10		8BU10	42BU8	8BU10	16BU25	8BU10
	Mark				8A3	6A3	8A3	8B3		8B3	6B3	8B3	16B3	8B3
	Full length (mm)				258	308	258	366		366	356.5	366	428	366
4	Art. No.						8AU9					8BU21		8BU21
	Mark						8A4					8B4		8B4
	Full length (mm)						302					341		341
5	Art. No.													16BU24
	Mark													16B2
	Full length (mm)													434
6	Art. No.													16BU25
	Mark													16B3
	Full length (mm)													428

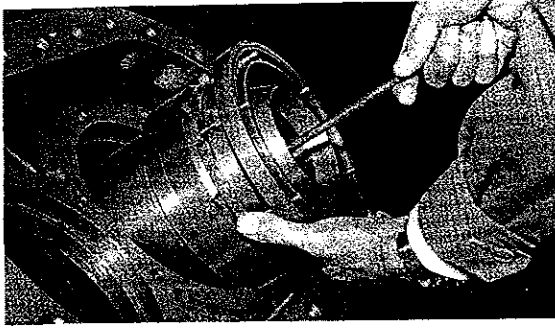
**Fig. 39-1 List of unloader push rods**



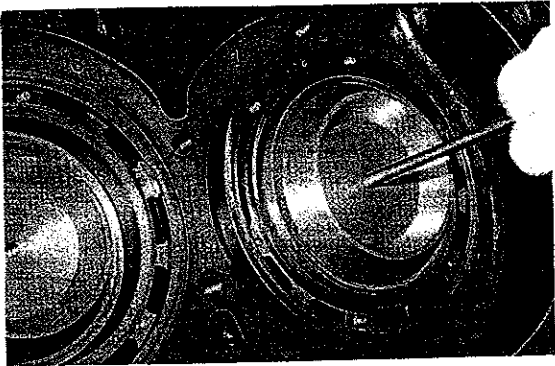
**Fig. 40 Dismantling oil cooler**



**Fig. 41 Removing con-rod cap**



**Fig. 42 Removing piston and cylinder**



**Fig. 43 Piston improperly aligned for removal**



**Fig. 44 Removing piston from cylinder sleeve**

### 1.11. Handhole cover

- a) Remove the oil feed piping. If the compressor is equipped with an oil tank for the automatic oil supply system, take off the pressure equalizing pipe.
- b) Remove all screws except the one at the top center.
- c) Remove the gasket by partially unscrewing the one remaining screw. Hold the cover securely and remove

it carefully. Be careful not to drop the cover. If it is equipped with an oil feed pipe, take care not to damage the float valve installed inside.

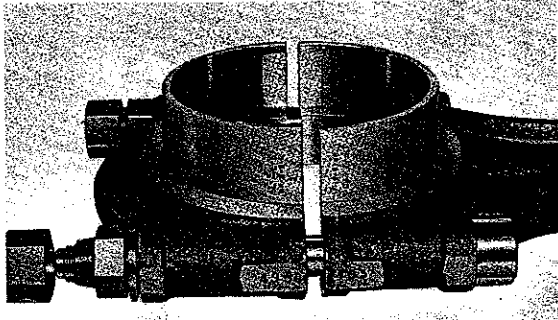
### 1.12. Disassembly of cylinder sleeve and piston

As the size of the connecting rod big end is larger than the inside diameter of the cylinder sleeve, take the cylinder sleeve, together with piston and connecting rod, from the crankcase.

- a) Remove the bolts and nuts of the connecting rod through the hand hole as shown in Fig. 41. Remove the double lock nuts one by one.
- b) When the nuts have been removed, pull off the cap.
- c) Screw the supplied eyebolt into the hole tapped in the piston top (ref. to Figs. 42 & 43).
- d) Turn the crankshaft so that the piston comes to the dead bottom position. The connecting rod must now be pulled off the bolts (index No. 78).
- e) The cylinder sleeve and piston can normally be lifted out together by the eyebolt. If the cylinder sleeve is too tight, loosen it by tapping the bottom end of the sleeve with a wooden block or by hooking a piece of bent iron wire around the guard of the sleeve and pulling.
- f) Should the cylinder sleeve be too tight and only the piston comes out, the compression rings will be withdrawn and released from the cylinder, making disassembly difficult (ref. to Fig. 43).
- g) When lifting, be careful not to allow the end of the connecting rod to hit the web plate of the crankcase.
- h) As the connecting rod is part of a set including the cap and sleeve, all these pieces should be grouped in order.

#### 1.12.1. Cylinder sleeve

- a) Place the cylinder sleeve on the table with its upper surface (suction valve side) downward to prevent damage. To prevent damage to the seat surface it is best to take out the lift pin. This can be done by turning the cam ring and then pulling it out, holding the connecting rod (ref. to Fig. 44).
- b) Usually, it is unnecessary to disassemble the cylinder sleeve. There are two types of cam rings; one of them has slots facing right, the other, slots facing left. A cam ring, must therefore be selected according to the position of the cylinder sleeve in the crankcase (ref. to Fig. 37).



Manufacturing assembly number  
(there is a cylinder number on  
the backside. See Fig. 64)

**Fig. 45 Assembly numbers of connecting rods**



**Fig. 46 Removing rings**

### 1.12.2. Piston and connecting rod

Put the piston with its top facing downwards. Remove the snap ring of the piston pin with a pair of pliers, tap the piston pin with a wooden block and pull out carefully. Do not taken off the bearings from the rod except when a change is necessary.

The connecting rod body and cap have manufacturing assembly numbers (three figures) and one or two figures to indicate the piston assembly number (cylinder number) stamped on the surface. Keep each pair together (ref. to Fig. 45).

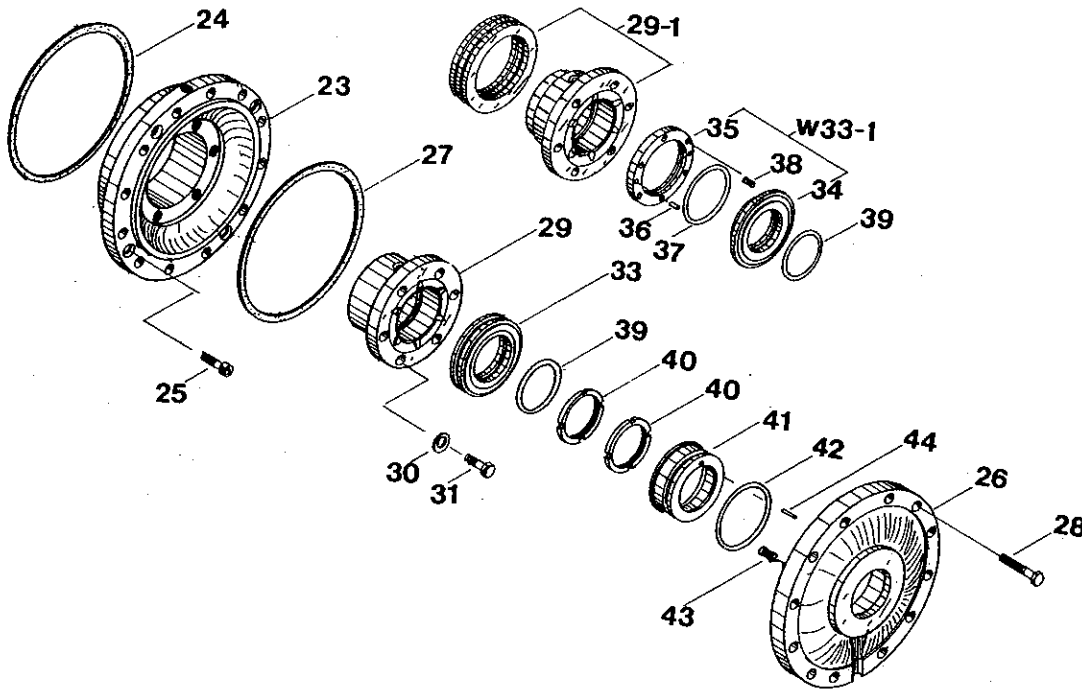
### 1.12.3. Piston ring

Take off the rings as shown in Fig. 46 only if replacement is necessary.

### 1.13. Shaft seal section

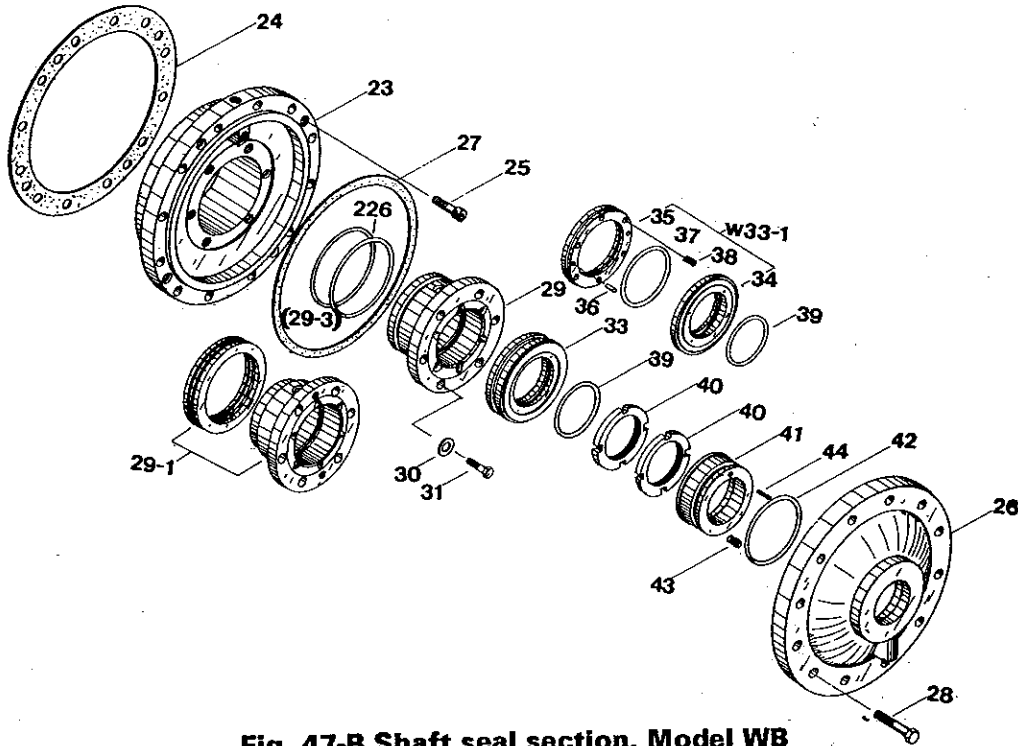
Refer to the following order for disassembly (Figs. 47 to 53).

- a) Remove all but two screws from the cover plate, leaving the two symmetrically positioned screws.
- b) Next, loosen these two screws alternately in the same manner as for the head cover. There is inside this cover an oil reservoir so position a tray under the cover plate during the work.
- c) When the screws are removed, the cover plate disengages from the seat of the bearing head. Draw it out, holding it perpendicular to the crankshaft. Be careful not to drop it on the crankshaft.



**Fig. 47-A Shaft seal section, Model WA,**





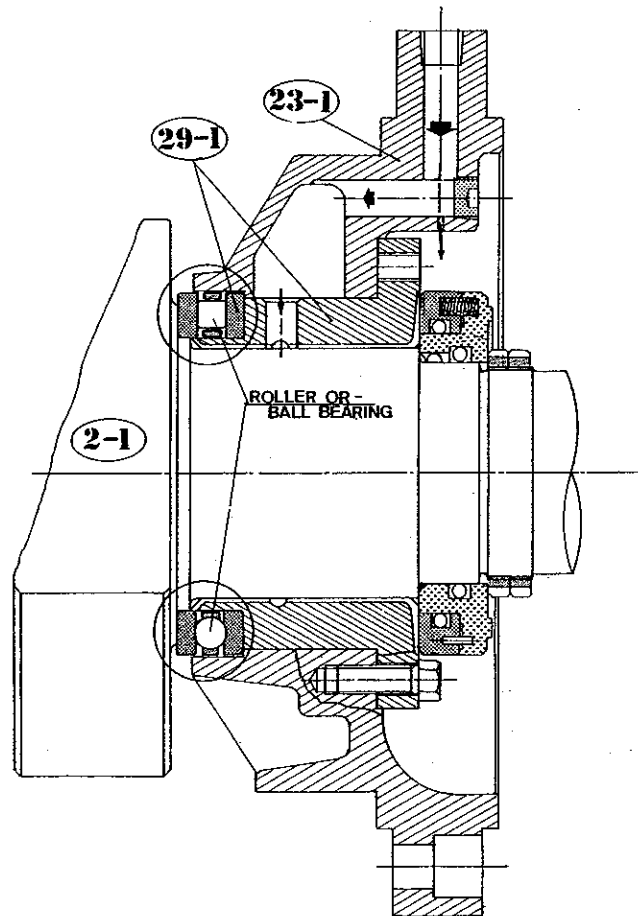
**Fig. 47-B Shaft seal section, Model WB**

No.	Part name	Model WA	Model WB	12WB & 12-4WB
		Q'ty	Q'ty	Q'ty
23	Bearing head	1	1	1
24	Gasket, bearing head	1	1	1
25	Screw, bearing head	4	4	4
26	Cover plate	1	1	10
27	Gasket, cover plate	1	1	1
28	Screw cover plate	8	12	1
29	Thrust bearing	1	1	1
30	Washer, thrust bearing	6	6	2
31	Screw, thrust bearing	6	6	1
33	Shaft seal collar	1	1	1
33-1	Shaft double seal collar	1	1	6
39	O'ring shaft seal collar	1	1	6
40	Locknut	2	2	1
41	Shaft seal ring	1	1	4
42	O'ring, shaft seal ring	1	1	1
43	Helical spring	10	10	1
44	Roll Pin	1	1	1

**Thrust ball bearing type parts**

29-1	Thrust ball bearing	1	1	1
23-1	Bearing head BB	1	1	1
2-1	Crankshaft BB	1	1	1

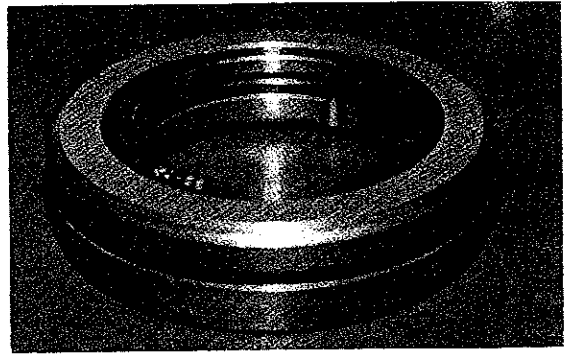
**Shaft seal components (ref. Fig. 47 to 48)**



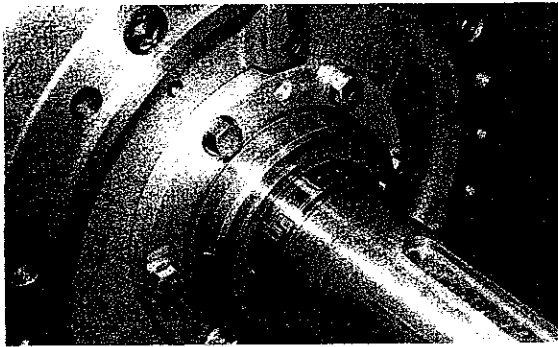
**Fig. 48 Ball bearing type thrust**

### 1.13.1. Shaft seal collar

- a) When the shaft seal mechanism is as shown in Figs. 47A & 47B, remove the locknuts (40), using extreme care not to scratch the bearing surfaces of the shaft seal collar (33) (ref. to Figs. 50).
- b) When the locknuts have been removed, pull out the shaft seal collar (33-1) through the groove on the outer circumference as shown in Fig. 52. Never risk gouging it by putting a screwdriver between the seal collar and the thrust bearing (29) even when it will not part easily. The components of the double seal collar are shown in Fig. 52.

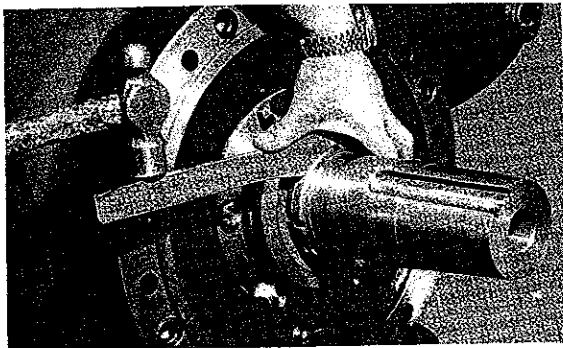


**Fig. 52 Double seal collar**



**Fig. 49 Shaft seal without cover plate**

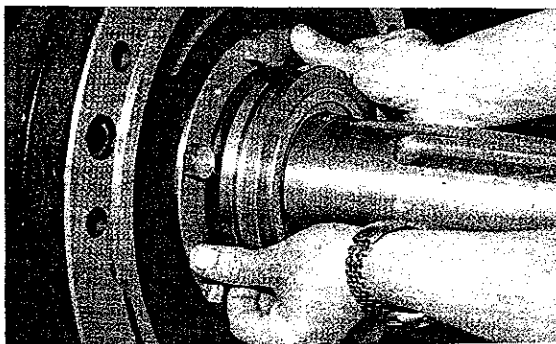
No.		Part name	Type WA	Type WB
			Q'ty	Q'ty
39	a.	"O" ring, shaft seal collar	1	1
34	b.	Retainer ring, double seal collar	1	1
38	c.	Spring, double seal collar	6	8
37	d.	"O" ring, double seat	1	1
36	e.	Pin, double seal collar stopper	1	1
35	f.	Floating seat, double seal collar	1	1



**Fig. 50 Unscrewing locknut**



**Fig. 53 Removing seal ring**



**Fig. 51 Removing seal collar**

### 1.13.2. Thrust bearing

When the screws have been removed, draw out the thrust bearing with the pulling screws by lifting up the crankshaft slightly.

### 1.13.3. Bearing head

Remove the screws (25) and then draw the bearing head out with the pulling screws in the hand tool kit. Just before it comes away through the opening of the crankcase, it should be held by two people, as it is very heavy (about 20 kgs). It should be pulled out carefully keeping it perpendicular to the crankshaft.

## 1.14. Oil pump

- a) Before removing, take note of the arrow mark (ref. to Fig. 10) indicating the direction of rotation.
- b) To remove the oil pump, press out the pump by inserting eye-bolts in the two blind bolt holes and pressing out evenly.
- c) Leave the oil pump as an assembly unless it is absolutely necessary to disassemble. An "O" ring remains on the main bearing and must also be removed.

### 1.14.1. Drag crank

When the oil pump is pulled out, the crankshaft end is seen where the drag crank is attached. It can easily be taken off from the crankshaft by hand.

## 1.15. Crankshaft

### 1.15.1. Models WA & WB

Wrap the bearing surfaces in cloth to protect them from damage. The crankshaft is held at one end by the main bearing, therefore it is best to keep the other end in position with a wooden block inserted from the hand-hole side.

If the crankshaft is twisted before it is pulled out completely, it will scar the bearing surface of the main bearing. Pull it out straight, slowly and carefully.

### 1.15.2. Models 12WB & 12-4WB

To remove the crankshaft of Models 12WB & 12-4WB, disassemble the main bearing head first. The shaft is then

held only by the intermediate bearing, as shown Figure 55.

- a) Before disassembling the main bearing, drain the oil inside the cuno-filter case by pulling out the drain plug. About 3 litres can be collected.
- b) Remove the oil pump assembly (56) by loosening screws (60). Do not loosen screws DG1-7-1. These screws are loosened only when reversing the direction of revolution. For this purpose, loosen screws (DG1-7-1) and turn the oil pump assembly 180°.
- c) Remove the drag crank (3).
- d) Using a box wrench, loose the locknut (133) of the taper pin (131) which holds the intermediate bearing to the main body (refer to Figure 56).
- e) When the locknut has been slackened off about 5 mm, tap the taper pin (131) and pull out.
- f) Although not included in our standard tool kit, a special shaft disassembly tool is available by order and will make this job much easier (refer Fig. 55).
- g) Push out the shaft with a wood block from the handhole cover side until the shaft comes out at the position shown in Fig. 55. Now hang the shaft at the intermediate bearing and pull out completely.
- h) Release the intermediate bearing by propping up the main bearing and thrust bearing sections with wooden blocks. Draw out the taper pin (134), and the mediate bearing will separate into two pieces.

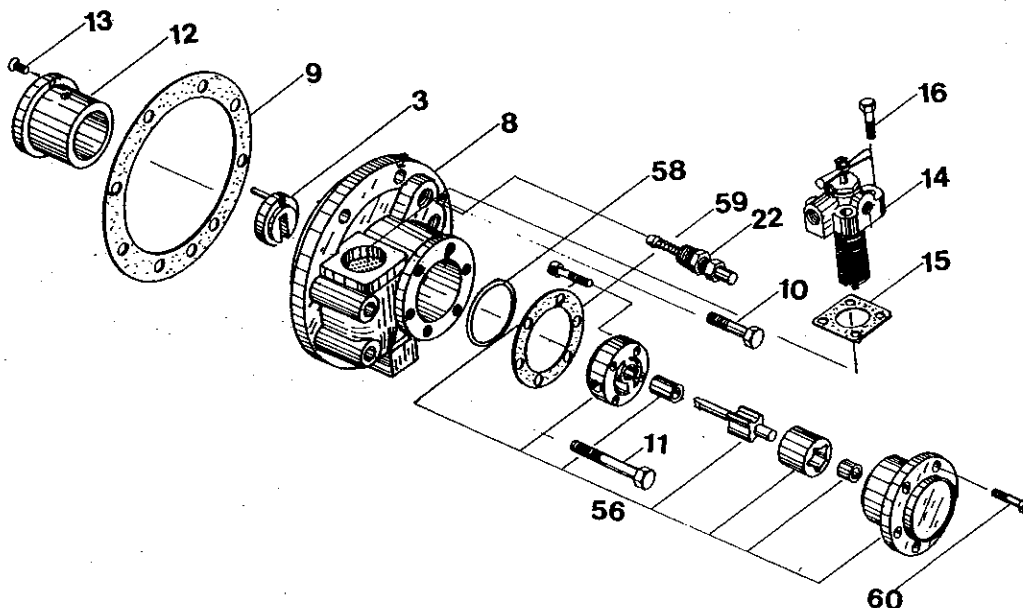
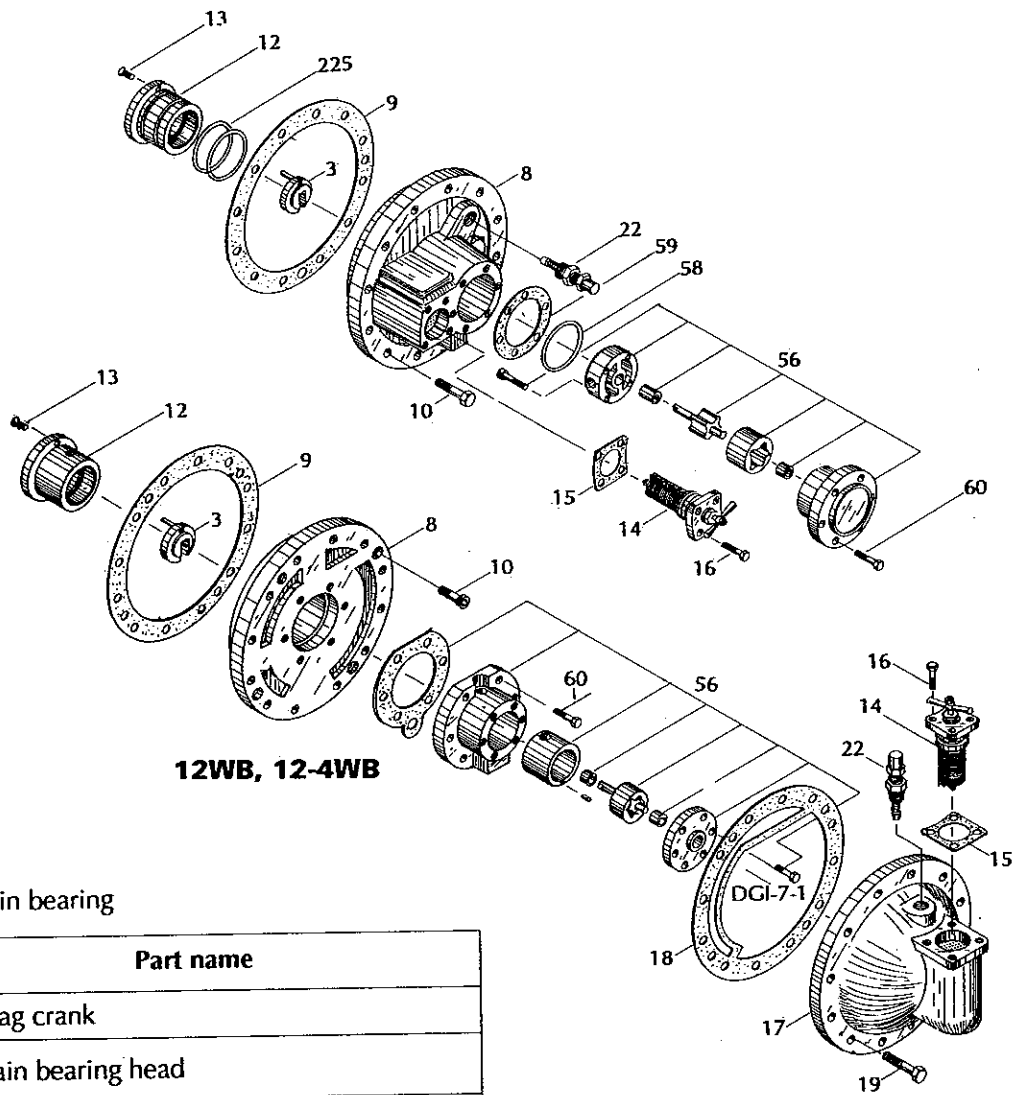


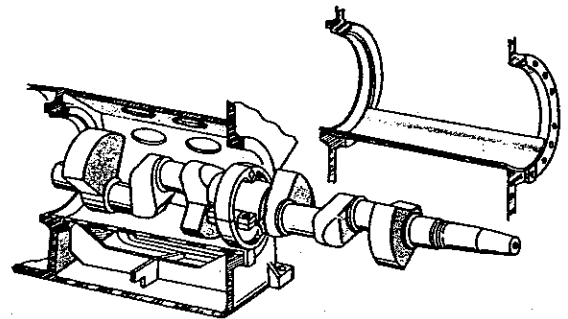
Fig. 54 Main bearing section, Model WA & WJ

**Fig. 54 Main bearing section, Model WB**

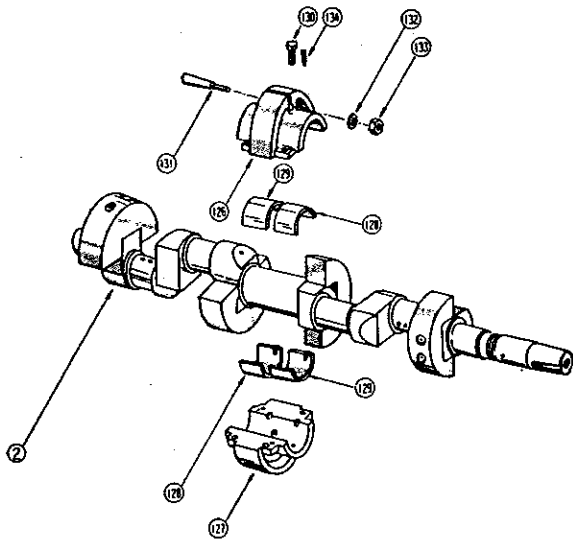


Parts list of main bearing

Index No.	Part name
3	Drag crank
8	Main bearing head
9	Gasket, main bearing head
10	Screw, main bearing head
12	Main bearing
13	Screw, main bearing
14	Cuno-filter assembly
15	Gasket, cuno-filter cover
16	Screw, cuno-filter cover
17	Case, cuno-filter
18	Gasket, cuno-filter case
19	Screw, cuno-filter case
22	Oil pressure regulating valve/oil relief valve
56	Oil pump assembly
60	Screw, oil pump



**Fig. 55 How to pull out crankshaft, Models 12WB & 12-4WB**



**Fig. 56 Intermediate bearing for Models 12WB & 12-4WB**

Parts list of crankshaft section:

Index No.	Part name	Q'ty
2	Crankshaft	1
	Oil drain plug	1
126	Intermediate bearing (upper)	1
127	- do - (lower)	1
128	- do - metal A	2
129	- do - metal B	2
130	- do - screw	4
131	Taper pin	1
132	Washer, taper pin	1
133	Locknut, taper pin	1
134	Taper pin (threaded)	2

### 1.16. Main bearing head

- Remove the pipes for oil pressure service and then remove the main bearing head with care in the same way as the bearing head. The cuno-filter cannot be turned if the filter disks are bent.
- Loosen the screws (10). During disassembly of Model WA, the screws cannot be taken out without disassembling the cuno-filter first. On Model WB this is possible.

- Take off the gasket attached to the main bearing head casing. Care must be taken not to damage the gasket.

### 1.17. Strainer

The following are utilized.

Model	2WA	4WA	6WA	8WA	42WA	62WA	4WB	6WB	8WB	42WB	62WB	12WB	12-4WB
Scale trap	—	—	1	1	—	1	—	1	1	2	2	—	—
Suction strainer	1	1	2	2	1	—	1	2	2	—	—	2	2

#### a) Scale trap

Remove the end cover of the scale trap. The screen is then easily removed as it is simply held down by the cover. Sometimes a small quantity of oil remains in the trap, therefore, when removing the cover, put a tray underneath.

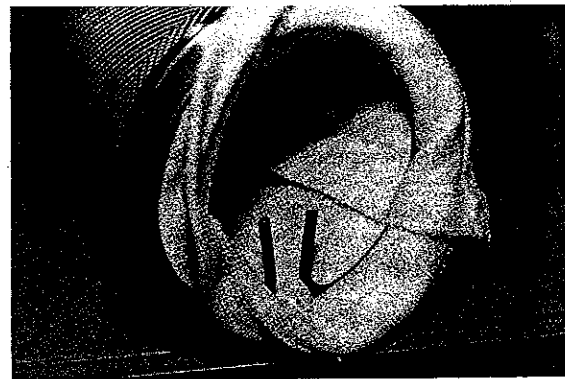
#### b) Suction strainer

The suction strainer is held down by a spring. Take off the screws for the cover, remove the spring, and then the suction strainer. The cloth-bag the strainer is locked with a snap ring, as shown in Fig. 57, and is easily removed.

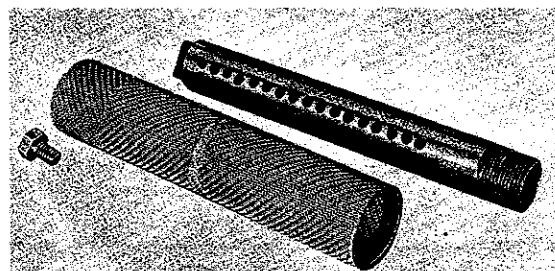
The suction strainers of Models 12WB & 12-4WB have no spring.

#### c) Oil strainer

The oil strainer can be removed easily by opening the oil strainer cover and/or handhole cover.



**Fig. 57 Removing suction strainer**



**Fig. 58 Oil strainer**

## 2. Reassembly

### 2.1. Checking parts

When replacing parts (in accordance with established standards given in chapter 3, Supplement) after inspection or repair is finished, parts are assembled in the reverse order of disassembly.

- a) Clean the parts and the crankcase thoroughly using light oil, etc. and coat surfaces with lubricating oil.
- b) Before assembling, apply a sufficient quantity of oil, particularly to moving parts.
- c) When cleaning, do not use woolen fabrics, as fibres will remain.
- d) After inspection, gaskets should be coated with lubricating oil or a graphite/oil mixture.
- e) Tighten the screws diagonally.
- f) Take care in assembling Models 12WB & 12-4WB. The assembly order for the shaft section is different from other models.

### 2.2 Assembly of main bearing and main bearing head

- a) When assembling, note carefully the position of the gasket hole; oil will not be sucked up if there is any deviation in the position of the oil suction port. Special care must be taken for Models 12WB & 12-4WB.
- b) Position the main bearing on the main bearing head before the crankcase is fixed, checking the position of the pin for the main bearing and also confirming the position of the oil hole.
- c) Install the cuno-filter after the main bearing head has been installed.
- d) In the case of Models 12WB & 12-4WB, the shaft must be assembled before attaching the main bearing and head.

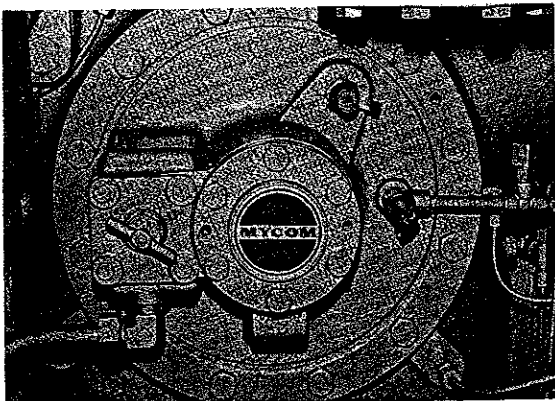


Fig. 59 Main bearing head, Model WB

### 2.3. Installation of crankshaft, Models WA & WB

Set the crankshaft into the crankcase taking care to protect the bearing surfaces from damage.

When a block is used to insert the crankshaft, be careful not to leave any residue inside the crankcase. Inspect after assembly is finished.

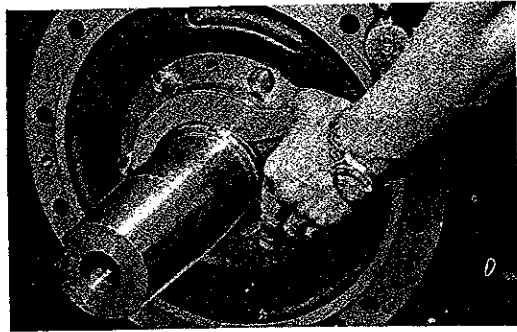
Put the crankshaft completely into the main bearing in one move.

### 2.4. Installation of crankshaft, Models 12WB & 12-4WB

- a) Fix the intermediate bearing to the crankshaft first. Each half of the bearing holds two babbit halves. Confirm that the locking notches match and that the oil groove and oil hole are correctly orientated. If set in reverse, oil will escape and serious damage will result.  
Set the notched edge of the bearing babbit in first and then push in the opposite side. When renewing the metal especially, take care that the bearing metal is not damaged against the housing. If necessary file smooth.
- b) When installing the metal, the ends protrude slightly but this is unimportant as the metals shape themselves to the housing when installation is completed.
- c) Confirm that the marks at both ends of the metal match. Measure the inner diameter with a cylinder gauge before setting onto the shaft. The out-of-roundness must be within 0.02 mm.
- d) Before tightening, apply compressor oil to the bearing surfaces. Fasten the bolts alternately and drive in the lock pin until tight.
- e) After completing the fastening, turn the intermediate bearing by hand. It should turn smoothly and freely. The taper pin must be positioned on the top before installing the shaft in the housing. This positioning cannot be accomplished after installation.
- f) Check for scars or marks on the outer surround and correct if found.
- g) Slide into the crankcase. The taper pin must be positioned on the top.
- h) Temporarily fasten the taper pin and locknut.
- i) After installing the main bearing, bearing head and shaft seal assembly, adjust the intermediate bearing placed with even gaps at each end, then fasten the locknut of the taper pin securely.

## 2.5. Bearing head and thrust bearing

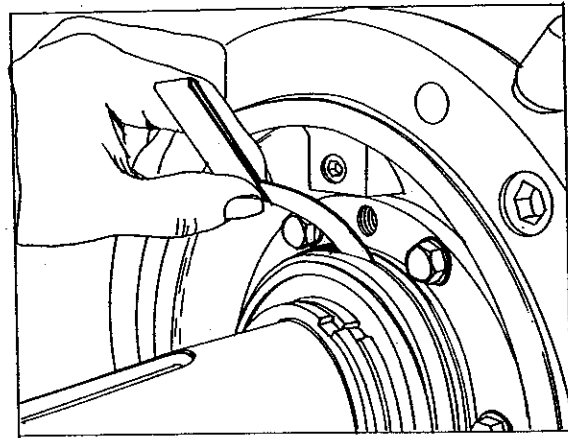
- a) Model WA, WB, 12WB and 12-4WB compressors have pipes for sealing oil return. Take care not to bend these pipes. The direction of oil escape must be towards the oil in the crankcase.
- b) Check that the pipe is correctly positioned in relation to the bearing head and match the two ports carefully.  
If the thrust bearing is an aluminum backed metal, do not forget to use a washer when fastening.
- c) After manting the thrust bearing, turn the crankshaft by hand to check for abnormality.
- d) The four screws must be fastened tightly. If this cannot be accomplished, disassemble the cover plate and set them up again.



**Fig. 60 Setting locknuts**

## 2.6. Shaft seal

- a) Turn the notch of the seal collar upward, fit the locking ball of the crankshaft in the notch, and insert the seal collar by hand, taking care not to damage the "O" ring.  
If it does not enter easily, push it forward by tightening the locknut carefully; check whether the locking ball is seated in the notch.
- b) Tighten the locknuts alternately, tapping the spanner handle with a hammer. (Fig. 60)  
Take care not to damage the contact surface of the seal collar.
- c) After pulling out the crankshaft by rotating it by hand, measure the clearance between the seal collar and the flowing collar with a thickness gauge at the top and bottom and also right and left positions (ref. Fig. 61).
- d) Fit the seal ring on the cover plate. Push the roll pin in the hole and examine its operation by applying equal force on the seal ring by hand.
- e) Apply a sufficient quantity of oil to the contact surfaces of the seal collar and seal ring.
- f) Inspect the gasket. If it is a new gasket, apply oil and fit to the cover plate.
- g) Fit the cover plate over the crankshaft. Tighten the bolts uniformly and ensure that the oil drain pipe points downward.



**Fig. 61 Measuring thrust gap**

**WA & WB = 0.08 ~ 0.20**

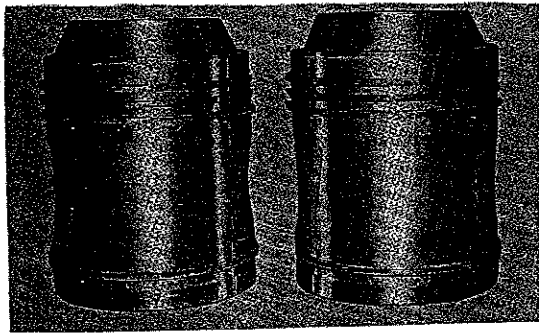
## 2.7. Oil pump

- a) Insert the drag crank so that the pin hole on the crankshaft comes to the top. The groove should be in the center.
- b) Attach the "O" ring to the oil pump.
- c) Insert the oil pump with its notch in the same direction as the groove of the drag crank. Do not tighten forcibly if the shaft of the oil pump does not enter into the groove.
- d) Tighten the screws uniformly after checking the direction of rotation.

## 2.8. Cylinder section

### 2.8.1. Piston

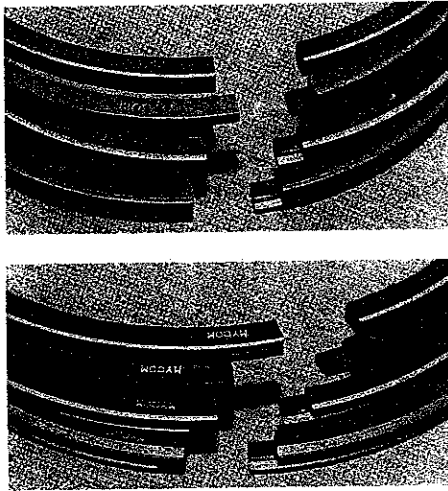
- a) Mount the compression and oil rings on the pistons. Do not align the ring gaps (Ref. Fig. 62).
- b) In mounting compression rings, the stamped surfaces should be facing upwards (ref. Fig. 63).



Incorrect

Correct

**Fig. 62 Arrangement of rings**



**Fig. 63 Ring marks A & B**

c) The standard arrangement of the rings is shown below. This can, however, differ depending on conditions.

Combination of Piston Rings (Same usage for WA and WB type):

Ring	SINGLE STAGE		COMPOUND	
	NH3	R23, R502	NH3	R22, R502
1st	FC-PC-BF		FC-PC-BF	
2nd	FC-VC		(GA-P)	FC-UC
3rd	FC-PC-BCP3			
4th	FC-PC-BC3			

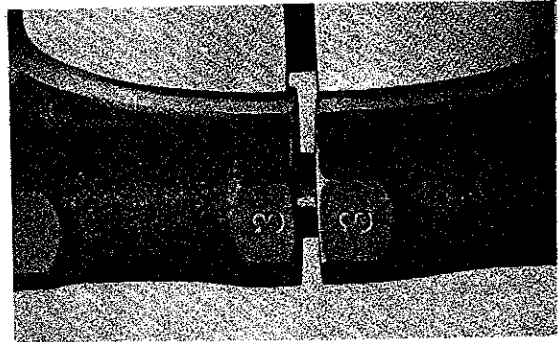
**Fig. 79 List of piston ring components For Model WA & WB compressors**

- d) Special care must be taken when handling piston rings as they warp easily. Warping may cause oil loss.
- e) It must be confirmed that the rings move freely in the grooves of the piston. If not, the ring is probably warped. The blow between the ring and groove width is about 0.05 to 0.09 mm as standard.

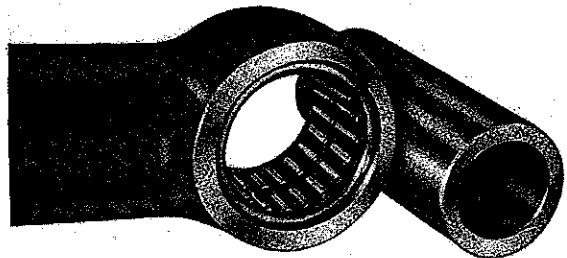
## 2.8.2. Connecting rod

Connect the piston and the connecting rod with the piston pin. It is ideal if the piston pin is tight in the pin hole of the piston but slightly loose in the bushing hole of the connecting rod. The tolerance between the bushing and the piston pin is 0.03 to 0.06 mm. For this reason, it is sometimes driven into the pin hole utilizing a block pad.

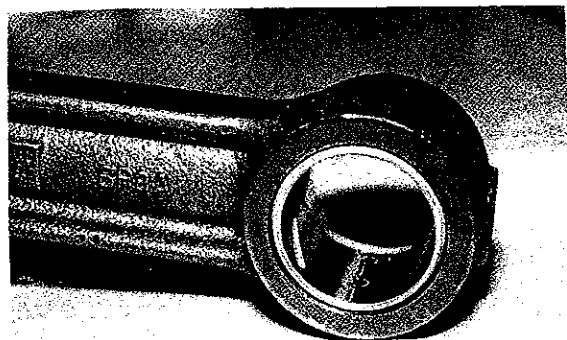
When replacing the bearings, do not mix the upper and lower halves. Fit the halves into the rod and cap. Do not forget to put the half having the oil hole in the center in the rod side, not in the cap. When the connecting rods are being assembled on the crankshaft, the numbers punched on the rod and cap must be matched (ref. Fig. 64).



**Fig. 64 Assembly numbers for connecting rod**

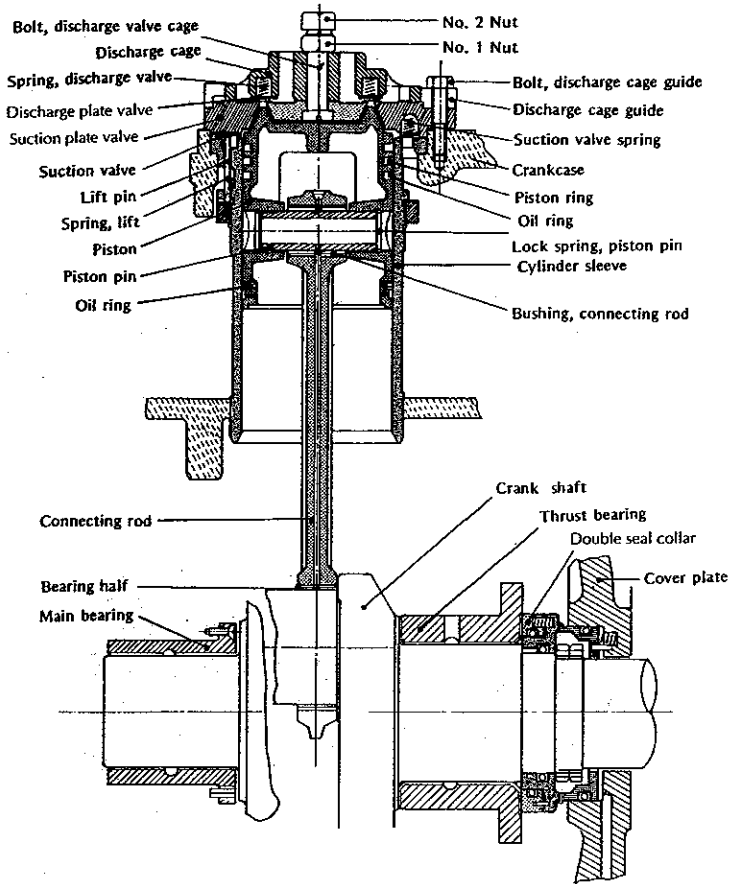


**Fig. 65 Bushing and piston pin of connecting rod, high stage**



**Fig. 66 Bushing, standard**





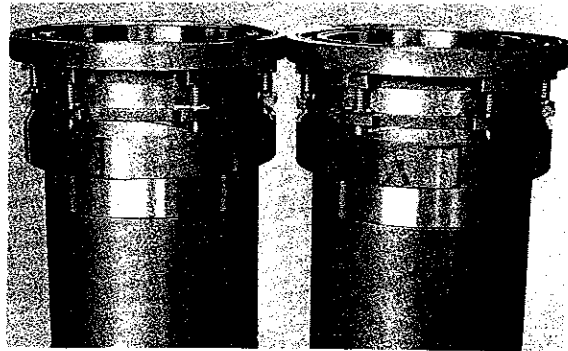
**Fig. 67 Piston, connecting rod and crankshaft (sectional)**

### 2.8.3. Cylinder sleeve

a) Check the direction of the notch on the cam ring referring to the cylinder numbers marked on the crankcase and the direction of the push rods.

b) The lower end of the cylinder sleeve is chamfered so that the piston and rings can be inserted easily. If the top ring enters, the piston can be pushed in easily. Push it in taking care not to damage the other rings.

Care should be taken not to damage the seat surface of the sleeve or the corners of the piston. Such damage will scar the inside of the cylinder sleeve during operation.



**Fig. 68 Example of incorrect assembly**  
The slanted notches are facing in opposite directions.



**Fig. 69 Inserting piston into sleeve**

### 2.9. Installation in casing

- Screw the eyebolt into the piston head.
- Attach the cylinder sleeve gasket to the back of the sleeve guard with oil.
- Inspect the assembled connecting rod and cap.
- Check the cylinder number.
- Turn the crankshaft to bring the appropriate crank pin to dead bottom.
- Bring the piston to the dead top point of the cylinder sleeve.
- Do not insert the crank fastening bolt pin, as it may damage the shaft. The numbering marks of the connecting rod and cylinder sleeve must be turned to face the handhole side.
- Assemble in the reverse order of disassembly. When the

guard of the cylinder sleeve enters the seat of the crankcase, push down the piston and install the connecting rod on the crankshaft, supporting its large end by hand. Take care not to damage the crankshaft with the bolts.

- i) Mount the cap. Be sure to match the paired numbers stamped on the surfaces.
- j) Tighten the bolts with a torque wrench to the torque values indicated below. The proper torque must be applied, otherwise the cap of the rod will become out-of-round.

#### Bearing Half Tightening Torque

ft-lb (kg-cm)

Nut	Model WA	Model WB
1st	45 (600)	90 (1200)
2nd	35 (450)	60 (800)

- k) Install the cylinders one by one, rotating the crankshaft slowly. The cylinder sleeves will jump up if the crankshaft is rotated abruptly as it is not yet tightened down.
- l) Check the lateral play of the connecting rods.

### 2.10. Unloader mechanism

- a) Check the mounting position of the push rod. It enters smoothly when pushed in slowly if the cam ring notch is accurately located.
- b) When the push rod has been inserted, correctly locate the position of the cylinder sleeve, setting it to the countermark (refer to Fig. 70).
- c) Insert the unloader piston. Examine the movement of the lift pin by pushing the unloader piston with your thumb.
- d) If the lift pin does not protrude above the seat surface of the cylinder sleeve when the countermarks meet and the unloader piston is pushed, nor goes back when it is released, check whether the length of the push rod is correct or whether the correct cam ring is installed.
- e) When all inspections are finished, mount the unloader piston cover.

In the case of newly replaced sleeves, take special care when stamping marks. If the setting is incorrect, unloading will become irregular and damage to the valve may result.

To stamp the marks on a new sleeve, push in the unloader piston using a hanger eye-bolt to bring the lift pins of the

new sleeve to a position level with the seat. So positioned, the lift pin moves in and out at the middle part of the piston strike. Now set the other lift pins. Position the same as above by turning the sleeve and then stamping the marks.

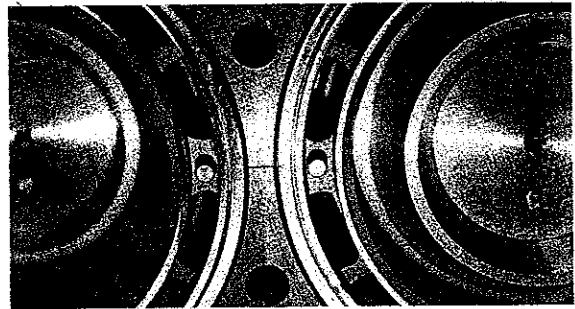


Fig. 70 Assembly marks for sleeve setting

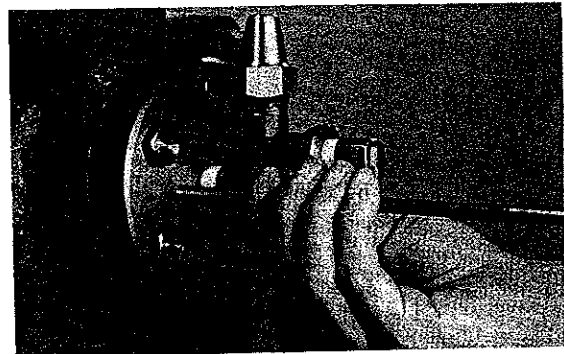


Fig. 71 Pushing unloader piston with eye-bolt

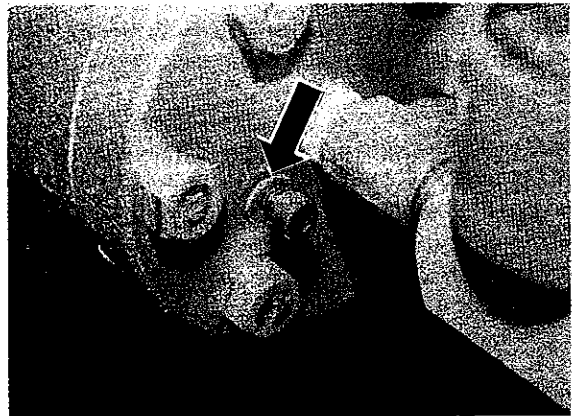
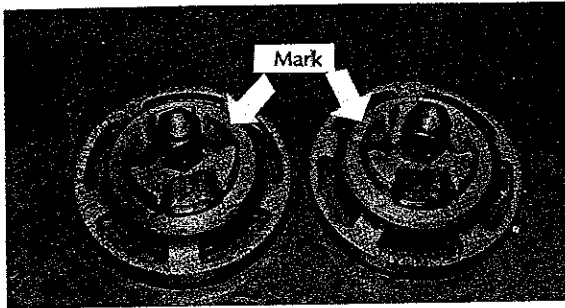
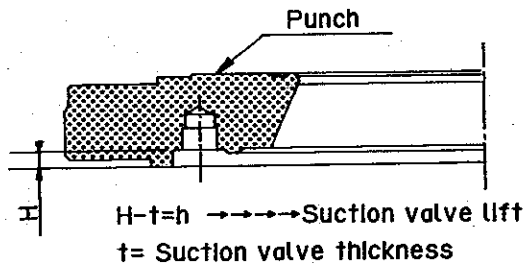


Fig. 72 Unloader cover cap screw & washer

## 2.11. Valve plate



**Fig. 73 Marks for discharge valve assembly mark**



**Fig. 74 Marks, valve plate**

- Mount the suction valve springs. The springs are slightly tapered. Push them in with the large end down, twisting against the coils.
- For the cylinder with the unloader mechanism, remove the cap bolt on the unloader cover, screw in an eyebolt, and put the bank in the loaded position. Lower the lift pins by pushing the unloader piston with the eyebolt screwed in as shown in Fig. 71. Neglecting this step will result in damage to the suction valve or problems such as gas leakage after assembly.
- Join the suction valve assembly and the valve plate. Check that the valve is set properly.
- To identify the valve plate, two classifications according to the model of the compressor are used:

Classification 1: 2WA, 4WA, 6WA, 8WA, 42WA, 62WA,

Classification 2: 4WB, 6WB, 8WB, 12WB, 42WB, 62WB, 12-4WB

### 1) Classification 1

The valve plate in effect caps the cylinder sleeve which extends above the surface of the crankcase 0.004 in (0.1 mm). If the sleeve does not extend this far above the surface, add another cylinder gasket to meet requirements.

### 2) Classification 2

The valve plate in effect is seated inside the cylinder. In this case the sleeve top is 0.0354 in (0.9 mm) below the top of the cylinder wall.

- Put on the guide and tighten the bolts. Ensure that the bolts are tightened evenly.
- When the valve plate has been attached, pull out the eyebolt from the unloader cover. Do not forget to screw in the cap screw (allen head) immediately after removal of the eyebolt (ref. Fig. 72).

## 2.12. Fittings

- Fit the screen for the scale trap, the suction strainer and the oil strainer.
- Before attaching the hand hole cover, feed a sufficient quantity compressor oil into the crankcase.
- Attach the Hand hole cover, the oil cooler and then connect the oil piping. Clean the oil pipes by blowing air compressed.

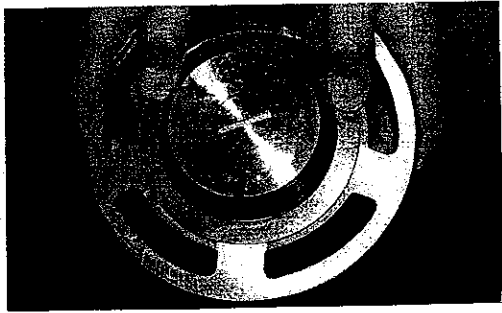
## 2.13. Discharge valve (assembly)

- Remove any carbonized oil or slag with a wire brush, taking care not to damage the seat surface.
- Put the discharge valve on the springs and tighten the bolt, pressing down the valve seat by hand.
- Tighten No. 1 and No. 2 (grooved) nuts. Torque to the values given below.

ft-lb (kg-cm)

Nut	Model WA	Model WB
No. 1	80 (1100)	90 (1200)
No. 2	60 (800)	60 (800)

- When assembly of these parts is finished, check operation as shown in Fig. 75.



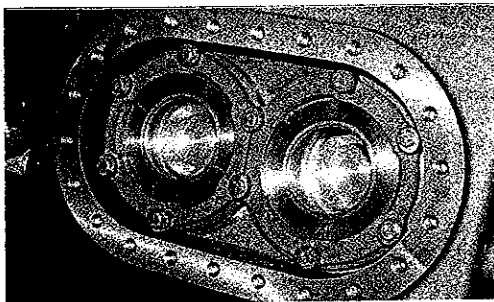
**Fig. 75 Testing discharge valve**

**2.14. Mounting parts**

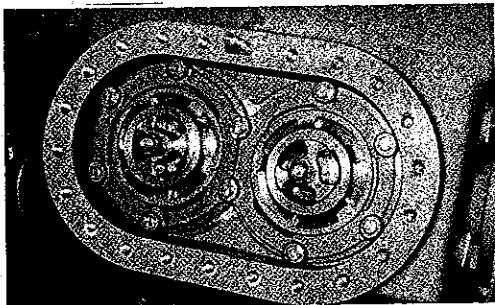
When break-in running operation is finished, mount the discharge valves, the safety head springs and the head covers. Mounting the head cover is easily done by screwing a headless bolt into the top center to support the cover.

Torque values of the head cover bolts are as follows:

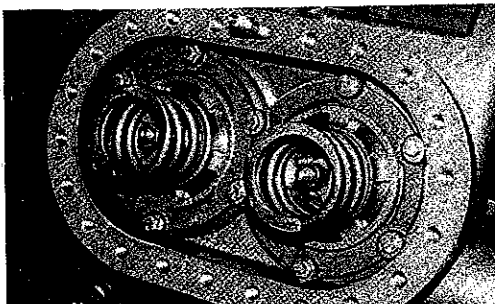
Model WA	60 (800) ft-lb (Kg-cm)
Model WB	90 (1200) ft-lb (Kg-cm)



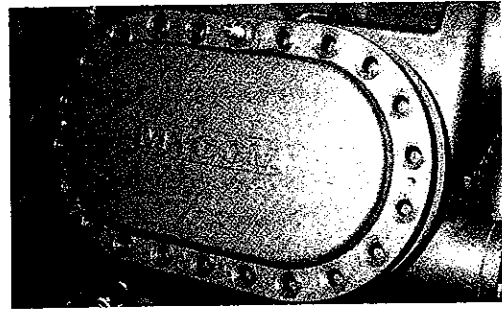
**Fig. 76 Checking cylinder surface after break-in running**



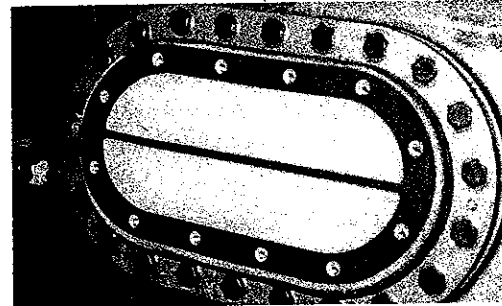
**Fig. 77 Mounting discharge valve assembly**



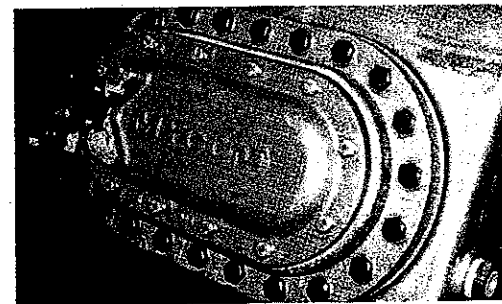
**Fig. 78 Mounting head spring**



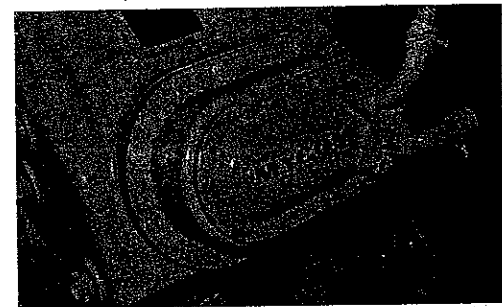
**Fig. 79 Mounting air-cooled head cover WB**



**Fig. 80 Mounting water-cooled head cover with gasket, WB**



**Fig. 81 Mounting water jacket cover, Model WB**



**Fig. 82 Mounting water jacket cover, Model WA**

**2.15. Water Jacket piping**

Install after cleaning the inside of the water jacket thoroughly.

**2.16. Final inspection**

Carry out final inspection before starting refrigerating operation. Check whether the eyebolt has been removed from the unloader piston cover, whether the self-flaring nuts for the oil pipes are securely tightened, etc.

## CHAPTER 3. INSPECTION & REPLACEMENT

### 1 Standards for changing of parts

To operate Mycom compressors in their best condition, inspect according to the following standards and make repairs whenever necessary.

\* Standard clearance given page 50

#### 1.1. Compressor oil in the crankcase

Check the oil in the crankcase through the sight glass at the hand hole cover. If scale, metal powder, etc. are found, determine the source correct. The cause may be scale from suction side piping, abrasion of cylinders or piston rings, etc.

If yellow metal powder is found in the oil, it is from abrasion of the piston rings.

#### 1.2. Suction strainer, oil strainer and cuno-filter

Clean with trichlorethylene, carbon tetroxide or light oil. Inspect to make sure solder is not worn or the screen is not broken. A broken screen allows foreign matter so enter and cause compressor scuffing. The stainless steel screen must be flux welded.

Inspect to see if cuno-filter discs and blades move smoothly. Sometimes, the blades are bent. If residue is deposited inside, remove with a safety razor and clean the inside by passing light oil or blowing compressed air from inside (in the direction of the oil pipe fittings). If this is done from outside, foreign matter will remain inside and enter the oil pipe during operation, causing abrasion and scuffing on the moving parts of the compressor.

#### 1.3. Crankshaft

Abrasion of the bearing must be checked and the bearing measured with a micrometer. In practice, it is sufficient to measure the gap between the metals. Abrasion can easily be found by feeling the bearing surface. If scars are found, they must be polished with fine emery paper or a oilstone.

The oil hole passing through the shaft must be well cleaned. Clean and pass oil through the hole several times. Do not forget to install the plug securely afterward.

Replace the crankshaft only if abrasion exceeds the values listed below:

\* Padding is absolutely not permitted.

(mm)

	Model WA	Model WB
Connecting rod bearing	69.85	89.82
Thrust bearing	82.40	111.85
Main bearing	66.90	91.85

#### 1.4. Shaft seal parts

If the moving surface of the seal collar or the seal ring does not make good contact, correct the surface by lapping or grinding with a fine compound. After correcting clean off the compound thoroughly. The moving surface of the seal collar should not be stepped. Replace any "O" rings which have hardened, expanded or cracked.

#### 1.5. Piston, piston pin and piston ring

The piston is rarely subject to abrasion. When its outer diameter becomes smaller than the value shown below, replace the piston with a new one.

Detail of piston ring see 1-15.

(mm)

Piston	Model WA	Model WB
Outer diameter	94.8	129.78

If vertical scratches are found on the surface, remove with emery paper or a whetstone. If the width of the ring groove has become markedly wide - larger than 0.10 mm - replace, as this will cause excessive oil consumption. The piston pin should fit tightly in the pin hole of the piston. If the clearance between the pin and the hole becomes larger than 0.20 mm (Model WA) or 0.25mm (Model WB), replace the pin. Clearance for a new pin is 0.10 mm.

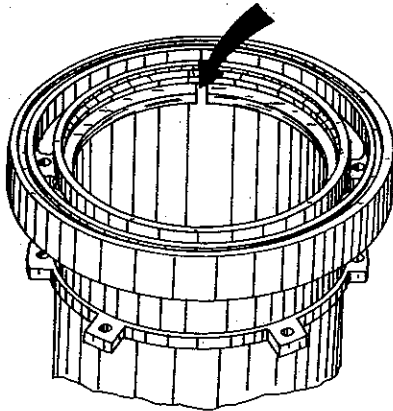
Replace the piston pin when the outer diameter becomes smaller than the values below:

(mm)

Piston pin	Model WA	Model WB
Outer diameter	25.05	39.90

The life of compression rings varies according to the operating conditions under which they are used. Judge whether they must be replaced during inspection. If the contact between the compression ring and the cylinder wall is not good or abrasion is unusual, replace the defective compression ring with a new one.

If abrasion is uniform and the amount of abrasion is not clear, either replace with a new one or determine the clearance by putting the ring in a comparatively new cylinder sleeve; if it is larger than the value shown below, replace the ring with a new one.



**Fig. 83 Piston ring**

(mm)

Ring	Model WA	Model WB
Top ring gap clearance	2.0	2.5
S.T.D. clearance	0.3-0.5	0.55-0.75

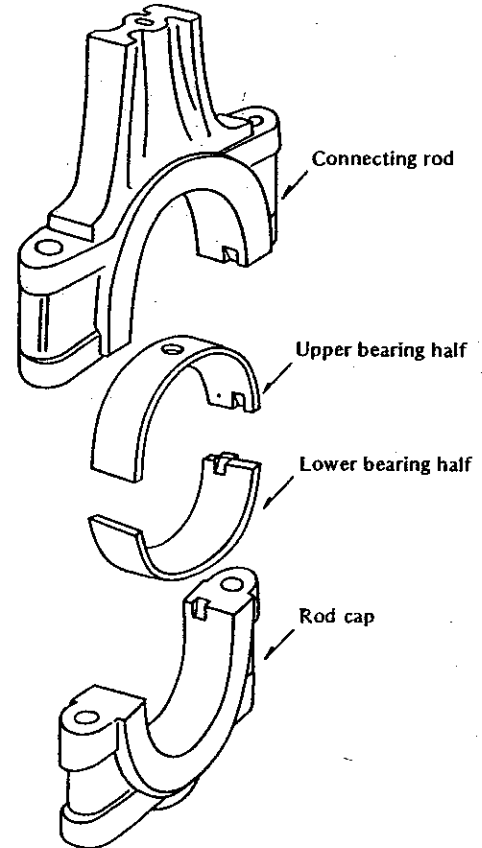
### 1.6. Connecting rod

Replace the connecting rod if the clearance between the bushing and piston pin (new) exceeds 0.20 mm. To replace the bushing only, a jig is required. If replacement is unavoidable, give a honing finish after pressure-insertion. When inserting, make sure that the piston pin hole is perpendicular to the rod. The bearing halves should be replaced if the clearance between the bearings and crankpin exceeds the value shown below.

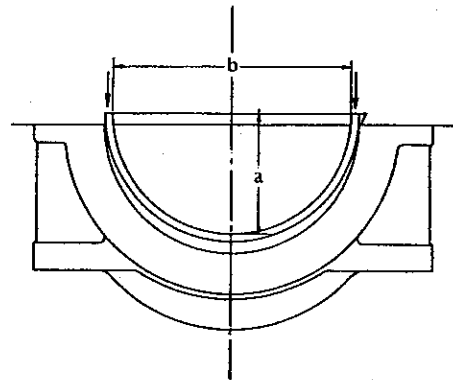
(mm)

Connecting rod	Model WA	Model WB
Clearance	0.25	0.30

The bearing is designed so that the radius is larger than that of the connecting rod and the bearing halves make a perfect circle when tightened, i.e., the diameter of the bearings is larger than that of the connecting rod. If the two halves have the same diameter, replace with new ones even if not worn. To assemble, install each bearing half with the notches in the same direction.

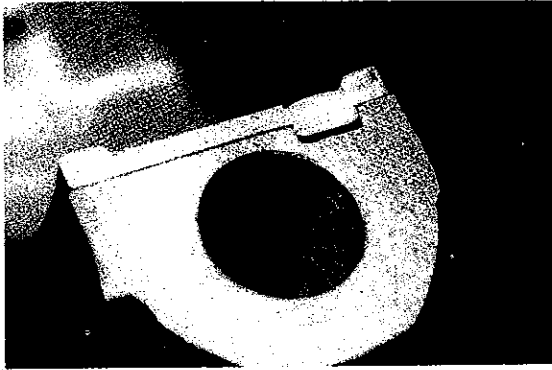


**Fig. 84 Connecting rod and bearing halves**



**Fig. 85 Bearing tolerance**

- 1) To replace the bearing halves with new ones, when you find that the width of the groove of the bearing notch section is larger than that of the connecting rod groove section by a maximum of 0.1 mm, reduce the excess with a fine file and then join together.



**Fig. 86 Connecting rod bearing notches**

- 2) In case of replacement, make sure the edge of the bearing is not protruding beyond that of the connecting rod. Standard dimension of the bearing is  $2a < b$ . When it is  $2a = b$ , do not use as it is a bearing of inferior quality. The bearings will not be secured unless you push them in with your thumbs.

### 1.7. Cylinder sleeve

The standard height of the seat surface of the cylinder sleeve is 0.5 mm. The guard thickness is reduced when the seat surface of the cylinder sleeve guard is lapped, so adjust the reduced thickness with gaskets for the cylinder sleeve. The thickness of one gasket is 0.2 mm

If the inner surface of the sleeve is not a mirror surface but has vertical scratches, cloudiness or marks of seizure from scale, smooth the surface with a piece of fine GC grinder or emery paper which is finer than No. 1200. The degree of abrasion can be seen by comparing with the upper part - about 3 mm from the top - where the top compression ring does not reach. The clearance between the piston and the cylinder sleeve determines whether the latter should be replaced.

If the maximum clearance between the bottom of the piston and the cylinder sleeve exceeds the value shown below, replace only the sleeve. If the clearance is still

larger than the value mentioned below even after the sleeve has been renewed, replace the piston also.

(mm)

Cylinder sleeve	Model WA	Model WB
Maximum clearance with piston	0.30	0.35
Maximum inside diameter	95.15	130.15
Standard inside diameter	95.0	130.0

### 1.8. Discharge valve and suction valve (assembly)

Remove carbon deposits with a wire brush. The life of a plate valve is about 6,000 hours. When this period has elapsed it is recommended that you replace the plate.

The maximum allowable abrasion is 0.2 mm from the standard thickness, which is 1.3 mm for Model WA and 1.4 mm for Model WB.

Even if the seat surface is not worn, replace it with a new one if the surface of the valve does not make uniform contact with the springs. Also check the springs.

Valves seats for discharge and suction valves:

A seat surface which is not worn uniformly can be adjusted by lapping. If the valve seat has dents or marks due to refrigerant leakage, replace the seat, depending on the severity of the dent or mark.

The maximum allowable abrasion of the valve seat is 0.25 mm.

The cylinder gasket must be prepared beforehand to prevent the seat from mixing with others, as top clearance is changed after correction of the seat.

#### Suction Valve Plate

- \* Three types of suction valve plate are available for Model WA, WB and WJ compressors. These suction valve plates are classified according to suction valve lift, size and number of suction valve springs. Suction valves should be selected according to operating conditions and must be confirmed by the dye stamp on the valve plate with reference to the following.

Refrigerant Type		NH3 (L)		R12, R22 & R502 (L)		PROPANE (L)	
WA Single-stage		WN	(1.1)	WR	(1.9)	WR	(1.9)
WA Compound	Booster	*N	(1.1)	*N	(1.1)	*N	(1.1)
	High-stage	WN	(1.1)	WN	(1.9)	WR	(1.9)
WB Single-stage		*WN	(1.2)	*WN	(3.0)	*WR	(3.0)
WA Compound	Booster	*N	(1.2)	*R	(1.5)	WR	(1.2)
	High-stage	WN	(1.2)	WR	(3.0)	WR	(3.0)

Thickness of plate valve for WA and WB compressors :

WA : 1.3 mm

WB : 1.4 mm

### Discharge Valve Cage Assembly

Discharge valve cage assemblies for Model WA and WB are also classified into three types having three different lift cages. The proper discharge valve cage assembly can be determined by referring to the dye stamp marks and the following table.

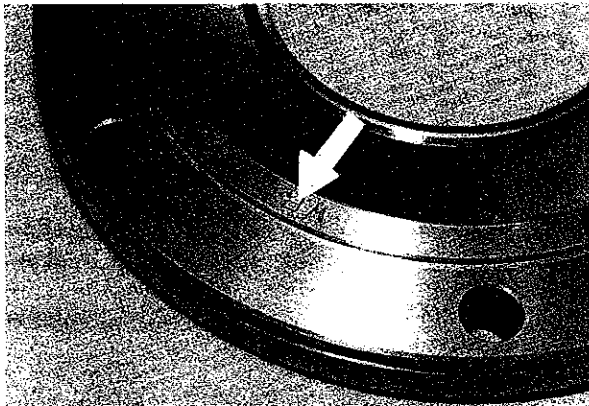


Fig. 87 Stamp, Valve plate & cage

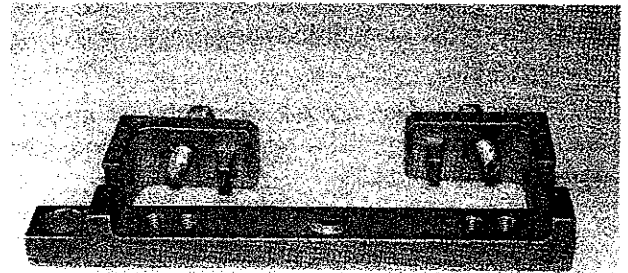
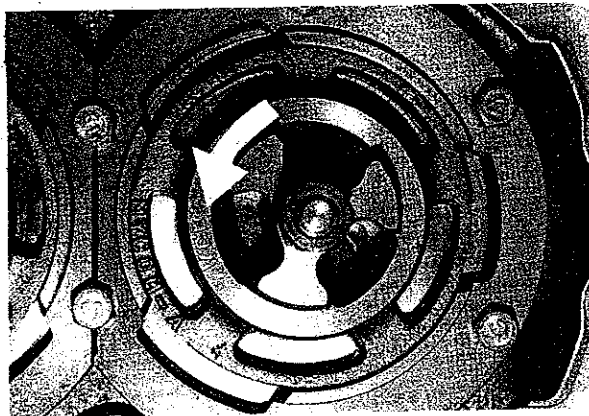


Fig. 88 Discharge valve cage assembly tool



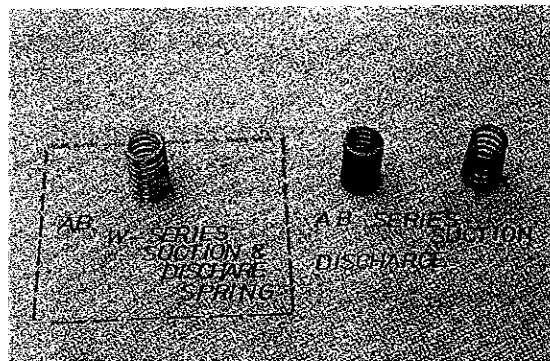
Refrigerant Type		NH3 (L)		R12, R22, & T502 (L)		PROPANE (L)					
		Standard	Booster	Standard	Booster	Standard					
WA Single-stage		WCN	(0.9)	*CN	(0.9)	WCR	(2.1)	*SR	(0.6)	WCR	(2.1)
WA Compound	Booster	*CN	(0.9)			*SR	(0.6)			WCR	(2.1)
	High-stage	WCN	(0.9)			WCR	(2.1)			WCR	(2.1)
WJ						WCR	(2.1)	SR	(0.6)	WCR	(2.1)
WB Single-stage		WCN	(1.0)	*SN	(1.0)	WCR	(2.4)	*SR	(1.2)	WCR	(2.4)
WB Compound	Booster	*SN	(1.0)			*SR	(1.2)			WCR	(2.4)
	High-stage	WCN	(1.0)			WCR	(2.4)			WCR	(2.4)

\*Figures in brackets indicate plate valve lifting height.



Thickness of discharge valve for WA and WB compressors:

- \* Dye stamps ("CN", "SN" and "SR" are the same as for WA and WB compressors with respective discharge valve springs.
- \* The actual working lift of the discharge valve is the figure obtained from the list minus the thickness of the discharge valve.



**Fig. 89 W series discharge & suction valve springs**

### 1.9. Oil pump

If oil pressure does not rise even after adjusting the oil pressure regulating valve during operation and if the cause is not abrasion of the bearings, take the following steps.

Move the oil pump shaft back and forth holding the shaft with your fingers. If there is a crack in the bushing or on the side, the part is worn away. In this case, replace the whole assembly. Never disassemble the pump if nothing is wrong with it, however.

If the oil pressure does not rise when the oil pump is normal, inspect the oil pressure regulating valve and/or the oil strainers for abnormality.

### 1.10 Free length of springs

The springs for discharge and suction valves are changed during periodic inspection carried out every 6,000 hours of operation. Renew other springs when they become shorter than the standard free length. The maximum allowable shortening is 10% from the standard length

Standard free length of springs:

(mm)

Spring	Model WA	Model WB
Helical	19.0	16.0
*Suction valve	13.8 ± 0.3 (Booster 12.7)	
*Discharge valve		
*Head	63 ± 1.5	79 ± 1.6
Lift pin	10.0	12.5
Unloader device	72.0	75.0

### 1.11. Main bearing and thrust bearing

If the gaps between main bearing, thrust bearing and shaft become larger than the values shown below, renew.

The motor side of the thrust bearing is easily abraded so do not over tension the belts.

WA = 0.08 ~ 0.20 WB = 0.08 ~ 0.20 Double collar

(mm)

	Model WA	Model WB	
			Mediate bearing
Maximum clearance between bearing and shaft	0.25	0.30	0.45
Inner diameter:			
Main bearing	67.15	92.18	
Thrust bearing	82.65	112.18	
Thrust gap	maximum 0.3	0.3	

### 1.12. Gasket

Replace if broken or elasticity is gone. Check the matching of holes for bolts and oil during assembly.

### 1.13. Bolts

Inspect to see whether the bolts for connecting rods and discharge valve seats are broken. Replace them if the threads are dull. Also inspect the threads of the head cover screws and replace if dull. Special care should be taken after trouble such as oil hammer, liquid hammer and/or burning have occurred.

### 1.14 Selection of compressor oil

The quality of the lubricating oil significantly affects the life of a compressor. Use oil of the best quality. If a large amount of carbonized oil or slag adheres to the discharge valve cage, or if moving parts show premature abrasion when the compression ratio and the discharge pressure are not high and oil consumption is normal, check the following:

- a) Whether the oil contains impurities or any foreign matter, or whether the oil is of poor quality.
- b) Whether the oil is stained or aged, even when it is an oil of fine quality.


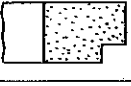
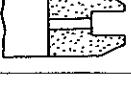

Judging the quality of lubricating oil is very difficult. Generally, it can be judged only after actual use. Therefore, the best way is to buy a well-known brand from a reliable dealer. Avoid selecting oil by price only.

The important factors for the oil are viscosity against temperature rise, low pour point and high flash point. After purchasing, oil should be stored with the utmost care to avoid contamination by impurities such as water or dust. This could cause abrasion or corrosion of the compressor when the oil is used.

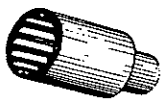



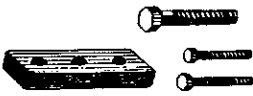









Class No.	Color (union)	Reaction	Flash Point	Viscosity 86°F (30°C)	Redwood per sec. 122°F (50°C)	Corrosion	Pour Point	Rate of Emulsification by Evaporation (per sec)
150	Max 3	Neutral	311°F up (155°C)	152 ± 20	Min 60	Max 1	Lower than -27.5°C	Max 200
300	Max 4	Neutral	329°F up (165°C)	301 ± 20	Min 91	Max 1	Lower than -22.5°C	Max 200

Class No. 300 oil is usually used; Capella D, Daphne CR 42 (or CR45), or Suniso 4G are most suitable for Mycom WA and WB compressors.

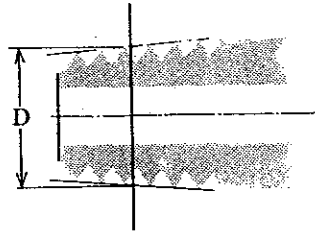
### 1.15 Piston rings

	Sectional view	Kind	Specification	Parts No.	
				Model WA	Model WB
PISTON RING		FC-PC-BF	For Freon & NH <sub>3</sub> , 1st	SAP411	SBP411
		FC-UC	For Freon & NH <sub>3</sub> , 2nd	SAP413	SBP413
OIL RING		FC-PC-BC <sub>3</sub>	For Freon & NH <sub>3</sub> , 3rd Same thickness piston ring	SAP527	SBP527
		FC-PC-BC <sub>4</sub>	For Freon & NH <sub>3</sub> , 4th	SAP528	SBP528

## 2 Special Tool Kit

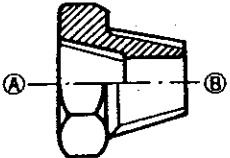
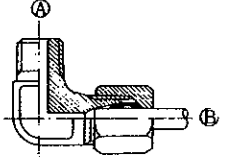
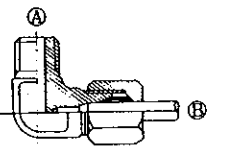
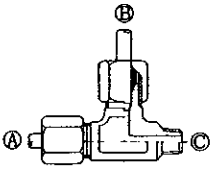
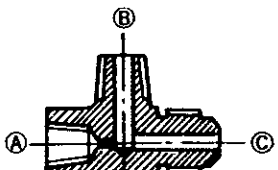
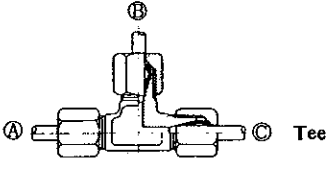
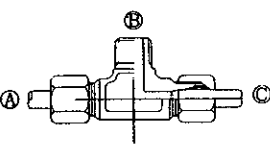
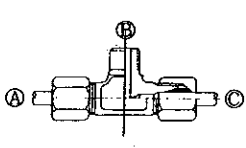
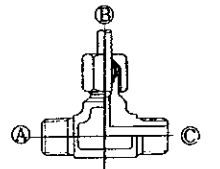
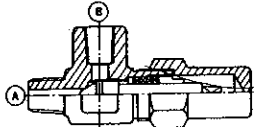
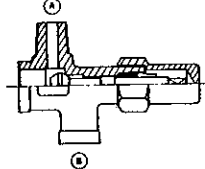
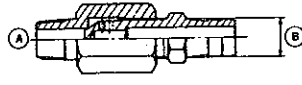
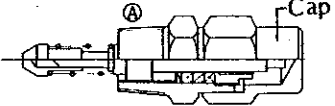
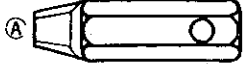
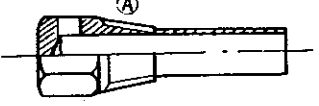
Name		Q'ty	Series A	Series B
Box Spanner		1	Width across flats of socket	Width across flats of socket
		1	" 14 mm "	" 17 mm "
		1	" 19 mm "	" 21 mm "
		1	" 17 mm "	" 26 mm "
		1	" 21 mm "	" 21 mm long socket "
		1	" 21 mm "	" 26 mm "
Box Spanner Handle		1	300 ℓ	300 ℓ
Hexagon Bar Spanner		1	Width across flats 5 mm	Width across flats 5 mm
		1	" 10 mm	" 14 mm
Double Headed Wrench		1	14 ~ 17 mm	14 ~ 17 mm
		1	17 ~ 19 mm	17 ~ 19 mm
		1	21 ~ 23 mm	21 ~ 23 mm
Pulley Puller		1	With 1 bolt 5 3/4" x 100 mm	With 1 bolt 3/4" x 100 mm
			With 2 bolts 1.1/2" x 45 mm	With 2 bolts 1/2" x 45 mm
Locking Nut Spanner		1	Small	Large
Hanger Eye Bolt		1	1/4"	5/16"
Monkey Wrench		1	10"	10"
Extension Bar		1	6"	10"
Ratchet handle		1	1/4"	1/4"
Sponge		1	20 x 160 x 160 (mm)	20 x 160 x 160 (mm)
Oil Charging Hose		1	15φ x 20φ x 750 (mm)	15φ x 20φ x 750 (mm)
Discharge Valve Disassembly Tool		1	With 2 bolts	With 2 bolts
Stud Bolt. Polished		2	1/2" x 69 mm	5/8" x 60 mm

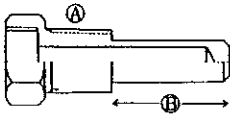

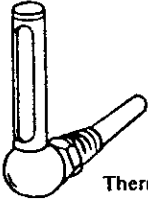

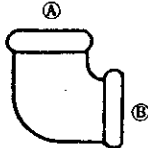
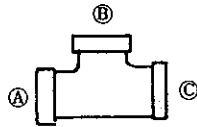
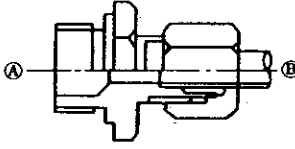
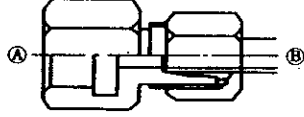
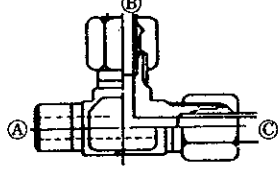
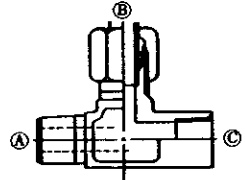
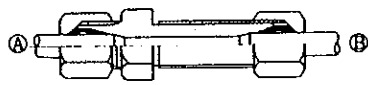
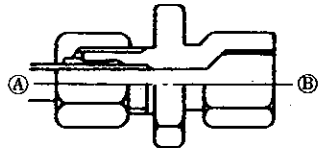
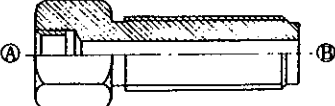
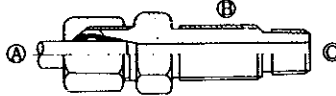
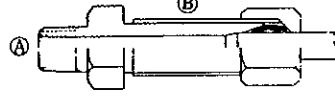
### 3 Pipefitting



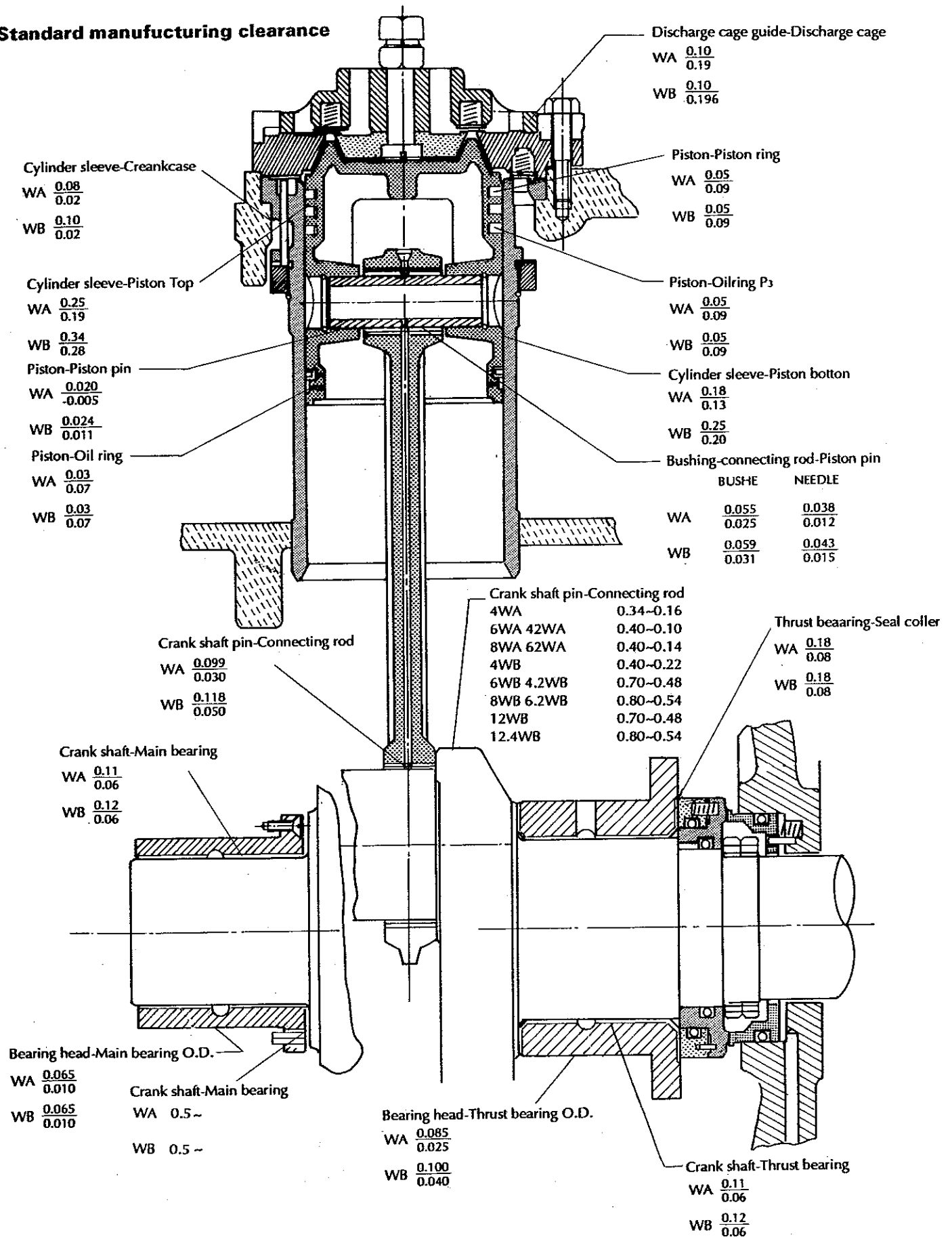
P.T. (inch)	D (φmm)
1/8	9.8
1/4	13.1
3/8	16.6
1/2	20.9
3/4	26.4
1	33.2
1 1/4	41.9

<p>Straight Half Union</p>		<p>Gauge fitting</p>		<p>Gauge fitting</p>	
Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ
JO 4610 JO 4010 JO 4020 JO 4030 JO 4040 JO 4570 JO 5020	6 φ × 1/8 P.T. 6 φ × 1/4 P.T. 6 φ × 3/8 P.T. 8 φ × 1/4 P.T. 8 φ × 3/8 P.T. 12 φ × 3/8 P.T. 12 φ × 1/2 P.T.	JO 4170 JO 4160 JO 4250	1/4 P.T × 6 φ 3/8 P.T × 6 φ 1/4 P.T × 1/4 P.T	JO 4240 JO 5450	6 φ × 3/8 P.T. 8 φ × 3/8 P.T.
<p>Union</p>		<p>Cross (reduction)</p>		<p>cross</p>	
Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ × Ⓒ × Ⓓ	Art. No.	Ⓐ × Ⓑ × Ⓒ × Ⓓ
JO 4180 JO 5010	6 φ × 6 φ 8 φ × 8 φ	JO 4230	6 φ × 1/4 P.T × 6 φ × 1/4 P.T	JO 4220 JO 4960	3/8 P.T × 6 φ × 3/8 P.T × 1/4 P.T 3/8 P.T × 8 φ × 3/8 P.T × 1/4 P.T
<p>Hexagonal nipple</p>		<p>Hexagonal plug</p>		<p>Flare nut</p>	
Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ
JO 4531 JO 4532 JO 4533	1/4 P.T × 1/4 P.T 3/8 P.T × 3/8 P.T 1/2 P.T × 1/2 P.T	JO 4541 JO 4542 JO 4543 JO 4544 JO 4545 JO 4546	1/4 P.T 3/8 P.T 1/2 P.T 3/4 P.T 1 P.T 1 1/4 P.T	JO 4190	6 φ

					
Hexagonal bushing		L type half union		L type half union (Reduction)	
Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ
JO 5001	1 1/4 P.T × 1 P.T	JO 4600	3/8 P.T × 6 φ	JO 4090	1/4 P.T × 6 φ
JO 5002	1 1/4 P.T × 3/4 P.T	JO 4080	3/4 P.T × 6 φ	JO 4970	1/4 P.T × 8 φ
JO 5003	1 P.T × 3/4 P.T	JO 4690	3/8 P.T × 6 φ	JO 4990-1	3/8 P.T × 12 φ
JO 5004	1 P.T × 3/4 P.T	JO 4050	1/4 P.T × 8 φ		
JO 5005	3/4 P.T × 1/2 P.T	JO 4060	3/8 P.T × 8 φ		
JO 5006	3/4 P.T × 3/8 P.T	JO 4070	1/2 P.T × 12 φ		
JO 5007	1/2 P.T × 1 1/8 P.T	JO 4990	3/8 P.T × 12 φ		
JO 5540	1 P.T × 1 P.T				
					
Tee		Tee		Tee	
Art. No.	Ⓐ × Ⓑ × Ⓒ	Art. No.	Ⓐ × Ⓑ × Ⓒ	Art. No.	Ⓐ × Ⓑ × Ⓒ
JO 5110	6 φ × 6 φ × 1/8 P.T	JO 4100	3/4 P.T × 1/2 P.T × 13 φ	JO 4110	6 φ × 6 φ × 6 φ
				JO 5030	8 φ × 8 φ × 8 φ
					
Tee		Tee		Tee	
Art. No.	Ⓐ × Ⓑ × Ⓒ	Art. No.	Ⓐ × Ⓑ × Ⓒ	Art. No.	Ⓐ × Ⓑ × Ⓒ
JO 4120	6 φ × 1/4 P.T × 6 φ	JO 4130	6 φ × 1/4 P.T × 6 φ	JO 4140	3/8 P.T × 6 φ × 3/8 P.T
JO 4150	6 φ × 1/2 P.T × 6 φ				
JO 5070	8 φ × 1/4 P.T × 8 φ				
JO 5080	8 φ × 3/8 P.T × 8 φ				
					
Angle valve		Manual unloader valve		Purge valve	
Art. No.	Ⓐ × Ⓑ	Art. No.	Ⓐ × Ⓑ × Ⓒ	Art. No.	Ⓐ × Ⓑ
JO 5840 (N)	1/4 P.T × 1/4 P.T	JO 5990 (N)	P.T 3/8 × P.T 1/4	JO 6080	3/8 P.T × 17 φ
JO 5850 (R)		JO 6000 (N)			
JO 5800 (N)	3/8 P.T × 3/8 P.T	JO 6010 (R)			
JO 5810 (R)					
JO 5720 (N)	3/8 P.T × 1/4 P.T				
JO 5830 (R)					
					
Oil By-pass valve (relief)		Oil return fitting		Pressure equalizing plug (for 2A)	
Art. No.	Ⓐ	Art. No.	Ⓐ	Art. No.	Ⓐ
JO 5920 (N)	without cap 3/4 P.T	JO 6110	3/8 P.T	JO 4950	3/8 P.T
JO 5930 (R)					

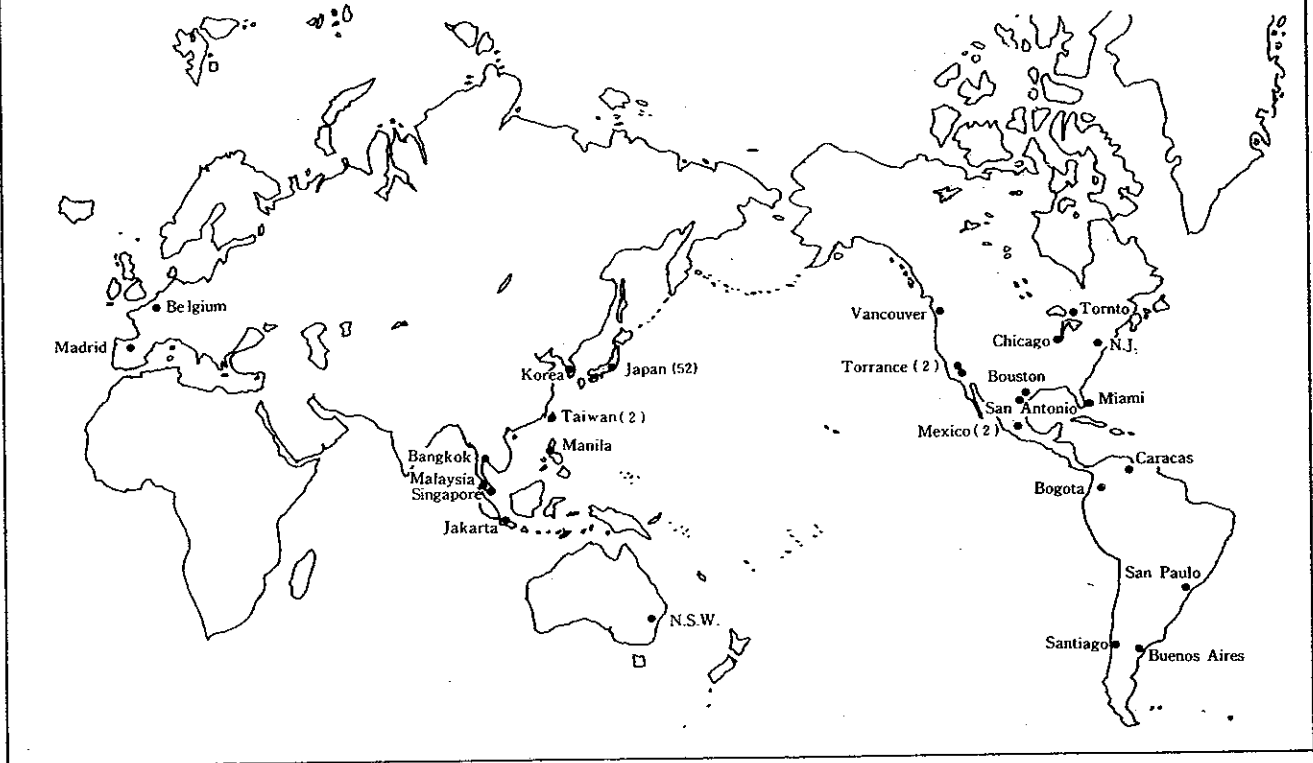
					
Temperature measuring plug		Thermometer (I type)		Thermometer (L type)	
Art. No.	A × B	Art. No.		Art. No.	
JO 470A JO 480A	$\frac{1}{2}$ P.T × long $\frac{1}{2}$ P.T × short (for 42A)	THS TLS	For high pressure use: (0 ~ 200°C) For low pressure use: (-50 ~ 50°C)	THL TLL	For high pressure use: (0 ~ 200°C) For low pressure use: (-50 ~ 50°C)
					
Square plug (for low pressure)		Elbow		Tee	
Art. No.		Art. No.	A × B	Art. No.	A × B × C
JOAP 8 JOAP10 JOAP15 JOAP20 JOAP25 JOAP32 JOAP40	$\frac{1}{4}$ P.T $\frac{3}{8}$ P.T $\frac{1}{2}$ P.T $\frac{3}{4}$ P.T 1 P.T 1 $\frac{1}{4}$ P.T 1 $\frac{1}{2}$ P.T	JOL 8H JOL10H JOL15H JOL20H	$\frac{1}{4}$ P.T × $\frac{1}{4}$ P.T $\frac{3}{8}$ P.T × $\frac{3}{8}$ P.T $\frac{1}{2}$ P.T × $\frac{1}{2}$ P.T $\frac{3}{4}$ P.T × $\frac{3}{4}$ P.T (For high pressure use)	JOT 8H JOT10H JOT15H JOT20H	$\frac{1}{4}$ P.T $\frac{3}{8}$ P.T $\frac{1}{2}$ P.T $\frac{3}{4}$ P.T For high pressure use
					
Seat for unloader manipulate valve		Half union		Special tee (reduction)	
Art. No.	A × B	Art. No.	A × B	Art. No.	A × B × C
JO 4270 JO 4260	W19 thread 16 × 6 φ W19 thread 16 × 8 φ	JO 4240 JO 5450	$\frac{3}{8}$ P.F × 6 φ $\frac{3}{8}$ P.T × 8 φ	JO 5510	$\frac{3}{8}$ P.T × 12 φ × 6 φ
					
Special tee		Electric control fitting		Electric control fitting	
Art. No.	A × B × C	Art. No.	A × B	Art. No.	A × B
JO 5520	$\frac{3}{8}$ P.T × 12 φ × $\frac{1}{4}$ P.T	JO 5680	8 φ × W16 <sup>18</sup> thread/in	JO 3030	6 φ × W11 <sup>20</sup> thread/in
					
Electric control fitting		Electric control fitting		Electric control fitting	
Art. No.	A × B	Art. No.	A × B × C	Art. No.	A × B
JO 3020	W11 <sup>20</sup> thread/in × W16 <sup>18</sup> thread/in	JO 3010-1	8 φ × W16 <sup>18</sup> thread/in × $\frac{1}{4}$ P.T	JO 5690	$\frac{1}{4}$ P.T × W16 <sup>18</sup> thread in

# Standard manufacturing clearance



# MYCOM Worldwide After-sales Service Networks

Outside Japan : 27 subsidiaries  
In Japan : 52 subsidiaries



We reserve the right to change design specifications according to technical developments and improvements without notice.



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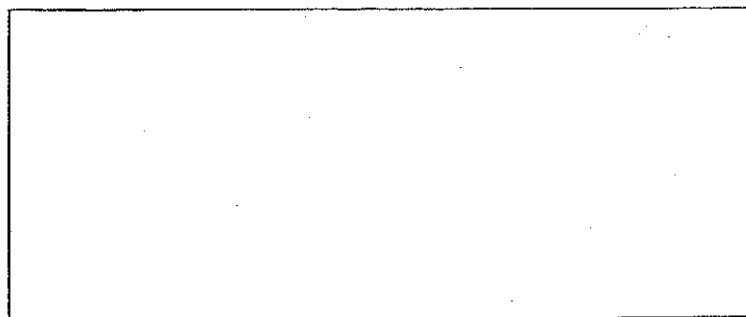
## **MAYEKAWA MFG. CO., LTD.**

2-13-1, Botan, Koto-ku, Tokyo (135), Japan

Tel: (03)3642-8181 Telex: 0262-2344 Cable: MYCOMMYK

Rifax: (03)3643-8771 and (03)3643-7094

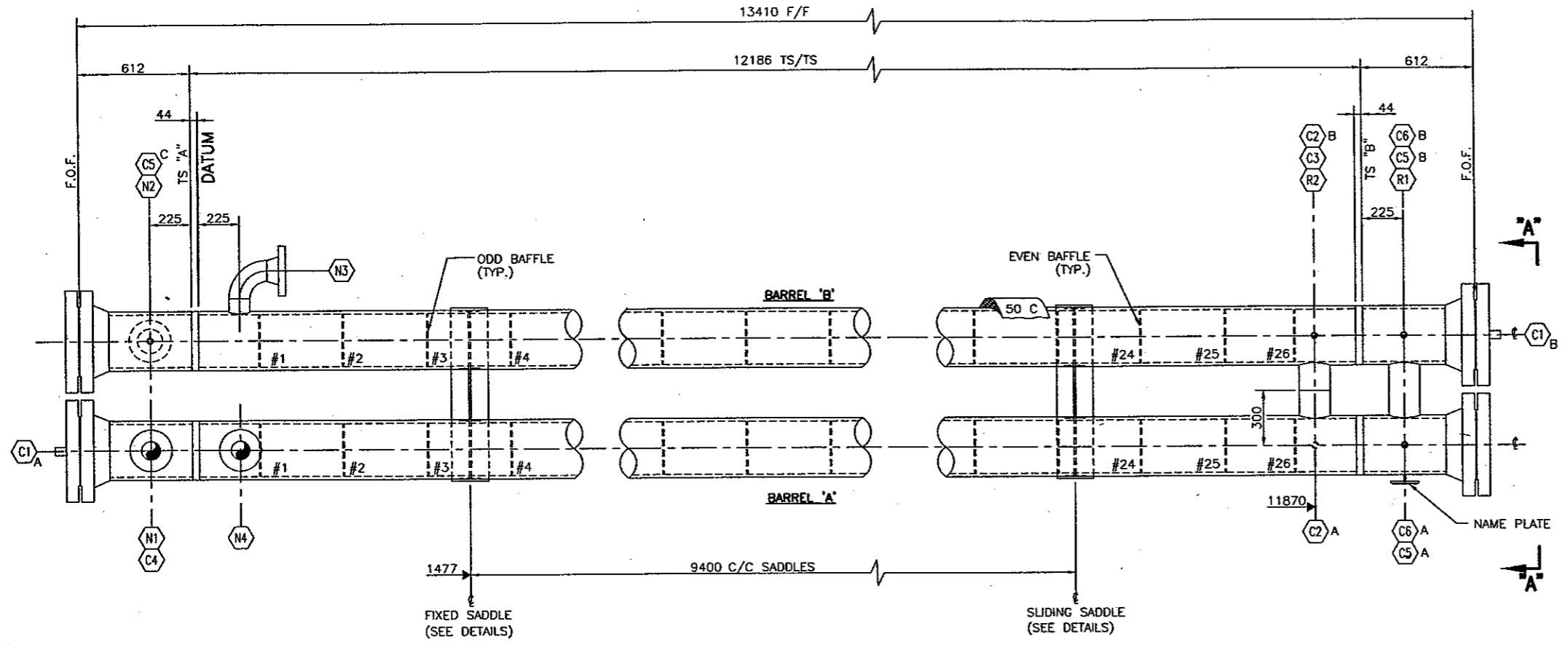
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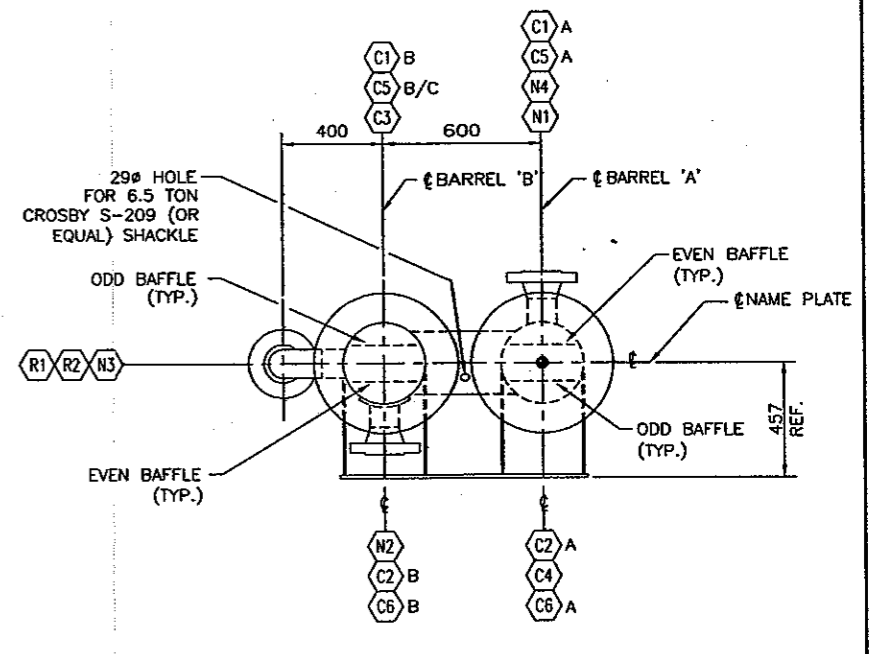
PROPAC SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SHELL & TUBE EXCHANGER				SHEET 1 OF 1		
				REV	BY	DATE	REVISION DESCRIPTION			
CUSTOMER : XXXXXX										
PLANT : REFRIGERATION PLANT 8B										
SERVICE : GAS/GAS EXCHANGER										
JOB NO. : XXXXXX TAG NO: E-600										
MFR. : PSL MODEL NO:										
1 EXCHANGER SIZE: 324ODx12186TS/TS		TYPE : HOR. X		VERT.		CONNECTED IN PARALLEL 1		SERIES 2		
2 SURF / UNIT ( GROSS / EFF)		157.8		m2		SHELLS / UNITS : 2		SURF / SHELL ( GROSS / EFF) 78.9 m2		
3 PERFORMANCE OF ONE UNIT										
4 FLUID ALLOCATION			SHELL SIDE				TUBE SIDE			
5 FLUID NAME			RESIDUE GAS				INLET GAS			
6 FLUID QUANTITY . TOTAL kg/s										
7 VAPOR (IN / OUT)										
8 LIQUID										
9 STEAM										
10 WATER										
11 NON CONDENSATE										
12 TEMPERATURE ( IN / OUT ) ° C										
13 DENSITY kg/cu.m										
14 VISCOSITY . LIQUID cP										
15 MOLECULAR WEIGHT . LIQUID										
16 SPECIFIC HEAT . LIQUID J/kg C										
17 VISCOSITY . VAPOR cP										
18 MOLECULAR WEIGHT . VAPOR										
19 SPECIFIC HEAT . VAPOR J/kg C										
20 THERMAL COND. LIQ./VAP. W/m C										
21 LATENT HEAT kJ/kg @ C										
22 INLET PRESS. kpa (ab)										
23 VELOCITY m/s										
24 PRESS. DROP ALLOW / CALC kpa										
25 FOULING RESISTANCE ( MINIMUM )			0.00018				0.00018			
26 TRANSFER RATE (w/M2 C)			(SERVICE)		(DIRTY)		(CLEAN)			
27 HEAT EXCHANGED kW			MTD				° C (CORRECTED)		° C (UNCORRECTED)	
28 CONSTRUCTION OF ONE SHELL						SKETCH ( BUNDLE / NOZZLE ORIENTATION )				
29 DESIGN / TEST PRESS. kpag			8963		8963					
31 DESIGN TEMP ° C			66 / -28.8		66 / -28.8					
32 NO. OF PASSES PER SHELL			1		1					
33 CORROSION ALLOWANCE mm			1.59		1.59					
34 CONNECTIONS :			IN 114-600#RF		114-600#RF					
35 QUANTITY , SIZE			OUT 114-600#RF		114-600#RF					
36 RATING & FACE			INTERMEDIATE							
37 TUBE NO		109		TUBE OUTSIDE DIA (OD) mm		19.05		THK ( MIN / AVG ) mm 14 GA		
38 TUBE TYPE		PLAIN		TUBE LENGTH m		12.192		PITCH & (30°/60°/90°/45°) 23.81MM/30		
39 SHELL ( ID / OD ) (mm/mm)		289 / 324		SHELL MATERIAL		SA-106B		SHELL COVER MATERIAL CS		
40 CHANNEL or BONNET		CHANNEL		CHANNEL COVER MATERIAL		SA-105		TUBE MATERIAL SA-179		
41 STATIONARY TUBESHEET		SA-516-70N		FLOATING TUBESHEET						
42 FLOAT HEAD COVER				IMPINGMENT PROTECTION		NONE		PAINT SYSTEM PSL STD PNT11		
43 BAFFLES - CROSS		SA-36		TYPE		HORIZ. BAFFEL		% CUT ( DIA / AREA ) 30%		
44 BAFFLES - LONG				SEAL TYPE				SPACING 457		
45 SUPPORT TUBE				U BEND				TYPE		
46 SOUR SERVICE				BYPASS SEAL ARRANGEMENT				TUBE - TUBESHEET JOINT EXPANDED		
47 EXPANSION JOINT				TYPE				X-RAY CODE		
48 pV2 INLET NOZZLE				pV2 BUNDLE IN / OUT				STRESS RELIEF NO		
49 GASKET - SHELL				GASKET - TUBE				GASKET - FLOAT HEAD		
50 CODE REQUIREMENT		ASME VIII DIV 1		STAMP REQUIRED		YES		TEMA CLASS C		
51 WEIGHT PER SHELL kg		8250 BOTH BARRELS		SHELL WT WITH WATER kg		9978 BOTH BARRELS		BUNDLE WEIGHT kg		
52										
53										
54										
55										
56 REMARKS:										
57										
58										

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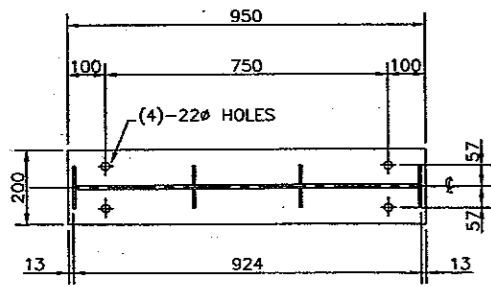
NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD		
N1	4 NPS	600#	RFWN	XXH	TUBESIDE INLET	200	-		
N2	4 NPS	600#	RFWN	XXH	TUBESIDE OUTLET	200	-		
N3	4 NPS	600#	RFWN	XXH	SHELLSIDE INLET	SPEC	-		
N4	4 NPS	600#	RFWN	XXH	SHELLSIDE OUTLET	200	-		
R1	4 NPS		PIPE	XXH	TUBESIDE RISER	-	-		
R2	4 NPS		PIPE	XXH	SHELLSIDE RISER	SPEC	-		
A/B	C1	1 NPS	3000#	CPLG	-	GLYCOL INJECTION	-		
A/B	C2	3/4 NPS	3000#	CPLG	B:XL	SHELLSIDE DRAIN (PLUGGED)	B=57 MIN		
	C3	3/4 NPS	3000#	CPLG	XL	SHELLSIDE VENT (PLUGGED)	57 MIN.		
	C4	3/4 NPS	3000#	CPLG	-	TUBESIDE DRAIN (PLUGGED)	-		
A/B/C	C5	3/4 NPS	3000#	CPLG	B&C:XL	TUBESIDE VENT (PLUGGED)	B&C=57MIN		
A/B	C6	1-1/2 NPS	3000#	CPLG	-	EQUALIZATION	-		



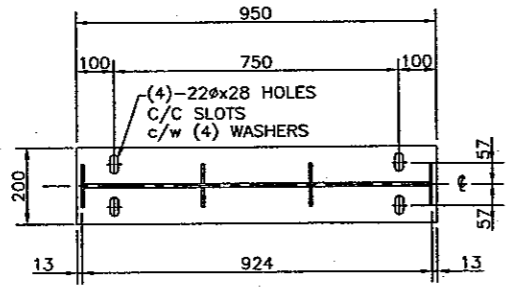
**PLAN VIEW**  
SCALE 1:15



**VIEW 'A-A'**  
SCALE 1:15



**FIXED SADDLE PLAN VIEW**  
SCALE 1:10



**SLIDING SADDLE PLAN VIEW**  
SCALE 1:10

**DESIGN DATA**

BARREL "A"		BARREL "B"	
<b>OPERATING TEMPERATURES</b>		<b>OPERATING TEMPERATURES</b>	
SHELLSIDE IN :	10°C	SHELLSIDE IN :	-17.8°C
SHELLSIDE OUT :	37.8°C	SHELLSIDE OUT :	10.0°C
TUBESIDE IN :	42.9°C	TUBESIDE IN :	25.8°C
TUBESIDE OUT :	25.8°C	TUBESIDE OUT :	8.7°C
<b>MEAN METAL TEMPERATURES</b>		<b>MEAN METAL TEMPERATURES</b>	
SHELL :	23.9°C	SHELL :	-3.9°C
TUBES :	29.13°C	TUBES :	6.7°C
T.S."A" :	40.4°C	T.S."A" :	4.4°C
T.S."B" :	17.9°C	T.S."B" :	17.9°C

SERVICE: GAS  
 LOADINGS PER UG-22(e) CONSIDERED GOVERNS: NO  
 PRODUCTION IMPACT TEST REQ'D: NO  
 IMPACT TESTING:  
 VESSEL: NO-PER UG20(f)(1-5)  
 -PER UCS-66(c)  
 TUBESHEETS: NO-PER UCS-66(a)(1)(c) & FIG UCS-66  
 CAPACITY: 1.73 m<sup>3</sup>  
 SURFACE AREA OF TUBES: 78.9 m<sup>2</sup>/BARREL  
 WEIGHT EMPTY: 8250 kg  
 WEIGHT FULL OF WATER: 9980 kg  
 APPROX. TUBE BUNDLE WEIGHT: 3070 kg/BARREL  
 PAINT SPEC: PNT-11  
 INSULATION: 50 THK FOAMGLASS c/w ALUMINIUM CLADDING (BARREL 'B' ONLY)  
 SHIP LOOSE: NO

SERIAL NO:	054468-101		CRN:	R7061.2
YEAR BUILT:	2005			
LSO #:				
CODE:	ASME SECT. VIII DIV I, '01, ADDENDA '03			
DESIGN PRESSURE	SHELLSIDE	8963 kPag		
	TUBESIDE	8963 kPag		
DESIGN TEMP.	NOTE: DES. PRESS IS MAWP			
	SHELLSIDE	65.5°C		
M.D.M.T.	SHELLSIDE	-28.8°C @ 8963 kPag		
	TUBESIDE	-28.8°C @ 8963 kPag		
HYDRO. PRESSURE	SHELLSIDE	11652 kPag		
	TUBESIDE	11652 kPag		
MAT'L:	HEAD:	SA-516-70N	SA-105N/SA-516-70N	
	SHELL:	SA-106-B SMLS	SA-106-B SMLS	
RADIOGRAPHY:	LONG	N/A	N/A	
	CIRC.	N/A	SPOT UW11(c)5(b)12(d)	
P.W.H.T.	NO	NO		
MIN TEMP / TIME	-	-		
CORR. ALLOWANCE	SHELLSIDE	1.59mm		
	TUBESIDE	1.59mm		
TAG NO:	<b>E-600</b>			

GENERAL NOTES		GENERAL NOTES		SKT	ISSUED FOR DOCUMENTATION	A. LOW	05/09/30	VK	MZ	APPROVED		DRAWN		FORT ENERGY CORP.	
DATE: 2005/09/30 10:04 AM J:\JOB505\054468\20-DRAWINGS\FAB\MISC\EXC-054468-101-SKT-01.DWG hmeng		No.		REVISION	BY	DATE	CKD	ENG	DATE	DATE	BY	DATE	BY	DATE	88 REFRIGERATION UNIT GAS/GAS EXCHANGER (E-600) 324 O/D x 12186 TS/TS
															440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3
															DWG. No.: D-EXC-054468-101-SKT SHT. 1 OF 1 REV. SKT

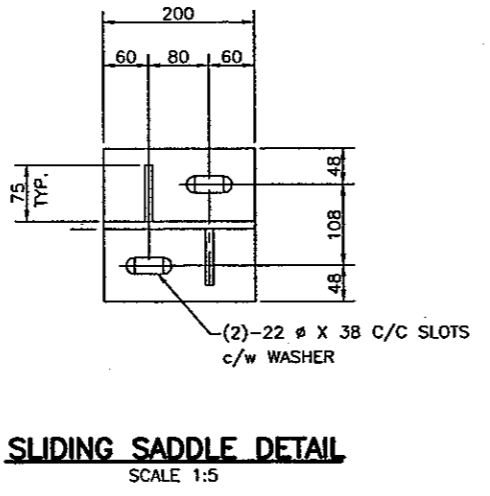
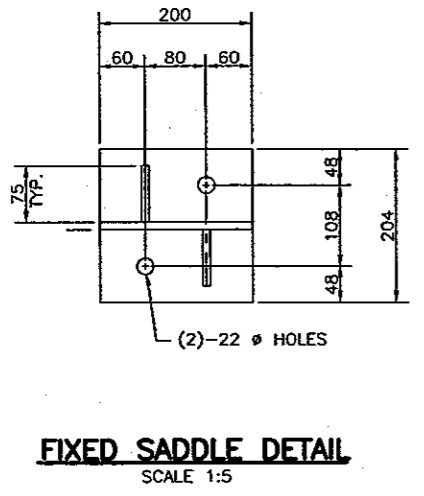
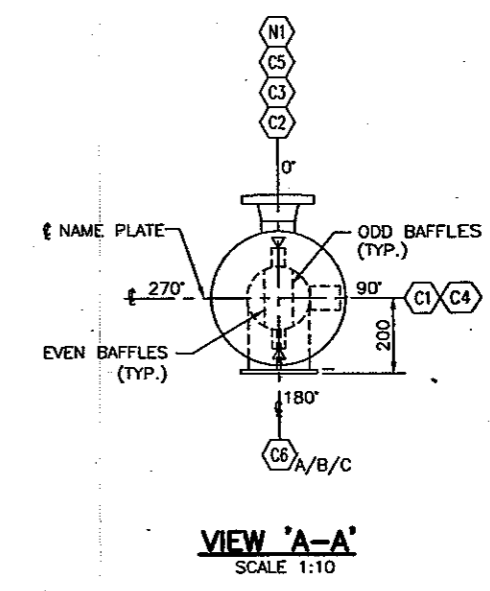
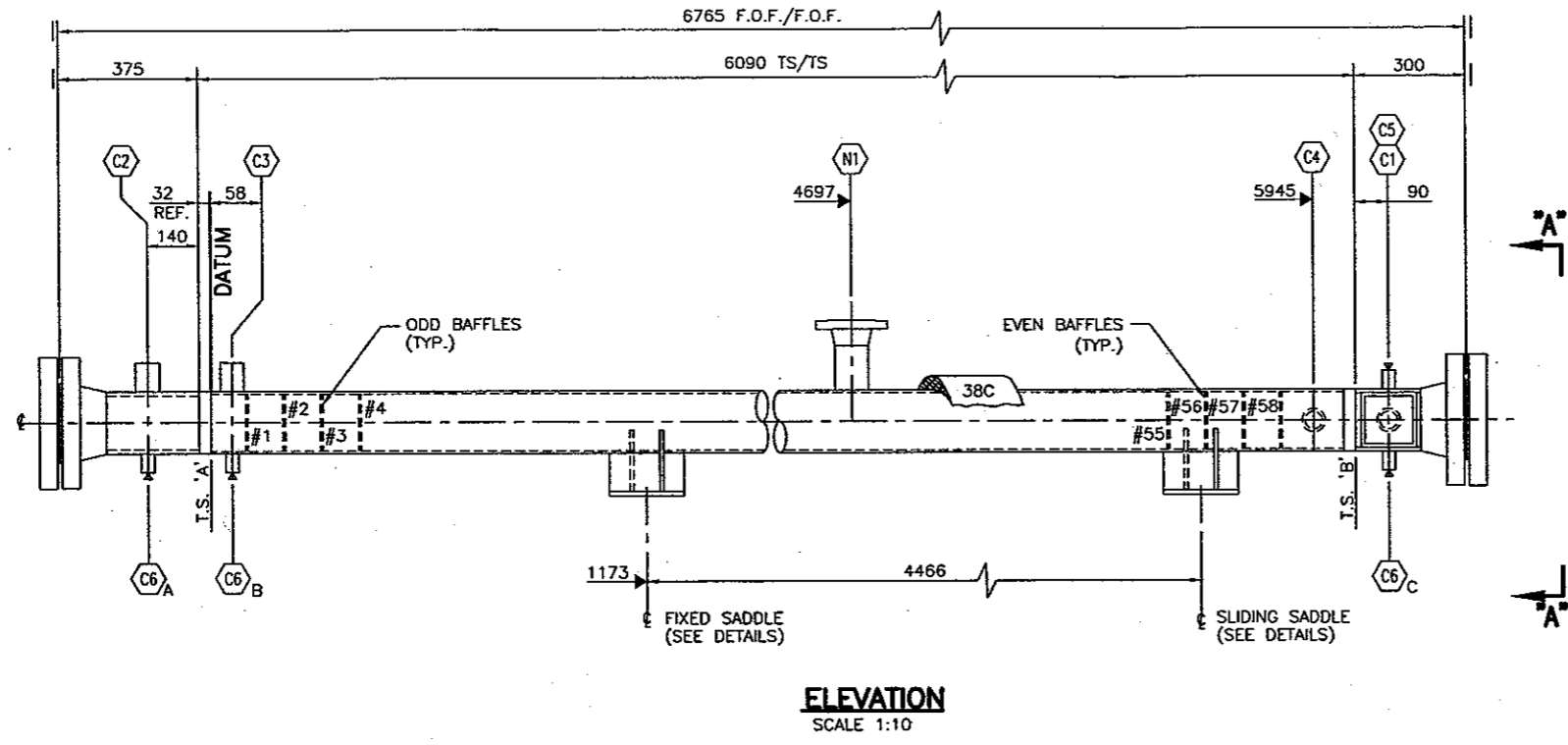
PROPAC SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3			SHELL & TUBE EXCHANGER				SHEET 1 OF 1	
CUSTOMER : XXXXXX			REV	BY	DATE	REVISION DESCRIPTION		
PLANT : REFRIGERATION PLANT 8B								
SERVICE : GAS CHILLER								
JOB NO. : XXXXXX TAG NO: E-610								
MFR. : PSL MODEL NO:								
1	EXCHANGER SIZE: 762ODx6090FOF/S	TYPE : HOR. BKU	VERT.	CONNECTED IN PARALLEL 1			SERIES 1	
2	SURF / UNIT ( GROSS / EFF)	48.71	m2	SHELLS / UNITS : 1	SURF / UNIT ( GROSS / EFF) 48.71			m2
3	PERFORMANCE OF ONE UNIT							
4	FLUID ALLOCATION	SHELL SIDE			TUBE SIDE			
5	FLUID NAME	PROPANE			INLET GAS			
6	FLUID QUANTITY . TOTAL	kg/s						
7	VAPOR (IN / OUT)							
8	LIQUID							
9	STEAM							
10	WATER							
11	NON CONDENSATE							
12	TEMPERATURE ( IN / OUT )	° C						
13	DENSITY	kg/cu.m						
14	VISCOSITY . LIQUID	cP						
15	MOLECULAR WEIGHT . LIQUID							
16	SPECIFIC HEAT . LIQUID	J/kg C						
17	VISCOSITY . VAPOR	cP						
18	MOLECULAR WEIGHT . VAPOR							
19	SPECIFIC HEAT . VAPOR	J/kg C						
20	THERMAL COND. LIQ./VAP.	W/m C						
21	LATENT HEAT	kJ/kg @ C						
22	INLET PRESS.	kpa (ab)						
23	VELOCITY	m/s						
24	PRESS. DROP ALLOW / CALC	kpa						
25	FOULING RESISTANCE ( MINIMUM )							
26	TRANSFER RATE (w/M2 C)	(SERVICE)	(DIRTY)	(CLEAN)				
27	HEAT EXCHANGED	kW	MTD	° C (CORRECTED)		° C (UNCORRECTED)		
28	CONSTRUCTION OF ONE SHELL				SKETCH ( BUNDLE / NOZZLE ORIENTATION )			
29		SHELL SIDE		TUBE SIDE				
30	DESIGN / TEST PRESS.	kpag	1724	8963				
31	DESIGN TEMP	° C	66 / -28.8	66 / -28.8				
32	NO. OF PASSES PER SHELL		1	2				
33	CORROSION ALLOWANCE	mm	1.59	1.59				
34	CONNECTIONS :	IN	TWO X 89 - 150# RF	114-600#RF				
35	QUANTITY , SIZE	OUT	168-150#RF	114-600#RF				
36	RATING & FACE	INTERMEDIATE						
37	TUBE NO	70	TUBE OUTSIDE DIA (OD)	mm	19.05	THK ( MIN / AVG )	mm	14 GA
38	TUBE TYPE	PLAIN	TUBE LENGTH	m	12.192	PITCH & ( 30°/60°/90°/45° )	23.81MM/60°	
39	SHELL ( ID / OD )	(mm/mm)	743 / 762	SHELL MATERIAL	SA-516-70	SHELL COVER MATERIAL	CS	
40	CHANNEL or BONNET	BONNET	CHANNEL COVER MATERIAL			TUBE MATERIAL	SA-179	
41	STATIONARY TUBESHEET	SA-516-70N	FLOATING TUBESHEET					
42	FLOAT HEAD COVER		IMPINGMENT PROTECTION	NONE		PAINT SYSTEM	PNT-11	
43	BAFFLES - CROSS	SA-36	TYPE	FULL BAFFLE		% CUT ( DIA / AREA )	0%	
44	BAFFLES - LONG		SEAL TYPE			SPACING	920	
45	SUPPORT TUBE		U BEND			TYPE	HORIZONTAL	
46	SOUR SERVICE		BYPASS SEAL ARRANGEMENT			TUBE - TUBESHEET JOINT	EXPANDED	
47	EXPANSION JOINT		TYPE			X-RAY	CODE	
48	pV2 INLET NOZZLE		pV2 BUNDLE IN / OUT			STRESS RELIEF	NO	
49	GASKET - SHELL		GASKET - TUBE			GASKET - FLOAT HEAD		
50	CODE REQUIREMENT	ASME VIII DIV 1	STAMP REQUIRED	YES		TEMA CLASS	C	
51	WEIGHT EMPTY	kg	4050	SHELL WT WITH WATER	kg	7200	BUNDLE WEIGHT	kg
52								
53								
54								
55								
56	REMARKS:							
57								
58								



PROPAC SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3			SHELL & TUBE EXCHANGER				SHEET 1 OF 1		
CUSTOMER : XXXXXXXX			REV	BY	DATE	REVISION DESCRIPTION			
PLANT : REFRIGERATION PLANT 8B									
SERVICE : REFRIGERANT SUBCOOLER									
JOB NO. : XXXXXXXX TAG NO: E-615									
MFR. : PSL MODEL NO:									
1	EXCHANGER SIZE: 168ODx6090TS/TS	TYPE: HOR. X	VERT.	CONNECTED IN PARALLEL 1			SERIES 1		
2	SURF / UNIT ( GROSS / EFF)	7.93	m2	SHELLS / UNITS : 1	SURF / SHELL ( GROSS / EFF)		7.93	m2	
3	PERFORMANCE OF ONE UNIT								
4	FLUID ALLOCATION	SHELL SIDE			TUBE SIDE				
5	FLUID NAME	PROPANE			HYDROCARBON LIQUID				
6	FLUID QUANTITY . TOTAL	kg/s							
7	VAPOR (IN / OUT)								
8	LIQUID								
9	STEAM								
10	WATER								
11	NON CONDENSATE								
12	TEMPERATURE ( IN / OUT )	° C							
13	DENSITY	kg/cu.m							
14	VISCOSITY . LIQUID	cP							
15	MOLECULAR WEIGHT . LIQUID								
16	SPECIFIC HEAT . LIQUID	J/kg C							
17	VISCOSITY . VAPOR	cP							
18	MOLECULAR WEIGHT . VAPOR								
19	SPECIFIC HEAT . VAPOR	J/kg C							
20	THERMAL COND. LIQ./VAP.	W/m C							
21	LATENT HEAT	kJ/kg @ C							
22	INLET PRESS.	kpa (ab)							
23	VELOCITY	m/s							
24	PRESS. DROP ALLOW / CALC	kpa							
25	FOULING RESISTANCE ( MINIMUM )								
26	TRANSFER RATE (w/M2 C)	(SERVICE)	(DIRTY)	(CLEAN)					
27	HEAT EXCHANGED	kW	MTD	° C (CORRECTED)		° C (UNCORRECTED)			
28	CONSTRUCTION OF ONE SHELL				SKETCH ( BUNDLE / NOZZLE ORIENTATION )				
29		SHELL SIDE		TUBE SIDE					
30	DESIGN / TEST PRESS.	kpag	1724	8963					
31	DESIGN TEMP	° C	66 / -28.8	66 / -28.8					
32	NO. OF PASSES PER SHELL		1	1					
33	CORROSION ALLOWANCE	mm	1.59	1.59					
34	CONNECTIONS :	IN	48-3000#	48-3000#					
35	QUANTITY , SIZE	OUT	48-3000#	48-3000#					
36	RATING & FACE	INTERMEDIATE							
37	TUBE NO	22	TUBE OUTSIDE DIA (OD)	mm	19.05	THK ( MIN / AVG )	mm	14 GA	
38	TUBE TYPE	PLAIN	TUBE LENGTH	m	6.096	PITCH & ( 30°/60°/90°/45° )	23.81MM/30°		
39	SHELL ( ID / OD )	(mm/mm)	154 / 168	SHELL MATERIAL	SA-106B	SHELL COVER MATERIAL	CS		
40	CHANNEL or BONNET	CHANNEL	CHANNEL COVER MATERIAL	SA-105	TUBE MATERIAL	SA-179			
41	STATIONARY TUBESHEET	SA-516-70N	FLOATING TUBESHEET						
42	FLOAT HEAD COVER		IMPINGMENT PROTECTION	NONE	PAINT SYSTEM	PNT-11			
43	BAFFLES - CROSS	SA-36	TYPE	VERTICAL	% CUT ( DIA / AREA )	25%			
44	BAFFLES - LONG		SEAL TYPE		SPACING	101			
45	SUPPORT TUBE		U BEND		TYPE				
46	SOUR SERVICE		BYPASS SEAL ARRANGEMENT		TUBE - TUBESHEET JOINT	EXPANDED			
47	EXPANSION JOINT		TYPE		X-RAY	CODE			
48	pV2 INLET NOZZLE		pV2 BUNDLE IN / OUT		STRESS RELIEF	NO			
49	GASKET - SHELL		GASKET - TUBE		GASKET - FLOAT HEAD				
50	CODE REQUIREMENT	ASME VIII DIV 1	STAMP REQUIRED	YES	TEMA CLASS	C			
51	WEIGHT EMPTY	kg	654	SHELL WT WITH WATER	kg	774	BUNDLE WEIGHT	kg	209
52									
53									
54									
55									
56	REMARKS:								
57									
58									

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NOZZLE SCHEDULE							
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD
N1	3 NPS	150#	RFWN	XH	PSV	190	-
C1	1 1/2 NPS	3000#	CPLG	-	TUBESIDE INLET	44 MIN.	-
C2	1 1/2 NPS	3000#	CPLG	-	TUBESIDE OUTLET	44 MIN.	-
C3	1 1/2 NPS	3000#	CPLG	-	SHELLSIDE INLET	44 MIN.	-
C4	1 1/2 NPS	3000#	CPLG	-	SHELLSIDE OUTLET	44 MIN.	-
C5	3/4 NPS	3000#	CPLG	-	VENT (PLUGGED)	44 MIN.	-
C6	3/4 NPS	3000#	CPLG	-	DRAIN (PLUGGED)	44 MIN.	-



**DESIGN DATA**

OPERATING TEMPERATURES	
SHELLSIDE IN :	30.11°C
SHELLSIDE OUT :	-4.28°C
TUBESIDE IN :	-23.33°C
TUBESIDE OUT :	4.44°C

MEAN METAL TEMPERATURES	
SHELL :	12.92°C
TUBES :	1.74°C
T.S."A" :	-13.81°C
T.S."B" :	17.28°C

SERVICE: HYDROCARBONS	SERIAL NO: 054468-103	CRN: R7137.2
LOADINGS PER UG 22(e) CONSIDERED	YEAR BUILT: 2005	
GOVERNS: NO	LSO #:	
PRODUCTION IMPACT TEST REQ'D: NO	CODE: ASME SECT. VIII DIV I, '01	ADDENDA '03
IMPACT TESTING:	SHELLSIDE	TUBESIDE
VESSELS:	DESIGN PRESSURE	DESIGN PRESSURE
NO-PER UG20(f)(1-5)	1724 kPag	8963 kPag
-PER UCS-66(c)	NOTE: DES. PRESS. IS MAWP	
TUBESHEETS:	DESIGN TEMP.	DESIGN TEMP.
NO-PER UCS-66(o)(1)(c)	65.5°C	65.5°C
CAPACITY: 0.12 m <sup>3</sup>	M.D.M.T.	M.D.M.T.
WEIGHT EMPTY: 654 kg	-28.8°C @ 1724 kPag	-28.8°C @ 8963 kPag
WEIGHT FULL OF WATER: 774 kg	HYDRO. PRESSURE	HYDRO. PRESSURE
APPROX. TUBE BUNDLE WEIGHT: 210 kg	2241 kPag	11652 kPag
PAIN'T SPEC: PNT-1	MATERIAL: HEAD:	MATERIAL: HEAD:
INSULATION: 38 C FOAMGLASS	SA-516-70N	SA-105N
c/w ALUMINUM CLADDING	SHELL: SA-106-B SMLS	SA-106-B SMLS
SHIP LOOSE: NO	RADIOGRAPHY: LONG	RADIOGRAPHY: LONG
	CIRC. N/A	CIRC. N/A
	P.W.H.T. MIN TEMP / TIME	P.W.H.T. MIN TEMP / TIME
	NO	NO
	CORR. ALLOWANCE	CORR. ALLOWANCE
	1.59 mm	1.59 mm
	TAG NO: <b>E-615</b>	

DATE	BY	DATE	CHKD	ENG
05/09/30	MZ			

**GENERAL NOTES**  
No. 1: ISSUED FOR DOCUMENTATION

**APPROVED** **DRAWN**

MECH/STRUCT. DATE \_\_\_\_\_ BY DATE \_\_\_\_\_  
ELECTRICAL DATE \_\_\_\_\_ BY DATE \_\_\_\_\_  
PROJECT DATE \_\_\_\_\_ BY DATE \_\_\_\_\_  
DATE \_\_\_\_\_ BY DATE \_\_\_\_\_

SCALE AS NOTED

**FORT ENERGY CORP.**  
88 REFRIGERATION UNIT  
REFRIGERANT SUBCOOLER (E-615)  
168 O/D x 6090 TS/TS

**PROPAK**  
440 East Lake Road,  
Postal Brg #2  
Airdrie, Alberta  
Canada T4B 2C3

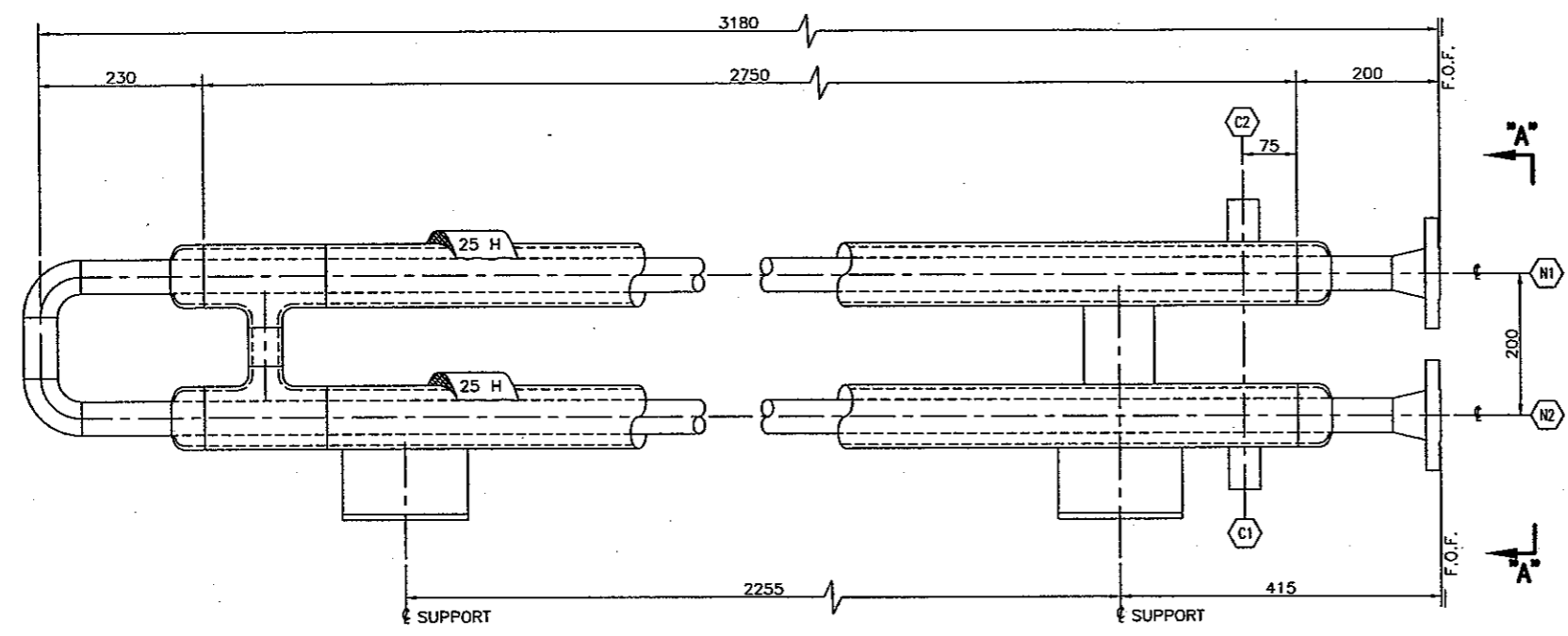
Dwg. No.: **D-EXC-054468-103-SKT** SHT. 1 OF 1 REV. SKT

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SHELL & TUBE EXCHANGER				SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : REFRIGERATION PLANT 8B SERVICE : OVERHEADS / C3 SUBCOOLER EXCHANGER JOB NO. : xxxxx TAG NO: E-625 MFR. : PSL MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
1	EXCHANGER SIZE(mm): 890D X 3048 S/EOP TYPE : HOR. X VERT.			CONNECTED IN PARALLEL			1 SERIES 2		
2	SURF / UNIT (EFF)	0.86	m <sup>2</sup>	SHELLS / UNITS : 2		SURF / SHELL (EFF)		0.43 m2	
3	PERFORMANCE OF ONE UNIT								
4	FLUID ALLOCATION			SHELL SIDE			TUBE SIDE		
5	FLUID NAME								
6	FLUID QUANTITY . TOTAL						kg/s		
7	VAPOR (IN / OUT)								
8	LIQUID								
9	STEAM								
10	WATER								
11	NON CONDENSATE								
12	TEMPERATURE ( IN / OUT ) ° C								
13	DENSITY						kg/cu.m		
14	VISCOSITY . LIQUID cP								
15	MOLECULAR WEIGHT . LIQUID								
16	SPECIFIC HEAT . LIQUID						J/kg ° C		
17	VISCOSITY . VAPOR cP								
18	MOLECULAR WEIGHT . VAPOR								
19	SPECIFIC HEAT . VAPOR						J/kg ° C		
20	THERMAL COND. LIQ./VAP. W/m ° C								
21	LATENT HEAT kJ/kg @ ° C								
22	INLET PRESS. kPa (ab)								
23	VELOCITY m/s								
24	PRESS. DROP ALLOW / CALC kPa								
25	FOULING RESISTANCE ( MINIMUM )								
26	TRANSFER RATE (W/m <sup>2</sup> ° C)		(SERVICE)		(DIRTY)		(CLEAN)		
27	HEAT EXCHANGED kW		MTD		° C (CORRECTED)		° C (UNCORRECTED)		
28	CONSTRUCTION OF ONE SHELL				SKETCH ( BUNDLE / NOZZLE ORIENTATION )				
29				SHELL SIDE		TUBE SIDE			
30	DESIGN / TEST PRESS. kPag		1724		3792				
31	DESIGN TEMP ° C		204/-28.8		204/-28.8				
32	NO. OF PASSES PER SHELL								
33	CORROSION ALLOWANCE mm		1.59		1.59				
34	CONNECTIONS :		IN		48-3000#		48-BEVELLED PIPE		
35	QUANTITY , SIZE		OUT		48-3000#		48-BEVELLED PIPE		
36	RATING & FACE INTERMEDIATE								
37	TUBE NO		1		TUBE OUTSIDE DIA (OD) mm		48mm OD PIPE		
38	TUBE TYPE		PLAIN		TUBE LENGTH m		5.699		
39	SHELL ( ID / OD ) (mm/mm)		78.02/89		SHELL MATERIAL		SA-106B		
40	CHANNEL or BONNET		WELD CAP		CHANNEL COVER MATERIAL				
41	STATIONARY TUBESHEET				FLOATING TUBESHEET				
42	FLOAT HEAD COVER				IMPINGMENT PROTECTION		NONE		
43	BAFFLES - CROSS				TYPE		PAINT SYSTEM		
44	BAFFLES - LONG				SEAL TYPE		NONE		
45	SUPPORT TUBE				U BEND		TYPE		
46	SOUR SERVICE				BYPASS SEAL ARRANGEMENT		TUBE - TUBESHEET JOINT		
47	EXPANSION JOINT				TYPE		X-RAY		
48	ρ · V <sup>2</sup> INLET NOZZLE				ρ · V <sup>2</sup> BUNDLE IN / OUT		STRESS RELIEF		
49	GASKET - SHELL				GASKET - TUBE		GASKET - FLOAT HEAD		
50	CODE REQUIREMENT		B31.3		STAMP REQUIRED		YES		
51	WEIGHT PER SHELL kg		145		SHELL WT WITH WATER kg		BUNDLE WEIGHT kg		
52									
53									
54									
55									
56	REMARKS:								
57									
58									

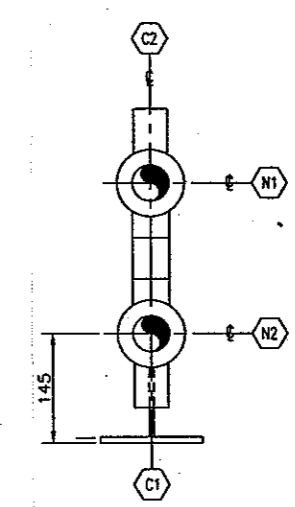


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NOZZLE SCHEDULE								
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD	
N1	1 1/2 NPS	300#	RFWN	XH	TUBESIDE INLET	-	SPEC	-
N2	1 1/2 NPS	300#	RFWN	XH	TUBESIDE OUTLET	-	SPEC	-
C1	1 1/2 NPS	3000#	CPLG	-	SHELLSIDE INLET	-	-	-
C2	1 1/2 NPS	3000#	CPLG	-	SHELLSIDE OUTLET	-	-	-



**ELEVATION**  
SCALE 1:5



**VIEW 'A-A'**  
SCALE 1:5

<b>SERVICE:</b> HYDROCARBONS  <b>CAPACITY:</b> 0.03 m <sup>3</sup>  <b>WEIGHT EMPTY:</b> 145 kg  <b>WEIGHT FULL OF WATER:</b> 175 kg  <b>PAINT SPEC:</b> PNT-12  <b>INSULATION:</b> 25 THK CALCIUM SILICATE C/W ALUMINUM CLADDING  <b>SHIP LOOSE:</b> NO	<b>SERIAL NO:</b> 054468-104 <b>YEAR BUILT:</b> 2005 <b>LSD #:</b> - <b>CODE:</b> ASME SECT. B31.3 '99 , ADDENDA '01 <b>CRN:</b> N/A																																							
	<table border="1"> <thead> <tr> <th></th> <th>SHELLSIDE</th> <th>TUBESIDE</th> </tr> </thead> <tbody> <tr> <td><b>DESIGN PRESSURE</b></td> <td>3792 kPag</td> <td>8963 kPag</td> </tr> <tr> <td colspan="3">NOTE: DES. PRESS. IS MAWP</td> </tr> <tr> <td><b>DESIGN TEMP.</b></td> <td>204 °C</td> <td>204 °C</td> </tr> <tr> <td><b>M.D.M.T.</b></td> <td>-28.8 °C @ 3792 kPag</td> <td>-28.8 °C @ 8963 kPag</td> </tr> <tr> <td><b>HYDROTEST PRESSURE</b></td> <td>5688 kPag</td> <td>13445 kPag</td> </tr> <tr> <td><b>MATERIAL:</b></td> <td>HEAD: SA-234-WPB</td> <td>N/A</td> </tr> <tr> <td></td> <td>SHELL: SA-106-B SMLS</td> <td>SA-106-B SMLS</td> </tr> <tr> <td><b>RADIOGRAPHY:</b></td> <td>LONG</td> <td>-</td> </tr> <tr> <td></td> <td>CIRC.</td> <td>10%</td> </tr> <tr> <td><b>P.W.H.T.</b></td> <td>NO</td> <td>NO</td> </tr> <tr> <td><b>MIN TEMP / TIME</b></td> <td></td> <td></td> </tr> <tr> <td><b>CORR. ALLOWANCE</b></td> <td>1.59 mm</td> <td>1.59 mm</td> </tr> </tbody> </table>		SHELLSIDE	TUBESIDE	<b>DESIGN PRESSURE</b>	3792 kPag	8963 kPag	NOTE: DES. PRESS. IS MAWP			<b>DESIGN TEMP.</b>	204 °C	204 °C	<b>M.D.M.T.</b>	-28.8 °C @ 3792 kPag	-28.8 °C @ 8963 kPag	<b>HYDROTEST PRESSURE</b>	5688 kPag	13445 kPag	<b>MATERIAL:</b>	HEAD: SA-234-WPB	N/A		SHELL: SA-106-B SMLS	SA-106-B SMLS	<b>RADIOGRAPHY:</b>	LONG	-		CIRC.	10%	<b>P.W.H.T.</b>	NO	NO	<b>MIN TEMP / TIME</b>			<b>CORR. ALLOWANCE</b>	1.59 mm	1.59 mm
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<b>CORR. ALLOWANCE</b>	1.59 mm	1.59 mm																																						
<b>TAG NO: E-625</b>																																								

APPROVED		DRAWN	
MECH/STRUCT.	BY	BY	DATE
DATE	DATE	DATE	DATE
ELECTRICAL	BY	CHECKED	DATE
DATE	DATE	DATE	DATE
PROJECT	DATE	DATE	DATE
DATE	DATE	DATE	DATE

<b>GENERAL NOTES</b> No. ISSUED FOR DOCUMENTATION		<b>GENERAL NOTES</b> No.		A. LOW 05/09/30 VK MZ BY DATE CKD ENG	FORT ENERGY CORP. 88 REFRIGERATION UNIT FEED/BOTTOMS EXCHANGER (E-625) 48" O/D x 89" O/D x 304B LG (2 PASS) DWG. No.: D-EXC-054468-104-SKT SHT. 1 OF 1 REV. SKT	<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3
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# Operating Instructions Peacock Model 3000L-2

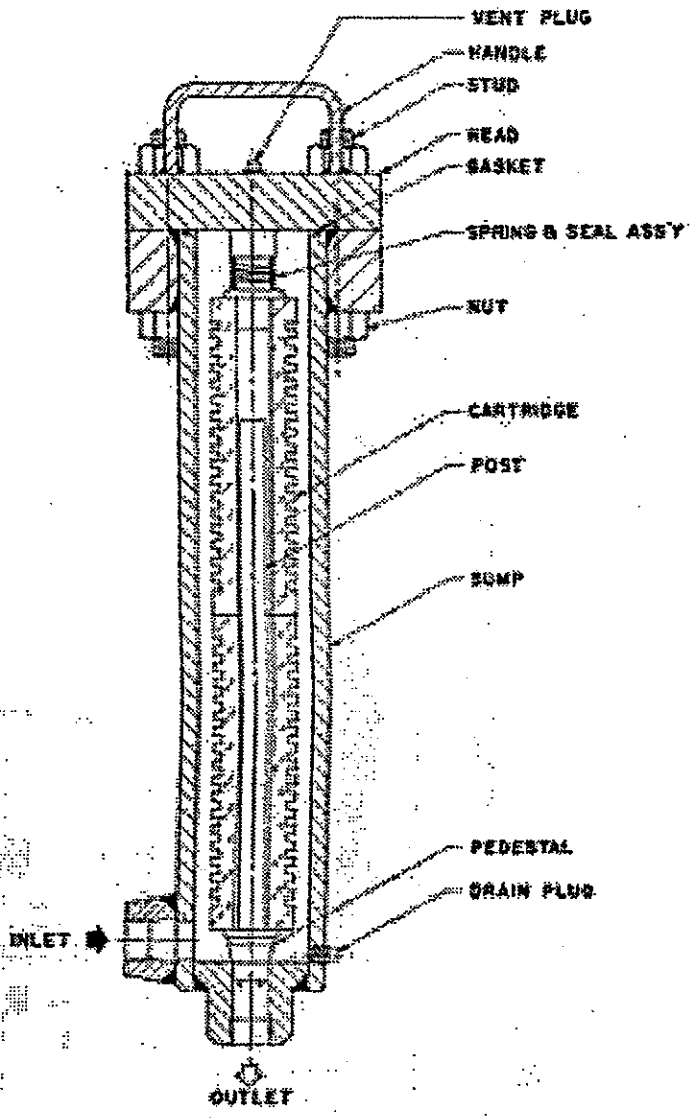
**NOTE:** Filter housings are normally shipped without cartridges. Before putting filter in service, be certain that the proper filter cartridges are installed.

**Housing Installation**

Install filter vertically as close to the equipment requiring protection as is practically possible. Inlet opening is located on the side of the unit, and outlet at the bottom of the unit. **DO NOT** install filter backwards. Due to significant weight of the housing, clamp supports are strongly recommended.

**Filter Cartridge Installation and Replacement**

- A. Relieve pressure in the housing:
  1. If the outlet line can be opened to atmospheric pressure - shut off the inlet line and open the outlet line.
  2. If the outlet line must remain pressurized - shut off the upstream and downstream isolation valves and bleed-off pressure through the vent opening on the top of the unit.
- B. Remove drain plug, drain filter of liquid, then unscrew head nuts and remove cover.
- C. (Cartridge replacement only): Remove spring and seal assembly. Remove old cartridges by lifting them off the post. If post is to be removed, a slight pull near its lower end will free it from the cartridge pedestal. Clean filter housing thoroughly, replacing gasket if necessary.
- D. Install new cartridges by placing post (if removed) into pedestal and slide the new cartridges over it. Re-install spring and seal assembly.
- E. Install the head, making sure that the gasket and cartridges are positioned properly. Tighten the bolts and install vent and drain plugs.



**Replacement Part Identification**

Description	Material	Part No.
Head Gasket	O-Ring Buna	P23901
Cartridge Post	304 st. st.	65541-32
Spring & Seal Ass'y	304 st. st.	63437-02

Specifications subject to change without notice.

**Starting Operation**

Slowly open inlet valves to fill filter and check for leaks. Bleed air through vent opening on top of the unit. Slowly open outlet valve. The filter is now in operation.

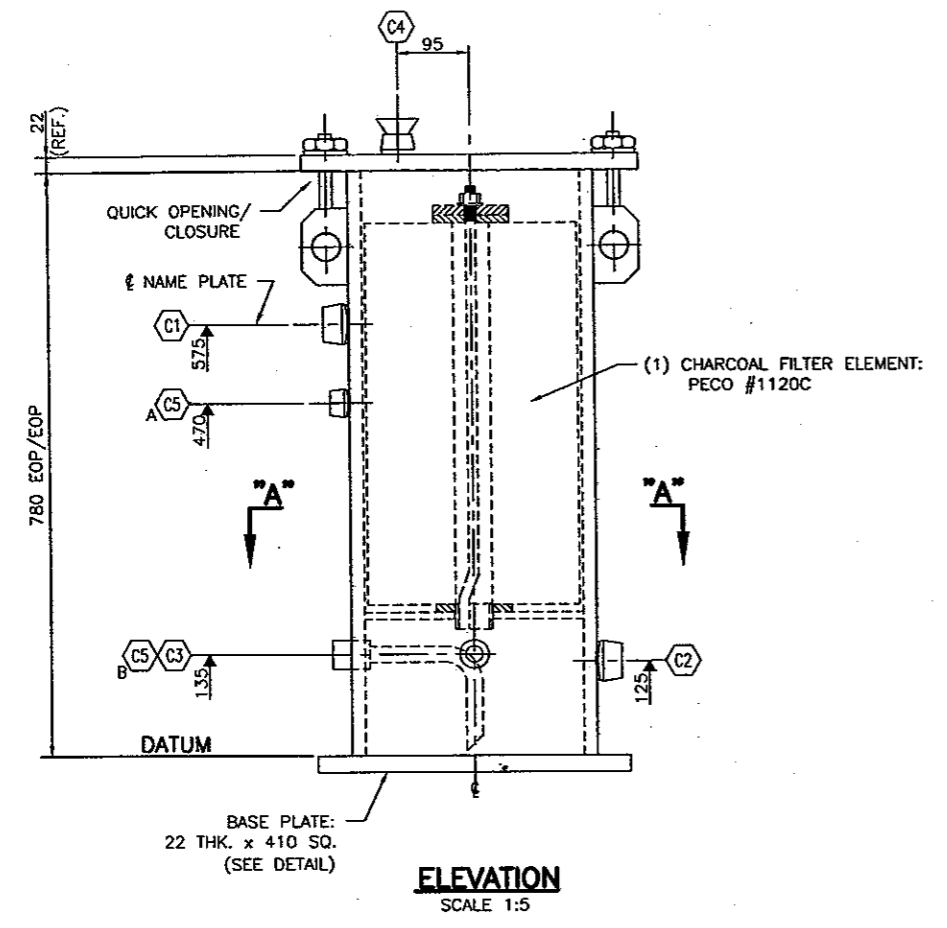


<p><b>HALIFAX</b> 7300 Victoria Rd., Box 9, Dartmouth, Nova Scotia B3B 1C7 Tel: (902) 488-1550 Fax: (902) 488-1661</p>	<p><b>EDMONTON</b> C37 88th Street, Edmonton, Alberta T6E 5R2 Tel: (403) 431-1122 Fax: (403) 435-0438</p>	<p><b>VANCOUVER</b> 2325 Bayview Street, Vancouver, B.C. V6J 3Z2 Tel: (604) 731-2545 Fax: (604) 731-6138</p>	<p><b>MONTREAL</b> The 1340, Suite A Montreal, Quebec H3C 2Z5 Tel: (514) 886-8880 Telex: 065 6221 Fax: (514) 355-4927</p>	<p><b>TORONTO</b> 1100 Adelaide Drive Mississauga, Ontario L4V 1P6 Tel: (416) 676-7100 Fax: (416) 676-7229</p>	<p><b>CALGARY</b> 1715 18th Street N.E., Calgary, Alberta T2E 7E8 Tel: (403) 250-7033 Fax: (403) 250-6825</p>	<p><b>BUFFALO, N.Y.</b> Filter Cartridge Equipment Division 540 North Road East Aurora, N.Y. 14202 U.S.A. Tel: (716) 652-7000 Fax: (716) 652-0545</p>
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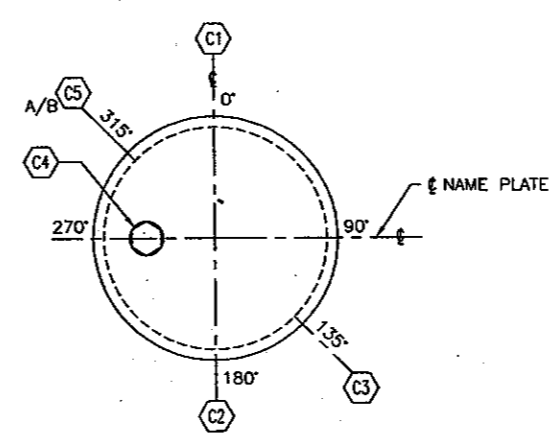
PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : GLYCOL CARBON FILTER									
JOB NO. : XXXXXX TAG NO: F-602									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106B	N1					
3	HEADS		SA-516-70	N2					
4	SKIRTS			N3					
5	SADDLES			N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES			N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS		SA-193-B7	N9					
11	NUTS		SA-194-2H	N10					
12	GASKETS			N11					
13	COIL			N12					
14	RISER								
15	PACKING SUPPORT			C1	GLYCOL INLET	33	3000#	TOL	
16	TRAY SUPPORTS			C2	GLYCOL OUTLET	33	3000#	TOL	
17	BAFFLES			C3	DRAIN	21	3000#	TOL	
18	INLET BAFFLE			C4	VENT W/PLUG	27	3000#	TOL	
19	VORTEX BREAKER			C5AB	DPI	21	3000#	TOL	
20	SYPHON DRAIN			C6					
21	DEMISTER			C7					
22	DISTRIB. SPIDER			C8					
23	PACKING			C9					
24	TRAYS			C10					
25	PLATFORM			C11					
26	LADDER			C12					
27	DAVIT								
28	INSULATION RINGS			M1					
29	LIFTING LUGS			M2					
30	PIPE CLIPS								
31	PIPE SUPPORTS				SKIRT VENTS				
32					SKIRT ACCESS				
33									
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD: (mm)	324	NOTES: 1) C/W ONE(1) PECO 1120C CANISTER				
37	S/S (mm)	780							
38	DES PRESS (kPa)	1000	OPER. PRESS (kPa)	135					
39	DES TEMP ° C	93	OPER. TEMP ° C	54					
40	HYDROTEST	1500	CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	NONE					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC- SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	GREY					
50									
51	WEIGHT EMPTY ((kg)	209	HYDRO WEIGHT (kg)	260					
52	LSD								
53									
54									
55									
56									
57									

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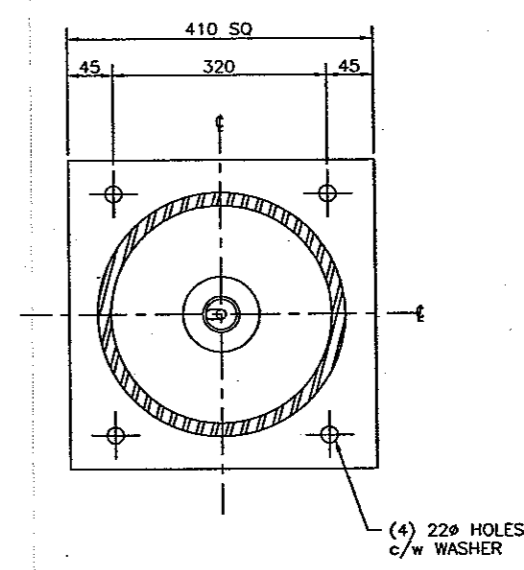
NOZZLE SCHEDULE						
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ WELD
C1	1 NPS	3000#	TOL	-	INLET	-
C2	1 NPS	3000#	TOL	-	OUTLET	-
C3	1/2 NPS	3000#	CPLG	-	DRAIN	-
C4	3/4 NPS	3000#	TOL	-	VENT w/ PLUG	-
C5	1/2 NPS	3000#	TOL	-	DPI	-



**ELEVATION**  
SCALE 1:5



**ORIENTATION**  
SCALE 1:5



**SECTION 'A-A'**  
SCALE 1:5

SERVICE: GLYCOL LOADINGS PER UG 22(e) CONSIDERED GOVERNS: NO PRODUCTION IMPACT TEST REQ'D: NO IMPACT TESTING: NO-- PER UG20(f)(1-5) CAPACITY: 0.051 m <sup>3</sup> WEIGHT EMPTY: 209 kg WEIGHT FULL OF WATER: 260 kg PAINT SPEC: PNT-11 INSULATION: NONE SHIP LOOSE: NO	SERIAL NO: 054468-114    CRN: P0718.123 YEAR BUILT: 2005 LSD #: - CODE: ASME SECT. VIII DIV I, '01, ADDENDA '03
DESIGN PRESSURE: 1000 kPag NOTE: DES. PRESS. IS MAWP DESIGN TEMPERATURE: 93.3°C M.D.M.T.: -28.8°C @ 1000 kPag HYDROTEST PRESSURE: 1300 kPag MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B SMLS RADIOGRAPHY: LONG: N/A CIRC: N/A P.W.H.T. NO MIN TEMP / TIME N/A CORR. ALLOWANCE: 1.59mm	TAG NO: F-602

APPROVED MECH/STRUCT. BY DATE ELECTRICAL BY DATE PROJECT BY DATE DATE		DRAWN CHECKED DATE		FORT ENERGY CORP. 88 REFRIGERATION UNIT CARBON FILTER (F-602) 324 O/D x 780 S/S		DWG. No.: D-FLT-054468-114-SKT SHT. 1 OF 1 REV. SKT	
GENERAL NOTES		GENERAL NOTES		SKT ISSUED FOR DOCUMENTATION		K. LU 05/09/30 VK MZ BY DATE CKD ENG	
DATE: 2005/09/30 10:07 AM J:\JOBS\054468\20-DRAWINGS\FAB\MISC\FLT-054468-114-SKT-01.DWG hmeng		REVISION		REVISION		REVISION	

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3



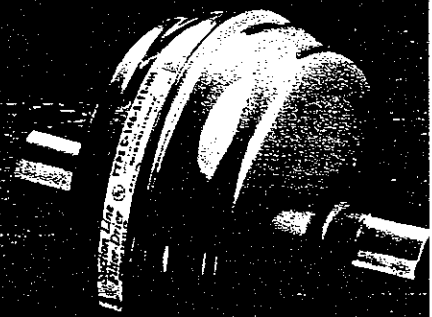
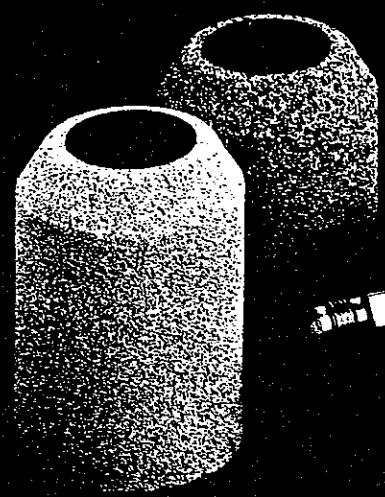
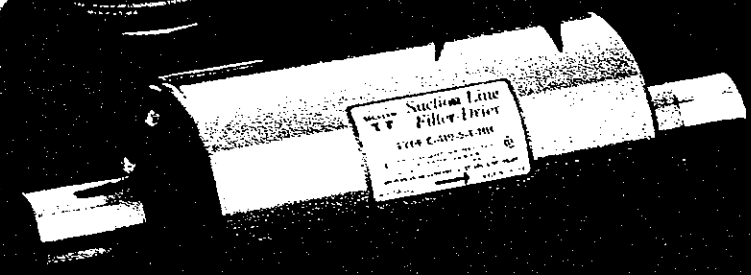
# Catch-All®

## LIQUID LINE and SUCTION LINE FILTER-DRIERS

plus AK-1 and AK-3  
ACID TEST KITS



Compatible  
with  
Refrigerants  
123, 124, 125, 134a,  
401A & B, 402A & B,  
404A, 507




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FOR USE ON REFRIGERATION and/or AIR CONDITIONING SYSTEMS ONLY


## WHY CHEMICAL BREAKDOWN OCCURS



**MOISTURE** — Water or moisture is always present in refrigeration systems. Acceptable limits vary from one unit to another and from one refrigerant to another. Moisture is harmful even if “freeze-ups” do not occur. Moisture is an important factor in the formation of acids, sludge, copper plating, and corrosion. To be **safe** and **sure**, keep the moisture level as low as possible.




**DIRT** — Dirt, oxide scale, sludges, flux, and metallic particles are frequently found in refrigeration systems. Numerous metallic contaminants — cast iron dust, rust, scale, plus steel, copper, and brass chips — can damage cylinder walls, bearings, and plug capillary tubes or thermostatic expansion valve screens. In addition to mechanical damage and “plug-ups,” these contaminants catalyze chemical reactions that contribute to decomposition of the refrigerant-oil mixture at elevated temperatures.



**ACIDS** — Refrigerants by themselves are very stable, even when heated to a high temperature. However under some conditions, reactions do occur which can result in the formation of acids. For example, at elevated temperatures, Refrigerant 12 will react with the oil to form hydrochloric and hydrofluoric acids. These acids are usually present as a gas in the system and are highly corrosive. Refrigerant 22 will decompose at high temperatures to form hydrochloric acid where an “acid acceptor” such as electrical insulation paper is present. The reaction of refrigerants with water may cause hydrolysis and the formation of hydrochloric and hydrofluoric acids. In ordinary usage this reaction is negligible, but in a very wet system operating at abnormally high temperatures, some hydrolysis may occur.

All of these reactions are increased by elevated temperature and are catalytic in effect, resulting in formation of corrosive compounds.

Another significant source of acidity in refrigeration systems is the organic acid formed from oil breakdown. Appreciable amounts of **organic acid** are found in the majority of oil samples analyzed in our laboratory. These acids will also corrode the metals in a system, and therefore they must be removed.



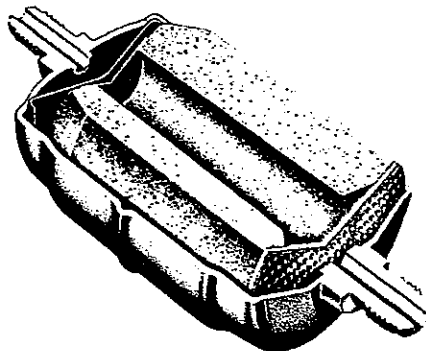
**SLUDGE and VARNISH** — Although the utmost precaution may be taken in the design and fabrication of a system, once in operation, unusually high discharge temperatures will cause the oil to break down, and form sludges and varnish.

Temperatures may vary in different makes of compressors and under different operating conditions. While temperatures of 265°F. are not unusual at the discharge valve under normal operation, temperatures well above 300°F. frequently occur under unusual conditions. Common sources of high temperatures in refrigeration systems are dirty condensers, non-condensable gases in the condenser, high compression ratio, high superheat of suction gas returned to compressor, fan failure on forced convection condensers, and others.

In addition to high discharge temperatures, there are certain **catalytic metals** that contribute to the oil-refrigerant mixture breakdown. The most noted of these in a refrigeration system is iron. It is used in one form or another in all systems and is an active catalyst. Copper is in the same category as iron, but its action is slower. However, the end result is the same. This reaction causes sludges and other corrosive materials that will hinder the normal operation of compressor valves and control devices. In addition, air in a system will accelerate the deterioration of the oil.



The famous molded porous core of the Catch-All Filter-Drier performs these vital functions:



**REMOVES MOISTURE** — The *Catch-All Filter-Drier* removes moisture from the refrigerant and oil by adsorbing and retaining any moisture deep within the desiccant granules. The blend of desiccants used in the *Catch-All Filter-Drier* is specially formulated for maximum moisture removal. The capacity tables on pages 6, 8, & 9 show the water capacity of the *Catch-All Filter-Drier* at the ARI standard rating conditions, which are normal liquid line conditions. The high degree of activation insures maximum water capacity and means that the core removes a large amount of water in one pass, thereby protecting the expansion valve from freezeup. Since the refrigerant must flow through the core, maximum contact between the two is assured, thus giving rapid drying.

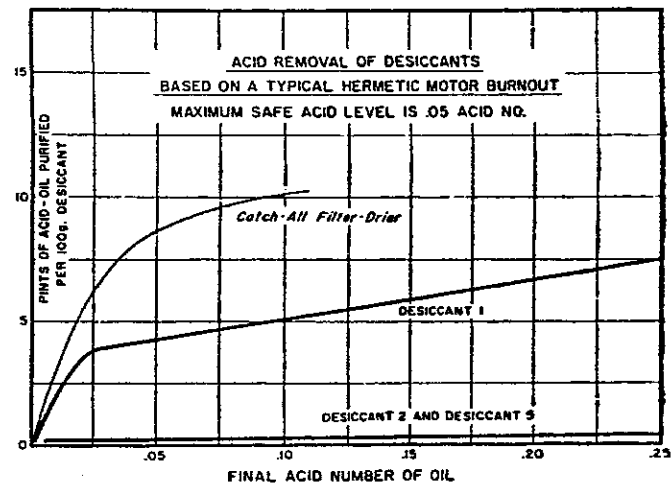
**REMOVES FOREIGN MATTER** — Scale, solder particles, dirt, and all types of foreign substances must be removed to protect the compressor, solenoid valves, expansion valves, capillary tubes, and other close tolerance parts of a refrigeration system. The ultra-fine smoke like particles sometimes found in a system seldom cause difficulty because they are so small they will pass through the small clearances. Large particles of solder or scale are easily removed. It is the intermediate size particles of metal powder, carbon, sludge, and fine copper oxide that are the most difficult to remove. These particles will go through an ordinary strainer. The solution to this problem is thorough filtration, instead of mere straining. The *Catch-All Filter-Drier* has been designed to do this job with maximum efficiency. It removes these particles, down to the minimum size, in one pass filtration. Furthermore the large filtering surface available on the core results in the ability to collect a large amount of dirt with negligible pressure drop. The *Catch-All Filter-Drier* will not burst if plugged, as strainers fre-

quently do, allowing the trapped substances back into the system. In many instances the cost of a *Catch-All Filter-Drier* is less than an ordinary strainer.

**REMOVES ACIDS** — The *Catch-All Filter-Drier* is unexcelled in acid removal ability. The hydrochloric, hydrofluoric, and various organic acids found in used oil samples can produce harmful corrosive effects on the system. These acids are adsorbed and held on the desiccant in a manner similar to the adsorption of moisture.

Laboratory tests have shown that the *Catch-All Filter-Drier's* desiccant has an acid removal ability superior to any of the desiccants used in other refrigeration driers. These tests show that the desiccant used in the *Catch-All Filter-Drier* removes over 10 times as much acid as the desiccant used in most driers, and over twice the amount of acid removed by the next best desiccant. These results are on an equal weight basis. Since the *Catch-All Filter-Drier* contains a greater weight of desiccant than most other driers, the acid removal ability is just that much more.

The *Catch-All Filter-Drier* has also given excellent field performance in cleaning up severely contaminated systems, whether due to acid, oil breakdown, or to hermetic motor burnout. Its success in field service work and in protecting new systems is largely due to its outstanding ability to remove acid and the products of oil breakdown.



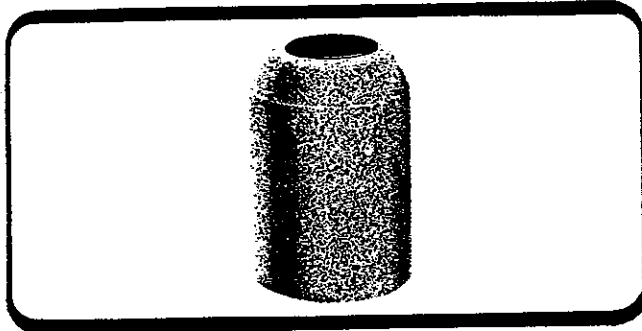
**REMOVES SLUDGE and VARNISH** — Even the best refrigeration oils frequently break down to produce varnish sludge, and organic acids. These products of oil decomposition are called "oleoresin" and are formed due to excessive heat or air in the system. This varnish will plug small orifices and build up on the compressor valves causing eventual valve failure.

The ability of various desiccants to remove these products of oil decomposition has been evaluated in sealed glass tubes. Of all the desiccants tested only the *Catch-All Filter-Drier* proved capable of removing the products of oil breakdown. It is this ability that makes the *Catch-All Filter-Drier* highly effective in cleaning up systems that have had a hermetic motor burnout, and in protecting new systems by preventing a build up of these oil breakdown products.

## THE INSIDE STORY OF THE

# Catch-All®

The famous molded porous core of the Catch-All Filter-Drier provides these proven benefits:

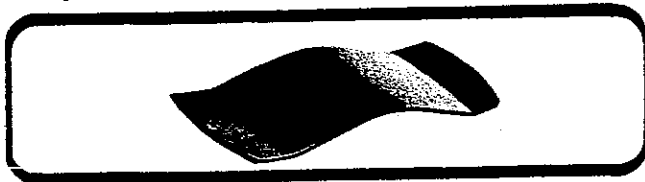


**BLEND OF DESICCANTS** — Thru constant engineering research Sporlan has developed a blend of desiccants that gives the core maximum contaminant removal characteristics. A special grade of activated alumina granules is used to obtain the maximum ability to remove acids and the products of oil breakdown. Additional water capacity is obtained by using a portion of molecular sieve 4A. The overall result is balanced contaminant removal ability.

**SPECIAL CHARCOAL BLEND** — Sporlan offers the "HH" style core which permits the user to select a core designed for the specific application involved. The HH core, which incorporates activated charcoal along with other desiccants, will remove wax, resins, and oil breakdown materials that the normal desiccants do not remove. Therefore this type of core is especially useful on low temperature Refrigerant 22 and 502 supermarket systems where wax problems can cause considerable trouble.

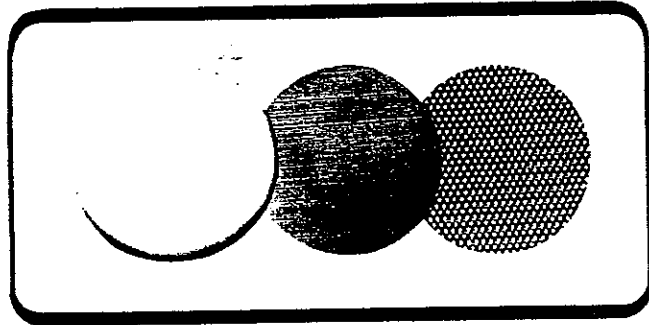
This HH style core has also found wide application for clean-up after a hermetic motor burnout where its ability to remove all types of contaminants is very advantageous. **BE SELECTIVE!** Choose a core designed for the specific application involved.

**UNIFORM MOLDING** — Sporlan pioneered the molded porous core. The core is carefully molded to assure a uniform porosity throughout the entire length and surface of the core. The granules of desiccant are carefully sized and controlled to obtain the proper porosity for maximum filtration ability.



**SHOCKPROOF ASSEMBLY** — The core is held in place by a heavy leaf spring at the inlet end of the Catch-All assembly. This spring holds the core in position and makes the assembly highly resistant to core breakage. The heavy spring gives a "pre-stressed effect" which significantly reduces the tendency of the core to break if the Catch-All is accidentally dropped.

**NO BYPASSING** — The core is sealed to the shell wall at the outlet end with a gasket or fiberglass pad, which prevents any possible bypassing of refrigerant around the core. All the flow passes thru the core for maximum contaminant removal.



**OUTLET SAFETY FILTER** — A final "safety filter" is used in the outlet of every Catch-All. This 100 mesh screen collects any stray core particles that might be rubbed off during assembly, and also serves as a protective safety device in case the molded core is broken.

**LEAKPROOF SHELL** — The Catch-All shell is welded by the heliarc method which gives a very smooth, strong, entirely leakproof joint. The fittings are attached to the shell by copper brazing. This type of joint is one of the strongest and most reliable joining methods known. Each Catch-All is pressure tested in our factory to make sure that it does not leak. The overall result is a Catch-All with strong, entirely leakproof joints.



**QUALITY FITTINGS** — The flare fittings and sweat fittings used on sealed model Sporlan Catch-Alls are inspected 100% during manufacture to make sure no defects are present. The sweat fittings are copper fittings with reliable ID dimension for exact fit to the copper tubing. The flare surfaces are smooth and free of scratches. Any imperfect flare fittings are resurfaced during manufacture.

**BE SELECTIVE** — In addition to being manufactured to high quality standards, the Catch-All has been designed specifically for field service work and OEM use. In situations requiring wax removal or clean-up after a hermetic motor burnout, you can be further selective by choosing the HH style Catch-All core which is specifically designed for these applications.





U.S. PATENT NUMBER 3,407,617

## LIQUID LINE RATINGS and SELECTION RECOMMENDATIONS

### GENERAL

The selection of a filter-drier for a given application involves such technical factors as: the amount of moisture to be expected in a system — operating temperatures — amount of foreign matter present — allowable pressure drop through the filter-drier — its ability to retain both liquid and solid contaminants, and bursting pressure. Proper evaluation of these factors is necessary for optimum service and economy.

The refrigeration industry has developed a standard for the comparison of filter-driers. However, only two ratings have been published — one for water capacity and one for flow capacity. Until ratings for filtration characteristics, acid removal and other important qualities are established, manufacturers of filter-driers should provide their own test evaluation data and recommendations for various applications. Nevertheless, those who design and service refrigeration systems must make the final choice. As an aid to them, the important factors to be considered for selection purposes are discussed briefly in the following sections.

### STANDARD RATINGS ASHRAE-ARI

The American Society of Heating, Refrigerating and Air Conditioning Engineers Standard 63, "Methods of Testing Liquid Line Refrigerant Driers," sets up a test procedure to follow for determining the water capacity and refrigerant flow capacity under certain conditions. The Air Conditioning and Refrigeration Institute subsequently issued ARI Standard 710, which specifies the rating conditions for water capacity, refrigerant flow capacity, and safety requirements.

This Standard is intended to provide **comparison points only**. It is a basis for drier evaluation at the specified rating conditions, but does not attempt to govern the performance of a drier over the entire range of possible applications. It serves only to compare driers on their ratings for water capacity, refrigerant flow capacity, and safety requirements.

**WATER CAPACITY** — is the amount of water (in drops or grams) that a drier will hold at the standard temperatures and equilibrium point dryness (EPD) specified. Twenty drops equal one gram, equal one milliliter or one cubic centimeter.

**Equilibrium Point Dryness (EPD)** — is used to define the lowest possible water content of a liquid refrigerant attainable by a specific drier at a specific temperature after it has collected a specific quantity of water, when the two have been in contact until an equilibrium between the water in the refrigerant and the water in the drier has been reached. Equilibrium point dryness is expressed in parts per million (ppm) by weight.

**REFRIGERANT FLOW CAPACITY** — is the maximum flow of liquid refrigerant (in tons) that a drier will pass at a 1 psi pressure drop. The "ton" ratings are based on 86°F. liquid temperature and refrigerant flows of . . .

- 4.0 lbs. per minute per ton for Refrigerant 12
- 3.1 lbs. per minute per ton for Refrigerant 134a
- 2.9 lbs. per minute per ton for Refrigerant 22
- 4.4 lbs. per minute per ton for Refrigerant 502

**SAFETY** — is based on drier shell bursting pressure. All liquid line driers manufactured under ARI Standard 710 must meet the requirements of Underwriters' Laboratories, Inc., Standard 207, "Refrigerant Containing Components and Accessories, Nonelectrical."

### SELECTION

When selecting a filter-drier the following should be considered:

**WATER CAPACITY and REFRIGERANT FLOW** — comparisons can be made on the basis of ARI Standard data supplied by the manufacturer. **However, it should be remembered that flow ratings are based on the idea of a completely clean system.** Flow is reduced as dirt accumulates on the filtering surface.

**FILTRATION** — Characteristics of a drier are not readily defined or evaluated since a standard does not exist. The ability to filter and **hold** foreign matter varies with the brand and type of drier. Until standards are developed, the simplest guide to follow is that filter capacity is proportional to **filtering area**. In the tables that follow, the filtering areas of all Catch-All Filter-Driers are tabulated. Filters should be selected with an adequate reserve capacity to allow for the contamination found in most systems.

**ACID REMOVAL** — is also difficult to measure. There are no standard ratings to follow. However, both laboratory and field tests have demonstrated that the **Catch-All** core has far superior acid removal ability — many times that available in other driers.

### SPORLAN RECOMMENDATIONS

Sporlan's **Selection Recommendations** are based on the technical data currently available and more than forty years of **field experience** with molded porous core filter-driers. Satisfactory results will be obtained with the sizes recommended for all normal refrigeration systems. We have considered the difference in requirements for air conditioning and refrigeration applications. Recommendations for these categories are made on pages 6, 7, 8, and 9. Recommendations for suction line use of filter-driers are given on pages 11 and 22, and a quick reference guide to suction line use is available as Form 40-109.

**Drier manufacturers establish ratings for their product, but . . . the final selection of the correct drier should be based on the conditions expected for each job.** Consideration should be given to providing extra water capacity and filtering area within economical limits.



# LIQUID LINE RATINGS and SELECTION RECOMMENDATIONS

## REFRIGERANT 12

TYPE	SURFACE FILTERING AREA Sq. In.	RATINGS AT ARI STANDARD CONDITIONS		REFRIGERANT FLOW CAPACITY Tons at 2 psi	SELECTION RECOMMENDATIONS (Tons)		
		WATER CAPACITY DROPS AT 15 PPM			REFRIGERATION Commercial & Low Temperature Equipment	AIR CONDITIONING	
		75°F	125°F			O. E. M. Self Contained	Field Replacement or Field Build Up Systems

### SEALED TYPES

C-032	9	39	33	1.6	1/4	3/4	1/2							
C-032-CAP														
C-032-S														
C-032-F														
C-032-FM														
C-033	15	85	74	3.8	1/3	1	3/4							
C-033-S				4.2										
C-052				2.3										
C-052-S				3.2										
C-0525-S				4.6										
C-053	15	85	74	5.3	1/3	2	1							
C-053-S														
C-082				2.3										
C-082-S				21				133	115	3.3	3/4	2	1 1/2	
C-0825-S														
C-083	21	133	115	4.9	1	3	2							
C-083-S				5.8										
C-084				9.1										
C-084-S				10.4										
C-162				2.3										
C-1625-S	33	244	181	3.3	1	2	1							
C-163	4.9													
C-163-S	5.8													
C-164	33	244	181	10.9										
C-164-S	12.0													
C-165	2	7 1/2	5	14.8	2	4	3							
C-165-S	16.9													
C-303	53	465	401	5.0										
C-304	53	465	401	10.9				3	4	3				
C-304-S	12.0													
C-305	53	465	401	16.0	4	10	7 1/2							
C-305-S	18.2	53	465	401	23.4	5	15	7 1/2						
C-307-S	23.4													
C-414	67								605	525	12.5	5	7 1/2	5
C-414-S	13.6													
C-415	67								605	525	17.0			
C-415-S	18.6													
C-417-S	67	605	525	23.8	10	15	10							
C-419-S	67	605	525	26.0	10	18	12							
C-607-S	106	930	802	30.7	15	20	15							
C-609-S				34.6										

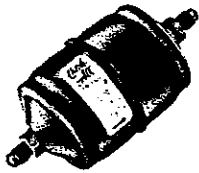
### REPLACEABLE CORE TYPES WITH HIGH CAPACITY CORES (RCW-48)

C-485	64	828	470	15.2	7 1/2	10	7 1/2			
C-487				25.5	12	15	12			
C-489-G				46.1	12	25	15			
C-967				128	1656	940	41.8	20	30	20
C-969				51.9	25	35	25			
C-1449	192	2484	1410	62.5	30	40	30			
C-14411				72.1	40	50	40			
C-19211				91.6	50	60	50			
C-19213				106	60	80	60			
C-19213-G				256	3312	1880	111	65	80	65

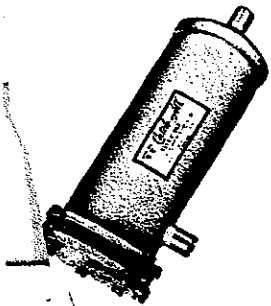
### REPLACEABLE CORE TYPES WITH STANDARD CORES (See Page 14)

C-R424	67	566	490	12.4	3	5	5			
C-R425				15.2	5	10	7 1/2			
C-R427				19.6						
C-485				15.2	7 1/2	10	7 1/2			
C-487				64	590	329	25.5	12	15	12
C-489-G	128	1180	658	46.1	12	25	15			
C-967				41.8	20	20	20			
C-969				51.9	25	30	25			
C-1449				62.5	30	40	30			
C-14411				72.1	40	50	40			
C-19211	192	1770	987	91.6	50	60	50			
C-19213				106	60	80	60			
C-19213-G				256	2360	1316	111	65	80	65
C-30013				294	4500	2139	120	75	100	75
C-40017				392	6000	2852	155	110	130	110

NOTE: The variation in flow ratings of filter-driers having the same size core and shell is caused by the difference in connection sizes used.



For Suction Line  
filter-driers  
See Page 22



*Catch-All*

**LIQUID LINE RATINGS and SELECTION RECOMMENDATIONS**

**REFRIGERANT 134a**

TYPE	SURFACE FILTERING AREA Sq. In.	RATINGS AT ARI STANDARD CONDITIONS		REFRIGERANT FLOW CAPACITY Tons at 2 psi	SELECTION RECOMMENDATIONS (Tons)		
		WATER CAPACITY DROPS AT 80 PPM			REFRIGERATION Commercial & Low Temperature Equipment	AIR CONDITIONING	
		75°F	125°F			O.E.M. Self Contained	Field Replacement or Field Build Up Systems

**SEALED TYPES**

C-032	9	33	28	1.9	1/4	3/4	1/2
C-032-CAP							
C-032-S							
C-032-F							
C-032-FM							
C-033	15	69	58	2.7	1/3	1	3/4
C-033-S							
C-052							
C-052-S	15	69	58	2.7	1/3	2	1
C-0525-S							
C-053							
C-053-S							
C-082	21	114	96	2.7	1/2	1	3/4
C-082-S							
C-0825-S							
C-083	21	114	96	2.7	3/4	2	1 1/2
C-083-S							
C-084							
C-084-S	21	114	96	2.7	1 1/2	4	2
C-162							
C-1625-S							
C-163	33	194	167	2.7	1	2	1
C-163-S							
C-163							
C-163-S	33	194	167	2.7	2	4	3
C-164							
C-164-S							
C-165	33	194	167	2.7	2	7 1/2	5
C-165-S							
C-303							
C-303	53	360	288	6.0	3	4	3
C-304							
C-304-S							
C-305	53	360	288	6.0	3	7 1/2	5
C-305-S							
C-307-S							
C-414	53	360	288	6.0	5	15	7 1/2
C-414-S							
C-415							
C-415-S	67	460	368	15.1	5	7 1/2	5
C-417-S							
C-419-S							
C-417-S	67	460	368	15.1	7 1/2	10	7 1/2
C-419-S							
C-607-S							
C-607-S	106	720	576	37.1	10	15	10
C-609-S							
C-609-S							

**REPLACEABLE CORE TYPES WITH HIGH CAPACITY CORES (RCW-48)**

C-485	64	708	544	18.4	7 1/2	10	7 1/2
C-487				30.7	12	15	12
C-489-G				55.5	12	25	15
C-967	128	1416	1088	50.4	20	30	20
C-969				62.5	25	35	25
C-1449				75.4	30	40	30
C-14411	192	2124	1632	86.8	40	50	40
C-19211				110	50	60	50
C-19213				127	60	80	60
C-19217-G	256	2832	2176	134	65	80	65

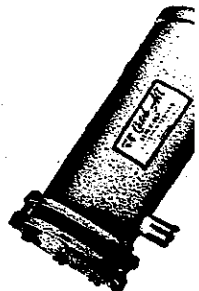
**REPLACEABLE CORE TYPES WITH STANDARD CORES (See Page 15)**

C-R424	67	460	368	14.9	3	5	5
C-R425				18.3	5	10	7 1/2
C-R427				23.6	5	10	7 1/2
C-485	64	428	366	18.4	7 1/2	10	7 1/2
C-487				30.7	12	15	12
C-489-G				55.5	12	25	15
C-967	128	856	732	50.4	20	20	20
C-969				62.5	25	30	25
C-1449				75.4	30	40	30
C-14411	192	1284	1098	86.8	40	50	40
C-19211				110	50	60	50
C-19213				127	60	80	60
C-19217-G	256	1712	1464	134	65	80	65
C-30013				145	75	100	75
C-40017				186	110	130	110

NOTE: The variation in flow ratings of filter-driers having the same size core and shell is caused by the difference in connection sizes used.



For Suction L  
filter-driers  
See Page 2.





**LIQUID LINE RATINGS and SELECTION RECOMMENDATIONS**

**REFRIGERANT 22**

TYPE	SURFACE FILTERING AREA Sq. In.	RATINGS AT ARI STANDARD CONDITIONS		REFRIGERANT FLOW CAPACITY Tons at 2 psi	SELECTION RECOMMENDATIONS (Tons)		
		WATER CAPACITY DROPS AT 60 PPM			REFRIGERATION Commercial & Low Temperature Equipment	O.E.M. Self Contained	Field Replacement or Field Build Up Systems
		75°F	125°F				

**SEALED TYPES**

C-032	9	26	22	2.1	1/4	1	1/2						
C-032-CAP													
C-032-S													
C-032-F													
C-032-FM													
C-033	15	57	48	4.9	1/3	1	3/4						
C-033-S				5.4									
C-052				15				57	48	2.9	1/3	2 1/2	1 1/2
C-052-S										4.1			
C-0525-S										6.0			
C-053	6.7												
C-053-S	6.7												
C-082	21	90	75	2.9	1/2	1	1						
C-082-S				4.3									
C-0825-S				6.3									
C-083				7.4									
C-083-S				12.1									
C-084	21	90	75	13.4	1 1/2	5	2						
C-084-S				2.9									
C-162				4.3									
C-1625-S				6.3									
C-163				7.4									
C-163-S	33	144	140	14.0	2	5	3						
C-164				15.4									
C-164-S				19.1									
C-165				21.8									
C-165-S				6.5									
C-303	53	310	260	14.0	3	5	4						
C-304				15.4									
C-304-S				20.6									
C-305				23.4									
C-305-S				30.1									
C-307-S	53	310	260	16.1	5	7 1/2	7 1/2						
C-414				17.5									
C-414-S				21.9									
C-415				24.0									
C-415-S				30.7									
C-417-S	67	404	338	33.5	10	20	10						
C-419-S				39.7									
C-607-S				44.8									
C-609-S				15									
				25									
	30												



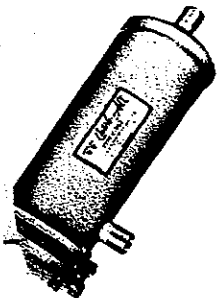
For Suction Line filter-driers See Page 22

**REPLACEABLE CORE TYPES WITH HIGH CAPACITY CORES (RCW-48)**

C-485	64	544	416	20	10	15	10
C-487				33	15	20	15
C-489-G				60	15	30	20
C-967				54	25	35	25
C-969				67	35	45	35
C-1449	192	1632	1248	81	40	55	40
C-14411				93	50	65	50
C-19211				118	70	80	70
C-19213				136	80	100	80
C-19217-G				143	85	100	85

**REPLACEABLE CORE TYPES WITH STANDARD CORES (See Page 14)**

C-R424	67	367	288	16	5	7 1/2	5			
C-R425				20	7 1/2	15	10			
C-R427				25	64	245	172	10	15	10
C-485				20				15	20	15
C-487				33				15	30	20
C-489-G	60	25	35	25						
C-967	54	35	40	35						
C-969	128	490	344	67	40	50	40			
C-1449				81	50	60	50			
C-14411				93	70	80	70			
C-19211				118	80	100	80			
C-19213				136	85	100	85			
C-19217-G	294	2670	1878	155	100	125	100			
C-30013				200	130	150	130			
C-40017				294	3560	2504	200	130	150	130



NOTE: The variation in flow ratings of filter-driers having the same size core and shell is caused by the difference in connection sizes used.



**LIQUID LINE RATINGS and SELECTION RECOMMENDATIONS**

**REFRIGERANT 502**

TYPE	SURFACE FILTERING AREA Sq. In.	RATINGS AT ARI STANDARD CONDITIONS		SELECTION RECOMMENDATIONS (Tons)			
		WATER CAPACITY DROPS AT 30 PPM		REFRIGERANT FLOW CAPACITY Tons at 2 psi	REFRIGERATION Commercial & Low Temperature Equipment	AIR CONDITIONING	
		75°F	125°F			O.E.M. Sell Contained	Field Replacement or Field Build Up Systems

**SEALED TYPES**

C-032	9	28	22	1.4	1/4	3/4	1/2						
C-032-CAP													
C-032-S													
C-032-F													
C-032-FM													
C-033	15	57	52	3.2	1/3	1	3/4						
C-033-S				3.5									
C-052				15				57	52	1.9	1/3	1 1/2	1
C-052-S										2.6			
C-0525-S										3.9			
C-053	4.4												
C-053-S	4.4												
C-082	21	94	73	1.9	1/2	1	3/4						
C-082-S				2.9									
C-0825-S				4.1									
C-083				4.8									
C-083-S				7.8									
C-084	21	94	73	8.7	1	4	2						
C-084-S				1.9									
C-162				33				167	144	2.9	3/4	2	1
C-1625-S										4.1			
C-163										4.8			
C-163-S	9.1												
C-164	10.0												
C-164-S	33	167	144	12.4	2	5	3						
C-165				14.2									
C-165-S				4.2									
C-303				9.1									
C-303				10.0									
C-304	53	270	254	13.4	2	4	3						
C-304-S				15.2									
C-305				19.5									
C-305-S				10.5									
C-307-S				11.4									
C-414	67	355	332	14.2	3	5	5						
C-414-S				15.6									
C-415				19.9									
C-415-S				7 1/2									
C-417-S				7 1/2									
C-419-S	67	355	332	21.7	7 1/2	12	7 1/2						
C-607-S				10									
C-607-S				15									
C-609-S				15									
C-609-S				20									

**REPLACEABLE CORE TYPES WITH HIGH CAPACITY CORES (RCW-48)**

C-485	64	518	380	12.8	7 1/2	10	7 1/2
C-487				21.4			
C-489-G				38.6			
C-967				35.0			
C-969				43.5			
C-1449	128	1036	760	25	25	30	25
C-1449				30			
C-14411				35			
C-19211				40			
C-19213				50			
C-19213	256	2072	1520	55	55	60	55
C-19217-G				60			
C-19217-G				65			
C-19217-G				60			
C-19217-G				60			

**REPLACEABLE CORE TYPES WITH STANDARD CORES (See Page 14)**

C-R424	67	325	281	10.4	5	7 1/2	7 1/2
C-R425				12.7			
C-R427				16.4			
C-485				12.8			
C-487				21.4			
C-489-G	64	162	100	38.6	10	12	10
C-967				15			
C-969				20			
C-1449				25			
C-1449				30			
C-14411	128	324	200	35.0	30	35	30
C-1449				43.5			
C-19211				50			
C-19213				50			
C-19213				55			
C-19217-G	256	648	400	55	60	65	60
C-30013				60			
C-30013				70			
C-30013				80			
C-30013				80			
C-40017	294	2610	1770	101	100	125	70
C-40017				130			
C-40017				100			
C-40017				100			
C-40017				100			

NOTE: The variation in flow ratings of filter-driers having the same size core and shell is caused by the difference in connection sizes used.



For Suction filter-dr  
See Pag





# SPECIFICATIONS



## SEALED TYPE

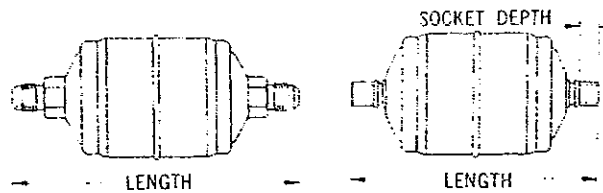
*Liquid Line and Suction Line*

Suitable for 500 psi Safe Working Pressure

Type C-032  
Through  
C-167-S



 and   
Listed



LIQUID LINE TYPE		SUCTION LINE TYPE	CONNECTION SIZE Inches	VOLUME of DESICCANT Cu. In.	LENGTH Inches		SOLDER SOCKET DEPTH Inches	DIAMETER of BODY Inches	SHIPPING WEIGHT Lbs.
SAE Flare	ODF Solder	ODF Solder			SAE Flare	ODF Solder			
C-032	C-032-S	—	1/4	3	4.19	3.81	0.38	1.75	1/2
—	C-032-CAP C-032-CAP-T	—	Extended 1/4 Male		—	5.81	—		
C-032-F	—	—	1/4 Male — Inlet 1/4 Female — Outlet		3.81	—	—		
C-032-FM	—	—	1/4 Female — Inlet 1/4 Male — Outlet		3.81	—	—		
C-033	C-033-S	—	3/8	5	4.69	3.88	0.44	2.44	3/4
C-052	C-052-S	—	1/4		4.75	4.19	0.38		
—	C-0525-S	—	5/16		—	4.38	0.44		
C-053	C-053-S	—	3/8	5.19	4.31	0.44	2.62	1 1/4	
C-082	C-082-S	—	1/4	5.62	5.12	0.38			
—	C-0825-S	—	5/16	—	5.31	0.44			
C-083	C-083-S	—	3/8	6.06	5.25	0.44			
C-084	C-084-S	C-084-S-T-HH	1/2	6.31	5.44	0.50	3.00	1 3/4	
C-162	C-162-S	—	1/4	6.25	5.75	0.38			
—	C-1625-S	—	5/16	—	5.94	0.44			
C-163	C-163-S	—	3/8	6.75	5.88	0.44			
C-164	C-164-S	C-164-S-T-HH	1/2	6.94	6.00	0.50	3.00	3 1/2	
C-165	C-165-S	C-165-S-T-HH	5/8	7.25	6.31	0.62			
—	—	C-166-S-T-HH	3/4	—	6.75	0.62			
—	C-167-S	C-167-S-T-HH	7/8	—	6.93	0.75			
C-303	C-303-S	—	3/8	30	9.69	8.88	0.44	3.00	3 1/2
C-304	C-304-S	—	1/2		9.88	9.00	0.50		
C-305	C-305-S	C-305-S-T-HH	5/8		10.19	9.25	0.62		
—	C-306-S	C-306-S-T-HH	3/4		—	9.65	0.62		
—	C-307-S	C-307-S-T-HH	7/8		—	9.80	0.75		
—	C-309-S	C-309-S-T-HH	1 1/8		—	9.75	0.88		
C-413	—	—	3/8	41	9.56	—	—	3.50	4 1/2
C-414	C-414-S	—	1/2		9.94	9.05	0.50		
C-415	C-415-S	—	5/8		10.25	9.35	0.62		
—	C-417-S	C-417-S-T-HH	7/8		—	9.81	0.69		
—	C-419-S	C-419-S-T-HH	1 1/8		—	9.75	0.91		
—	—	C-437-S-T-HH	7/8	48	—	10.38	0.75	4.75	8
—	—	C-439-S-T-HH	1 1/8		—	10.62	0.94		
—	—	C-4311-S-T-HH	1 3/8		—	10.94	1.00		
—	—	C-4313-S-T-HH	1 5/8		—	10.94	1.06		
—	C-607-S	C-607-S-T-HH	7/8	60	—	16.00	0.75	3.00	6
—	C-609-S	C-609-S-T-HH	1 1/8		—	16.00	0.91		

Listed by Underwriters' Laboratories Inc. — Guide-SMGT-File No. SA-1756A & B and Canadian Standards Association — File LR-19953.

### SIGNIFICANCE OF THE TYPE NUMBER . . . . .

The letters and numerals in the Catch-All type number each have a significance.

“C” indicates Catch-All.

“FIRST TWO DIGITS” indicate the cubic inches of desiccant in the given drier size.

“LAST ONE OR TWO DIGITS” indicates the fitting size in eighths. For example: a “3” indicates 3/8” fitting size; a “25” indicates a 5/16” fitting size.

“NO LETTER” following the last digit indicates an SAE flare fitting.

“-S” following the last digit indicates an ODF Solder fitting. Other suffix letters indicate special qualities. Example:

“-T” indicates a pressure tap consisting of a Schrader type access valve on the inlet end of the Catch-All.

“-HH” indicates a charcoal style core for wax removal and cleanup after a hermetic motor burnout.

“-F” indicates a female flare outlet fitting with a male flare inlet fitting.

“-FM” indicates a female flare inlet fitting with a male flare outlet fitting.

“-CAP” indicates a Catch-All particularly designed for installation on capillary tube systems. The fittings (a 1/4” OD copper tube brazed into each end of the Catch-All) permit inserting the capillary tube into this 1/4” tube, pinching down, and soldering to make the connections.

The type numbers used on replaceable core Catch-Alls have the same basic significance.

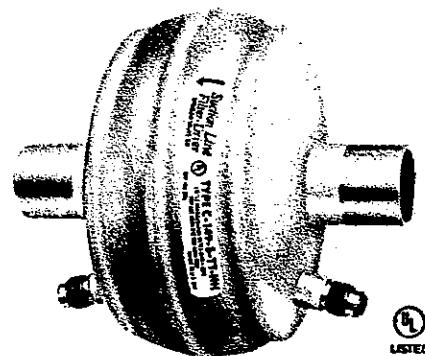
See Page 4 for a description of Construction details.

*Catch-All*®

**COMPACT STYLE SUCTION LINE FILTER-DRIERS**

**DESIGN BENEFITS**

- Short overall length, suitable for cramped piping situations — shorter than other similar type filter-driers.
- Suitable for use on 1 through 5 ton air conditioning systems, with suction line sizes in the range of 1/2" to 1 1/8". Also applicable on the common suction line of heat pump systems.
- The famous Sporlan HH core removes all types of contaminants including moisture, acid, dirt and sludge. A blend of two desiccants, plus activated charcoal, gives maximum performance.
- Access valves on either end permit measuring the pressure drop across the filter-drier during cleanup, following a hermetic motor burnout.



**APPLICATION** — The short overall length of these filter-driers permits easy installation, even on systems with restricted space. While designed for the minimum possible overall length, these filter-driers are still suitable for use on the most popular size air conditioning systems. The filter-drier has two access valves for measuring the pressure drop across the filter-drier core during the cleanup process.

Heat pump systems frequently have cramped piping in a very compact cabinet. The C-140 series Catch-All is not a reversible filter-drier, therefore it must be installed in the common suction line. The serviceman needs a short suction line filter-drier to fit in this restricted space. The C-140 series Catch-Alls meet this essential need.

**CONSTRUCTION** — The core is held in place by a leaf spring at the inlet end. Filtration occurs on the core surface, and a 100 mesh screen is used as a safety filter at the outlet end. The screen and core are sealed to the shell wall with a fiberglass pad. The threaded valve core for each access valve is supplied in a separate envelope. This way the heat sensitive valve core can be installed after brazing the drier into the line. The Catch-All utilizes copper connections for ease in brazing with any type of alloy.

While designed for use in the suction line these filter-driers may be installed in the liquid line, if desired under unusual circumstances. The performance of these filter-driers in the liquid line is similar to the more familiar C-160 series Catch-All filter-driers.

**SELECTION RECOMMENDATIONS**

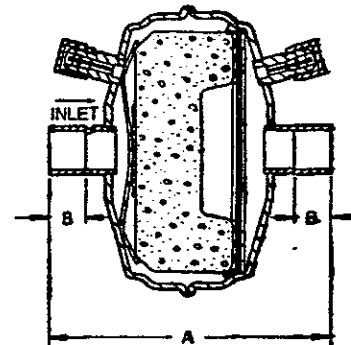
TYPE NUMBER	CONNECTIONS INCHES	*FLOW CAPACITY in Tons EVAPORATOR TEMPERATURE												SELECTION RECOMMENDATIONS HORSEPOWER		
		40°F			20°F			0°F			-20°F					-40°F
		PRESSURE DROP												REFRIGERANT		
		2	2	3	1 1/2	1 1/2	2	1	1	1	1 1/2	1 1/2	1			1/2
		12	134a	22	12	134a	22	12	134a	22	12	22	22	22	12, 134a & 502	
C-144-S-TT-HH	1/2 ODF	1.1	1.3	2.1	0.7	0.8	1.3	0.4	0.5	0.9	0.2	0.4	0.2	2	1	
C-145-S-TT-HH	5/8 ODF	1.9	2.1	3.4	1.2	1.3	2.2	0.7	0.8	1.4	0.4	0.8	0.4	3	2	
C-146-S-TT-HH	3/4 ODF	2.6	2.9	4.8	1.7	1.8	3.0	1.0	1.1	2.0	0.5	1.2	0.6	3	2	
C-147-S-TT-HH	7/8 ODF	2.9	3.2	5.3	1.9	2.1	3.3	1.1	1.3	2.2	0.6	1.3	0.7	5	3	
C-149-S-TT-HH	1 1/8 ODF	3.8	4.2	7.0	2.5	2.7	4.4	1.5	1.6	2.9	0.8	1.7	0.9	5	3	

\*Refrigerant 502 flow capacity is 80% of the values shown above for Refrigerant 22, when expressed in TONS. When expressed in HORSEPOWER, the proper Refrigerant 502 selection is the same as for Refrigerant 12. Rated in accordance with ARI Standard 730.

**SPECIFICATIONS**

CATCH-ALL TYPE NUMBER	CONNECTION SIZE ODF Solder	LENGTH "A" Inches	SOLDER SOCKET DEPTH "B" Inches	DIAMETER OF BODY Inches	SHIPPING WEIGHT Lbs.
C-144-S-TT-HH	1/2	4.14	.50	4.44	2.0
C-145-S-TT-HH	5/8	4.38	.62		
C-146-S-TT-HH	3/4	4.83	.69		
C-147-S-TT-HH	7/8	4.97	.75		
C-149-S-TT-HH	1 1/8	4.93	.96		

Volume of desiccant is 14 cu. in. Filtering area is 27 sq. in. Listed by Underwriters Laboratories for a safe working pressure of 450 psig — File SA1756.



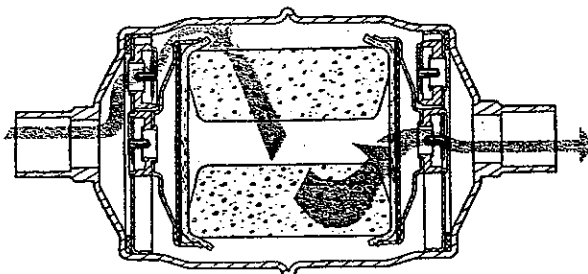
The water capacity and acid capacity of the C-140 series are comparable to the more familiar C-160-S-T-HH series filter-drier. Specific values are not listed since there is no industry standard method for testing the water capacity or

acid removal ability in the suction line of refrigerant systems. The flow capacity information above permits selecting C-140 series Catch-Alls for various conditions with confidence.

# REVERSIBLE HEAT PUMP FILTER-DRIERS

## DESIGN BENEFITS

- A short overall length for easy installation.
- Drier operates in either flow direction with low pressure drop.
- Proven metal check valves used in construction — no synthetic materials.
- The Sporlan dependable molded core used for maximum filtration ability. When the flow direction reverses, dirt already collected remains in the filter-drier.
- A carefully engineered blend of desiccants for maximum water capacity and acid removal ability. The HPC-160-HH Series also has the HH style core with activated charcoal which offers maximum ability to remove oleoresin and other reactive chemical constituents in the oil.
- Same rugged construction as used in the Catch-All.



## APPLICATION

These filter-driers are **easy to install** — even on compact units — because they are designed for installation in the reversing liquid line. The smaller HPC-100 series, using the standard Catch-All core, is designed specifically for new installations and for use on OEM equipment. The HPC-160-HH series uses a larger core which includes activated charcoal for maximum performance in removing all types of contaminants that might be found in a hermetic motor burnout, or other highly contaminated field system.

## CONSTRUCTION

Both filter-driers consist of one core in a shell with two check valves at either end. These check valves control the flow so filtration occurs on the outside of the core, regardless of the flow direction. The HPC driers do not release the dirt collected in one mode when the flow direction reverses. The **reliable check valves** used in these filter-driers have passed the most rigid OEM testing — no synthetic materials are used. These check valves have been thoroughly proven in field systems over a period of many years. They function well even in the presence of solid contaminants.

## SPECIFICATIONS

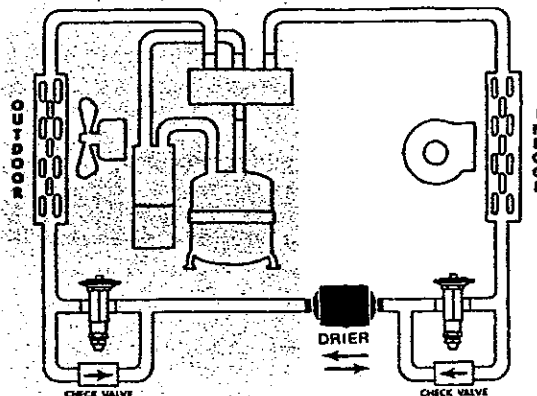
TYPE NUMBER	CONNECTION SIZE Inches	SELECTION RECOMMENDATIONS Tons	DIMENSIONS		FLOW CAPACITY R-22 Tons at 2 psi ΔP	WATER CAPACITY Refrigerant 22 Drops at 60 ppm		LIQUID CAPACITY Oz. R-22 100°F.
			OVERALL LENGTH Inches	DIAMETER Inches		75°F.	125°F.	
<b>FOR NEW INSTALLATIONS AND OEM USE</b>								
HPC-103	3/8 Flare	1 thru 5	6.75	3.0	4.8	100	95	12.2
HPC-103-S	3/8 Solder		5.88					
HPC-104	1/2 Flare		6.94		6.3			
HPC-104-S	1/2 Solder		6.00					
<b>FOR CLEANUP AFTER BURNOUT</b>								
HPC-163-HH	3/8 Flare	1 thru 5	7.78	3.0	5.2	93	81	14.5
HPC-163-S-HH	3/8 Solder		6.92					
HPC-164-HH	1/2 Flare		7.95		5.7			
HPC-164-S-HH	1/2 Solder		7.07					
HPC-165-HH	5/8 Flare	8.28	6.9					
HPC-165-S-HH	5/8 Solder	7.35						

Core volume is 10 cubic inches for HPC-100 series and 14 cubic inches for the HPC-160-HH series. Core surface filtering area is 18 sq. in. for the HPC-100 series and 26 sq. in. for the HPC-160-HH series.

Listed by Underwriters' Laboratories Inc. — Guide-SMGT-File No. SA-1756A & B and Canadian Standards Association — File LR-19953.

While intended for use in the reversing liquid line, these driers can be used in the reversing gas line, providing the system size does not exceed one ton. Since heat pump systems can operate in the winter at very low evaporator temperatures, problems with wax can occur. The HPC-160-HH series filter-driers using the Sporlan charcoal style core, will remove this wax and prevent problems with the expansion device.

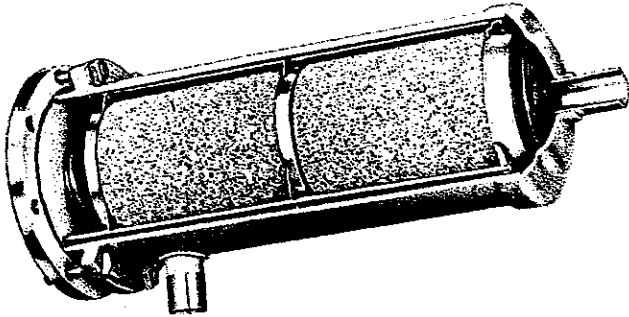
In cleaning up a system **after a hermetic motor burnout**, follow the same general principles used on standard air conditioning systems. Always remove any driers on the unit at the time of burnout. Test a sample of oil from the burned out compressor to see if a suction line filter-drier should be used in addition to a new liquid line drier. The HPC style reversible filter-driers can be used in the reversing liquid line, or the driers originally on the units can be replaced with similar standard filter-driers.





# Catch-All®

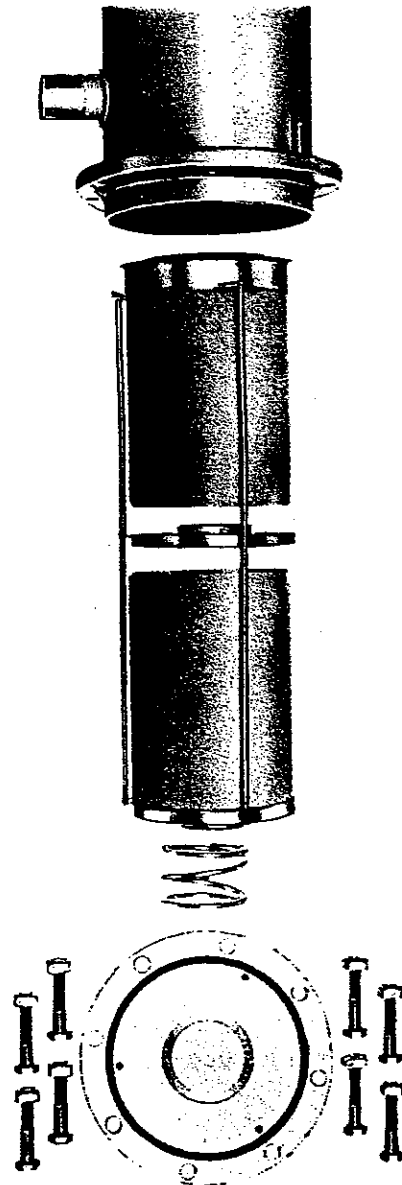
## REPLACEABLE CORE TYPE



The rugged construction of the Sporlan replaceable core **Catch-All Filter-Drier** has proven itself in the field for many years because of these . . .

### ... DESIGN BENEFITS

- The heart of the Catch-All Filter-Drier is the famous **molded porous core**. The blend of desiccants used in the Sporlan replaceable core filter-driers is the same as used in the sealed models. This blend provides maximum water capacity, excellent acid removal characteristics, and the ability to remove the products of oil decomposition. Various other types of cores and felt elements are available for special applications.
- The **bolt and nut attachment** of the end plate allows for simple trouble-free installation. The nuts lock against the side of the shell for ease in tightening. Other designs, using cap screws threaded into the flange ring, run the risk of twisting off the head of the screw, and finding it difficult to remove.
- The **internal tie-rod construction** permits assembling of the cores to the end plate and then inserting the entire assembly. This allows for inspection to make certain all cores and spacer plates are properly aligned, so no bypassing occurs. The resulting one-piece assembly is easy to insert. Furthermore, it is simple to remove — even if the cores have collected a considerable amount of foreign material.
- A **complete line of fitting sizes** — Solder connections from 1/2" to 4 1/8" ODF — and pipe connections from 1/2" to 2".
- **Copper fittings** for fast easy soldering. Pre-sized for proper fit and suitable for use with soft solder, silver solder, Sil-Fos, or Phos-Copper. These fittings are brazed to the shell with high temperature brazing alloy so they never come loose during brazing on the job.
- **Heavy steel shell for high bursting strength** — listed by Underwriters' Laboratories Inc. and Canadian Standards Association.
- All internal parts are **plated steel** — no plastic parts.
- **Outlet seal gasket** prevents bypassing. Assembly held tight against gasket by spring.
- Shell exterior is **painted to prevent corrosion** even under the most adverse conditions.



The construction illustrated is used on the C-480 through C-19200 series **Catch-All Filter-Driers**. A similar construction is used on the C-30,000 and C-40,000 series models. The C-R424, C-R425 and C-R427 models differ slightly in construction, but maintain all the same desirable features.

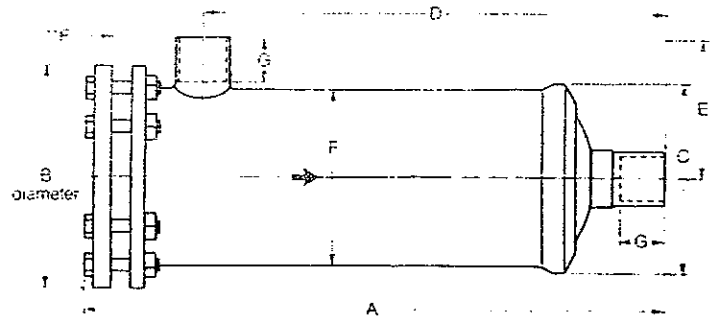
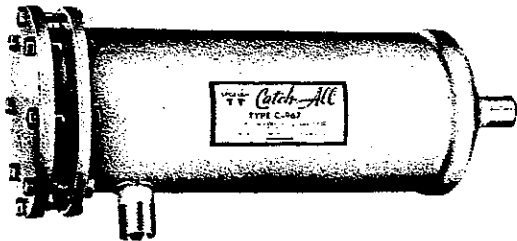
*Catch-All*

**SPECIFICATIONS**

**REPLACEABLE CORE TYPE**

*Liquid Line and Suction Line*

Suitable for 500 psi Safe Working Pressure



UL and SP Listed

TYPE	CONNECTIONS Inches ODF Solder	NO. OF CORES OR FILTER ELEMENT	CORE Part No.	VOLUME OF DESICCANT Cu. In.	FILTER ELEMENT Part No.	MOUNTING BRACKETS	SHELL DIMENSIONS Inches							NET WEIGHT Lbs.	SHIPPING WEIGHT Lbs.		
							A	B	C	D	E	F	G			**P	
*C-R424 *C-R425 *C-R427	1/2 5/8 7/8	1	RC-4267	42	—	A-175-1	9.00 9.06 9.44	4.75	—	6.76 6.94 7.25	2.81 2.89 3.03	3.50	.50 .62 .75	6.50	5 1/2	6 1/2	
C-485 C-485-G C-487 C-487-G C-489-G C-4811-G C-4813-G	5/8 5/8 7/8 7/8 1 1/8 1 3/8 1 5/8	1	RC-4864, RC-4864-HH or RCW-48	48	RPE-48-BD	A-685	9.15 9.15 9.30 9.30 9.50 9.60 9.60	6.00	5.00	5.92 5.92 6.07 6.07 6.37 6.37 6.37	3.50 3.50 3.72 3.72 3.78 3.94 3.97	4.75	.50 .50 .75 .75 .91 .97 1.09	7.50	10	12	
C-967 C-967-G C-969 C-969-G C-9611-G C-9613-G	7/8 7/8 1 1/8 1 1/8 1 3/8 1 5/8	2			96	RPE-48-BD	A-685	14.84 14.84 15.04 15.04 15.14 15.14	6.00	5.00	11.61 11.61 11.81 11.81 11.91 11.91	3.72 3.72 3.78 3.78 3.94 3.97	4.75	.75 .75 .91 .91 .97 1.09	13.00	14	16
C-1449 C-1449-G C-14411 C-14411-G C-14413-G	1 1/8 1 1/8 1 3/8 1 3/8 1 5/8	3			144	RPE-48-BD	A-685	20.58 20.58 20.68 20.68 20.68	6.00	5.00	17.35 17.35 17.45 17.45 17.45	3.78 3.78 3.94 3.94 3.97	4.75	.91 .91 .97 .97 1.09	18.62	17	20
C-19211 C-19211-G C-19213 C-19213-G C-19217-G	1 3/8 1 3/8 1 5/8 1 5/8 2 1/8	4		192	RPE-48-BD	A-685	26.22 26.22 26.22 26.22 26.22	6.00	5.00	22.99 22.99 22.99 22.99 22.43	3.94 3.94 3.97 3.97 4.65	4.75	.97 .97 1.09 1.09 1.34	24.25	20	23	
C-30013 C-30013-G C-30017-G	1 5/8 1 5/8 2 1/8	3	RC-10098 or RC-10098-HH	300	RPE-100	A-175-2	27.94 27.94 28.06	7.50	6.25	23.88 23.88 24.00	5.12 5.12 5.12	6.00	1.12 1.12 1.25	25.62	36	40	
C-40017 C-40017-G C-40021-G C-40025-G C-40029-G C-40033-G	2 1/8 2 1/8 2 5/8 3 1/8 3 5/8 4 1/8	4			400	RPE-100	A-175-2	34.56 34.56 34.75 34.44 34.81 35.12	7.50	6.25	30.50 30.50 30.56 29.81 30.06 29.81	5.31 5.31 5.38 5.06 5.50 5.62	6.00	1.38 1.38 1.50 1.75 2.00 2.19	32.12	43 43 45 45 47 47	47 47 47 49 51

**NPT PIPE CONNECTIONS**

C-484-P	1/2	1	RC-4864,	48	RPE-48-BD	A-685	9.08	6.00	5.00	5.85	3.41	4.75	—	7.50	10	12
C-966-P	3/4	2	RC-4864-HH	96			14.67			3.48	13.00			14	16	
C-1448-P	1	3	or	144			20.42			3.66	18.62			17	20	
C-19212-P	1 1/2	4	RCW-48	192			25.85			3.76	24.25			20	23	
C-40016-P	2	4	RC-10098 or RC-10098-HH	400	RPE-100	A-175-2	34.44	7.50	6.25	30.38	4.38	6.00	—	32.12	46	51

Listed by Underwriters' Laboratories Inc. — Guide-SMGT-File No. SA-1756A & B and Canadian Standards Association — File LR-19953.

\* Underwriters' Laboratories listed for 302 psi safe working pressure.

\*\*\*P" Dimension is the pull space required to change core.

Type numbers with G suffix indicate that unit is supplied with 1/4" female pipe connection in the flange plate and pipe plug. . . . If the unit is intended liquid line service an angle charging valve for system charging purposes can be installed in place of the pipe plug. . . . If the unit is used in the suction line for clean up after burnout, then insert a Schrader type access valve to serve as a pressure tap. . . . Angle charging and Schrader type access valves are available from your Sporlan wholesaler.

Type numbers with P suffix indicates female threaded pipe connections.

*Catch-All*®

**CORES**

**ELEMENTS**

**REPLACEABLE CORES and FILTER ELEMENTS — Order Separately**

Cores for replaceable core type filter-driers are molded of exactly the same desiccants that are used in the popular sealed filter-driers.

Cores are individually packed in *metal cans*, fully activated, and hermetically sealed against moisture and dirt.

Filter Elements are dried and packed in individual sealed metal cans. This method of packaging prevents the element from picking up moisture from the atmosphere.

The method of mounting the cores or filter elements on the end plate by means of tie rods makes them very *easy to install and remove*. Detailed *instructions* are printed on each can. Each can contains a *"triple gasket"* consisting of a new endplate gasket, an endplate gasket for certain competitive filter-driers, and a core gasket where desired. See the specifications on Page 14 for the number of cores required for each type drier.

RC-4864 — Activated Core — Order as separate item — Fits types C-480 thru C-19200 series shells. This is the standard core suitable for most installations in the liquid line or suction line.

RC-4864-HH — Activated Charcoal Core — Order as separate item — Fits types C-480 thru C-19200 series shells. This core should be used for wax removal on low temperature R-22 and R-502 systems, and for clean-up after burnout on all types of systems.

RCW-48 — High Water Capacity Core — Order as separate item — Fits same shells as RC-4864. Designed specially for use with polyolester oils. This core should also be used on systems that have a ruptured water cooled condenser, or that have been exposed to the atmosphere, or for some reason are expected to have a very high amount of water in the system.

RPE-48-BD — Filter Element — Order as a separate item — Fits types C-480 thru C-19200 series shells. This element should be used in replaceable core Catch-Alls installed in the **suction line** to obtain the lowest possible pressure drop. In cleaning up a system after a hermetic motor burnout, cores should be used first. Then after the system is thoroughly clean, this filter element can be installed in the Catch-All.

RC-4267 — Activated Core — Order as separate item — Fits **ONLY** shell types C-R424, C-R425, and C-R427.



RC-10098 Activated Core — Order as separate item — Fits types C-30,000 and C-40,000 series shells. This core has a high water capacity and should be used on all standard liquid line and suction line applications.

RC-10098-HH Activated Charcoal Core — Order as separate item — Fits types C-30,000 and C-40,000 series shells. This core should be used on low temperature Refrigerant 22 and 502 systems for wax removal, and for clean-up of systems that have had a hermetic motor burnout.

RPE-100 Filter Element — Order as a separate item — Fits types C-30,000 and C-40,000 series shells. This filter element should be used in the same way as the RPE-48-BD.

*Sporlan Cores and Filter Elements can be used for replacement in drier shells made by most other drier manufacturers.*

**UNIT NET WEIGHTS and CARTON SHIPPING WEIGHTS**

PART NUMBER	REPLACEABLE CORES			FILTER ELEMENTS	
	RC-4267	RC-4864, RC-4864-HH & RCW-48	RC-10098 & RC-10098-HH	RPE-48-BD	RPE-100
No. Per Carton	10	12	6	12	6
Shipping Weight - Lbs.	22	28	30	7	11
Net Weight - Lbs. Ea.	1.8	2.1	4.3	0.5	1.2
Core Dimensions - O.D. x Length Inches	3.18 x 6.00	3.74 x 5.50	4.80 x 6.47	3.70 x 5.50	4.80 x 6.47



## AMMONIA TYPE

**AMMONIA CATCH-ALL FILTER-DRIERS** — The molded porous Catch-All core effectively removes scale and other fine particles — keeping the system clean — and prolonging the life of all moving parts.

Small amounts of water are not considered a problem in ammonia systems. Therefore, the "drier" function of the desiccant core is not normally required. See the information below for more details.

The Type C-413-P is a sealed model filter-drier. All of the other models shown at the right are replaceable core types. Use Types RC-4864 or RC-10098 for excellent filtration ability.

**NOTE:** Do not use RPE-48-BD and RPE-100 Filter Elements on Ammonia Systems.

### CLEANLINESS IS VITAL IN AMMONIA REFRIGERATION SYSTEM

**Scale and other contaminants in an ammonia system cause all kinds of unnecessary problems.**

Solid contaminants circulating in an ammonia system tend to plug the float valve, cause erosion of the expansion valve pin by sand blasting, and damage the compressor. These circulating particles can easily be removed by installing a filter in the liquid line.

Probably the biggest benefit to such an installation is longer compressor life. Keeping the systems free of dirt and scale eliminates cylinder wall scoring, and thus greatly extends the life of the compressor. A filter in the liquid line frequently means compressor rebuilding is not necessary for many years.

The Sporlan Catch-All filter-drier is readily available with steel pipe fittings welded to the drier shell. These filters are made with an all steel construction and an aluminum end plate that is designed specifically for ammonia systems. The table above can be used to select the specific model Catch-All required for a given system.

The **standard** core is the best selection for use on ammonia systems. Filter elements will deteriorate on ammonia service and should not be used.

The filter-drier should be installed with a bypass line around it, so the shell can be pumped down and valved off for changing cores. A pressure relief valve should be installed next to it. When it is first installed on a dirty system, it may be necessary to change the cores after several days of operation due to the large amount of scale collected. Changing the cores several times will gradually clean up the entire system. Once the system is clean, changing the cores once or twice a year will keep the system operating properly.

**WHAT ABOUT WATER?** — Normally, water is not considered a problem in ammonia systems. Moisture remaining in a system from installation, or that enters thru a small leak, will combine with the anhydrous ammonia to form ammonium hydroxide. Usually this ammonium hydroxide circulates in the system without causing difficulty. For example, it will not freeze up in the expansion device until the temperature drops below  $-110^{\circ}\text{F}$ . However, water in the system in any appreciable amount will increase the corrosion rate of the compressor parts, and will tend to contribute to thickening and sludging of the oil.

As the ammonia boils in the evaporator, the gas formed is essentially 100%  $\text{NH}_3$ . Any water associated with the ammonia remains as liquid ammonium hydroxide. In a normal system containing small amounts of water, this ammonia-water solution is carried back to the compressor as droplets by the velocity of the suction gas. If larger amounts of water are present, this liquid will build up in the suction accumulator.

If appreciable amounts of water are present, the operator will also notice that the evaporator temperature does not correspond to the indicated pressure according to the ammonia chart. The evaporator temperature will be higher than normal when excess water is present. A  $5^{\circ}\text{F}$ . rise in the evaporator temperature

CATCH-ALL FILTER-DRIER TYPE	FITTING SIZE FPT	AMMONIA SYSTEM CAPACITY		REPLACEABLE CORE TYPE AND QUANTITY REQUIRED
		Tons $\Delta P = 4 \text{ psi}$	Gal./Hr.	
C-413-P	$\frac{3}{8}$	20	102	—
C-484-P	$\frac{1}{2}$	40	204	RC-4864 (1)
C-966-P	$\frac{3}{4}$	100	510	RC-4864 (2)
C-1488-P	1	150	765	RC-4864 (3)
C-19212-P	$1\frac{1}{2}$	280	1,428	RC-4864 (4)
C-40016-P	2	350	1,785	RC-10098 (4)

If the Catch-All is to be used in the suction line, then select on the basis of 10% of the liquid line flow capacity shown above.

indicates approximately 12% water in the ammonia. The operator may also notice a high head pressure that cannot be reduced by purging.

**TEST METHOD** — The following test method has been recommended for determining if a system contains excessive water. Remove a sample of liquid ammonia into an open beaker from the low side of the suction accumulator. Place a glass plate over the top of the beaker. If the system contains excessive water, then droplets of water will form on the lower side of this glass plate.

A method of removing excessive water from a direct expansion system is to pump the system down and collect the water and oil from the evaporator in the suction accumulator during defrost. This water-oil mixture from the suction accumulator is then discarded.

Another effective method of removing water from an ammonia system is to build a re-boiler still. Information on the design of this pressure vessel can be obtained from International Institute of Ammonia Refrigeration Bulletin 108. The ammonia-water mixture from the low pressure recirculation line is pumped into the still and hot gas from the compressor is used to boil off the ammonia. The ammonia vapor goes into the suction line. The accumulated water in the bottom of the still is then discarded. By gradually removing the ammonia-water solution from the low pressure side of the system, the water can be gradually removed from the system. In the typical pumped recirculation system, the water-ammonia solution is continually recirculated in the low side and, as evaporation occurs, the pure ammonia vapor returns to the compressor and pure ammonia liquid comes back to the pumped recirculation loop. Thus the greatest concentration of water is always in the low side of the system.

The filter-driers recommended above use a desiccant core. These cores are recommended only because the molded core is an excellent filtering element, and is readily available. The "drier" function is not usually required. Because of the specific characteristics of ammonia-water solutions, the commonly used desiccants are not effective in drying the ammonia.

**RECOMMENDATIONS** — Two procedures are recommended to keep ammonia systems clean.

**First**, install the system with cleanliness in mind. If ammonia systems were built to the same degree of cleanliness as used for halocarbon systems, then considerably fewer problems would result. Use nitrogen as a pressure test gas. Use an oil separator to prevent oil logging in the evaporator.

**Secondly**, to remove residual scale and solid contaminants from the system, install a replaceable core-type filter-drier in the liquid line. The continuous filtering action will keep the system clean, and pay for itself many times over in reduced compressor maintenance. **Be modern — equip your existing and new ammonia systems with the Sporlan Catch-All Filter-Drier designed for ammonia use.**

*Catch-All*®

**ACCESSORIES**

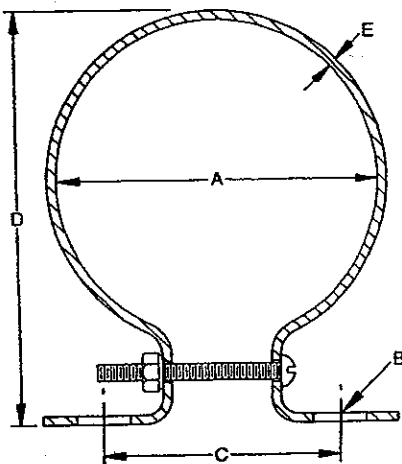
**MOUNTING BRACKETS — Order Separately**

Mounting Brackets designed especially for **replaceable core type filter-drier** installations are available. All brackets are supplied with a bolt, nut, and washer.

A-685 — Mounting Bracket for shell types C-480 thru C-19200 series. **ONE** bracket per package. Depending on shell size and installation requirements, more than one bracket may be required. Catch-Alls larger than the C-480 series generally require two brackets. These brackets are also used for Replaceable Suction Filters.

A-175-1 — Mounting Bracket for shell types C-R424, C-R425 and C-R427 **ONLY**. **ONE** bracket per package. Usually one bracket is adequate for mounting these Catch-Alls.

A-175-2 — Mounting Bracket for shell types C-30,000 and C-40,000 series. **TWO** brackets per package. Two brackets are generally adequate for mounting these large Catch-Alls.

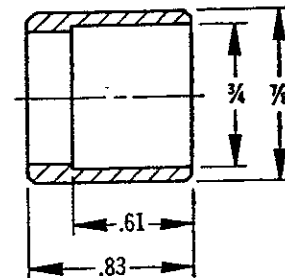


**MOUNTING BRACKETS DIMENSIONS — Inches**

MODEL NUMBER	A	B	C	D	E
A-685	4.75	.41 x .81 Slot	3.50	6.12	0.12
A-175-1	3.50		3.50	4.62	0.12
A-175-2	6.00		4.00	7.44	0.12

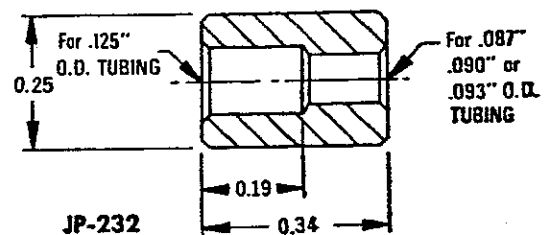
**FLUSH BUSHING KIT-KFB-7/8**

The copper flush bushings are 7/8" OD x 3/4" ID. They may be slipped into any 7/8" ODF Solder connection and then 3/4" OD tube can be slipped into the bushing. The soldering or brazing operation of the tube to bushing and bushing to fitting can be accomplished at one time.



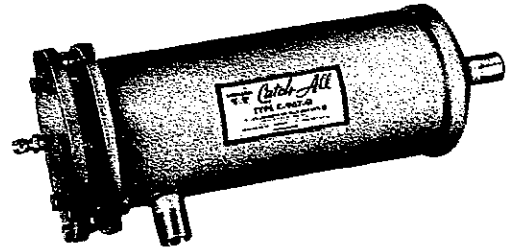
**JP-232 CAP TUBE ADAPTER**

To simplify the application of **Catch-All Filter-Driers** on systems with cap tubes, Sporlan has designed a brass adapter which fits all standard 1/4" ODF Solder fittings. This adapter can be used with the C-032-S, C-052-S, and C-082-S models. As shown in the drawing, one end of the adapter is suitable for 0.125" OD tubing and the other is suitable for cap tubes of .087", .090", or .093" OD. This adapter **CANNOT** be used with the C-032-CAP or C-032-CAP-T Catch-Alls.



The adapter can be brazed to the capillary tubing and the unit fitting in one operation. These adapters are available from all Sporlan wholesalers — just ask for **part JP-232**.

## APPLICATION—INSTALLATION



### CATCH-ALL LOCATION

The Catch-All Filter-Drier is most effective in the **liquid line**. Place it immediately ahead of other liquid line controls, such as thermostatic expansion valve, solenoid valve, and **See • All moisture & liquid indicator**. When applied in this way the filter-drier provides maximum protection for the expansion valve and solenoid valve from any dirt that may be in the system. If the system contains appreciable moisture, then this location gives the best results in protecting the expansion valve from freeze-up. If possible, place the filter-drier in a **cold location**. The **acid removal ability** of the Catch-All Filter-Drier is the same regardless whether it is installed in the liquid line or suction line.

Catch-All Filter-Driers are frequently installed in the **suction line** just ahead of the compressor. This procedure is used to clean up a new system or a system that has had a hermetic motor burnout. The main advantage of this location is that it is directly ahead of the compressor, and therefore offers maximum protection to the compressor from all contaminants, even those that may be in the low side of the system. The **suction line** filter-drier gives excellent performance in removing water, dirt and acid. A larger size filter-drier is required than if it had been placed in the liquid line. The refrigerant velocity in the suction line is about six times the velocity in the liquid line. Therefore, a larger filter-drier is required in order to maintain a sufficiently low pressure drop.

The **water capacity of a Sporlan filter-drier in the suction line** is equal to or slightly greater than the liquid line water capacity. Filtration and acid removal in the suction line is equal to that obtained in the liquid line. The main disadvantage of the suction line location is that a larger more expensive filter-drier is required.

Catch-All Filter-Driers are not recommended for use in the **discharge line**. There are other better locations. The water capacity in this location would be reduced due to the high operating temperature.

**Catch-All Filter-Driers** may be installed in **any position**, with top or bottom feed. However, it is advisable to mount

replaceable core models horizontally so that foreign material cannot drop into the outlet fitting when the cores are removed. Always observe the flow direction. Catch-Alls must never be subjected to reverse flow.

### CAPILLARY TUBE SYSTEM

The C-032-CAP Catch-All is designed specifically for capillary tube systems. This unit consists of a C-032-S Catch-All with ¼" copper tubes brazed into each end, giving an overall length of 5.81". Capillary tubes of any size may be inserted into the ¼" copper tube on this Catch-All, then the tubing pinched down, and soldered. In this way the excellent contaminant removal qualities of the Catch-All can be used on domestic refrigerators and freezers. The C-032-CAP-T model also has an **access valve for charging purposes**.

The best filter-drier location is immediately ahead of the capillary tube. The **amount of liquid refrigerant** which the smaller size Catch-All Filter-Driers will contain at 100°F. is given below:

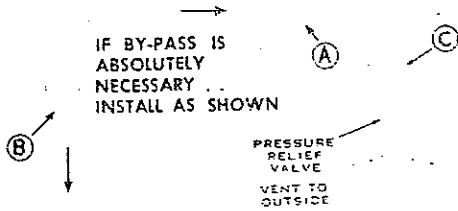
CATCH-ALL Series Type No.	OUNCES OF REFRIGERANT BY WEIGHT at 100°F.			
	Refrigerant 12	Refrigerant 134a	Refrigerant 22	Refrigerant 502
C-030	2.1	1.9	1.9	1.9
C-050	5.3	4.9	4.8	4.8
C-080	7.6	6.9	6.8	6.9
C-160	12.0	11.0	10.8	10.9
C-300	19.2	17.6	17.3	17.5
C-410	27.0	24.7	24.3	24.5

### BYPASS INSTALLATION

It is preferred that the Catch-All Filter-Drier be installed in the **main liquid line** for maximum protection. When located in a bypass, dirt or foreign material may pass into the system through the unprotected main line.

When a **bypass** installation is necessary (see sketch on Page 19), a hand throttling valve (A) is recommended. By

throttling Valve (A), a certain portion of refrigerant can be made to pass through the filter-drier. Note that hand valves (B) and (C) are required only if it is desired to replace the filter-drier without pumping down from the receiver. Always pump out the section of the line containing the filter-drier by closing hand valves (A) and (B) (note direction of flow). Permit isolated section to pump out, close valve (C), then change **Catch-All Filter-Drier**.



### WARNING

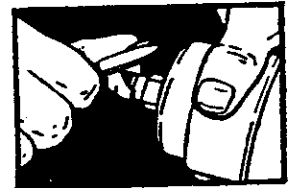
Dangerous hydraulic pressures may develop if hand valves (B) and (C) are closed and the filter-drier is full of liquid. If there is a possibility of inexperienced personnel closing the valves without pumping down, a pressure relief device is recommended.

### BRAZING AND SOLDERING

The fittings on most sealed model Catch-Alls are constructed of heavily **copper plated steel**, suitable for all types of brazing and soldering alloys, including soft solder, 95-5 solder, Sta-Brite solder, silver brazing alloy, Sil-Fos, or phos-copper alloys. The fittings on the replaceable core model Catch-All are copper and can be used with all the same alloys. The fittings on the Catch-All have been carefully cleaned and sealed before shipment, and should not require further cleaning before brazing. Proper brazing technique involves using the proper torch tip for rapid heating, and also directing the flame away from the Catch-All shell. In this way one avoids damaging the paint.

### SEAL REMOVAL

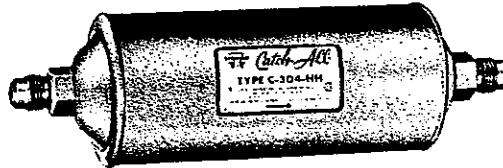
The normal procedure in removing seals from either sweat or flare connections is to gently cut them away with a knife, as shown in the illustration. With flare connections **caution** should be exercised to avoid damaging the flare surface. The seals cannot be removed and replaced without tearing them.



*Catch-All*®

HH STYLE for WAX REMOVAL

U.S. PATENT NUMBER 3,407,617



Small amounts of wax are often a problem on **low temperature Refrigerant-22 and Refrigerant-502 systems**. Even well engineered systems frequently contain minute quantities of wax which are sufficient to clog expansion valve screens or cause sticking of the valve. Sporlan has developed a special blend of desiccants including activated charcoal which removes small amounts of wax in the liquid line before this wax can cause trouble at the expansion valve. These Catch-All Filter-Driers have been very successful in correcting trouble jobs in the field.

By installing HH Style Catch-All Filter-Driers in the liquid line of all low temperature Refrigerant-22 and Refrigerant-502 systems these wax problems can be entirely prevented. In addition to their wax removal ability, these filter-driers will remove all of the other harmful contaminants that the standard filter-driers remove.

The following **Catch-All Filter Driers** are available with the HH core to meet the needs of low temperature systems. For dimensions refer to the **specifications** for standard filter-driers on Page 10.

TYPE	CONNECTIONS Inches	WAX CAPACITY Grams
C-052-HH	1/4 SAE Flare	2.4
C-082-HH C-083-HH	1/4 SAE Flare 3/8 SAE Flare	3.8
C-162-HH C-163-HH C-163-S-HH C-164-HH C-164-S-HH C-165-HH C-165-S-HH	1/4 SAE Flare 3/8 SAE Flare 3/8 ODF Solder 1/2 SAE Flare 1/2 ODF Solder 5/8 SAE Flare 5/8 ODF Solder	6.4
C-303-HH C-304-HH C-304-S-HH C-305-HH C-305-S-HH	3/8 SAE Flare 1/2 SAE Flare 1/2 ODF Solder 5/8 SAE Flare 5/8 ODF Solder	14.8
C-414-HH C-415-HH C-417-S-HH	1/2 SAE Flare 5/8 SAE Flare 7/8 ODF Solder	18.3
RC-4864-HH RC-10098-HH	Replaceable Core	13.6 27.8

**SPORLAN  
SUCTION LINE  
Filter-Driers**

**DESIGNED SPECIFICALLY for  
CLEAN-UP after BURNOUT  
using the HH type  
CHARCOAL CORE**

**OFFERS YOU THESE PROVEN BENEFITS...**

- Positive protection for the compressor
- Most economical method of clean-up
- Minimum down time — system operates during clean-up
- Method is applicable to almost any size system
- Removes all contaminants — moisture, acid, sludges, dirt ...
- Recommended by the leading equipment manufacturers

THE SUCTION LINE FILTER-DRIER METHOD of cleaning up a system after a hermetic motor burnout is favored by servicemen and recommended by manufacturers throughout our industry. This method gives the most practical and positive protection to the new compressor, since the refrigerant-oil mixture is filtered and purified just before it returns to the compressor. It is important that all contaminants remaining in the system be removed to prevent a repeat burnout of the new compressor.

THE CONSTRUCTION OF THE SUCTION LINE FILTER-DRIER is not significantly different from the standard liquid line filter-drier. Both driers remove the important contaminants such as moisture, dirt, acid, and the products of oil decomposition. The suction line filter-driers utilize the HH style charcoal core to obtain the maximum ability for oil cleanup and removing all types of contaminants. The sealed models have an access valve (-T) at the inlet end to permit measuring the pressure drop during the first several hours of operation. The replaceable core models have a ¼" female pipe connection (-G) in the endplate to permit installing an access valve for measuring the pressure drop. The access valve on either type Catch-All can also be used for charging the system. If the proper style drier is not available, then a suction line filter-drier can be used in the liquid line, or a liquid line filter-drier can be used in the suction line. The pressure drop characteristics of the two types of driers are essentially the same for a given line size.

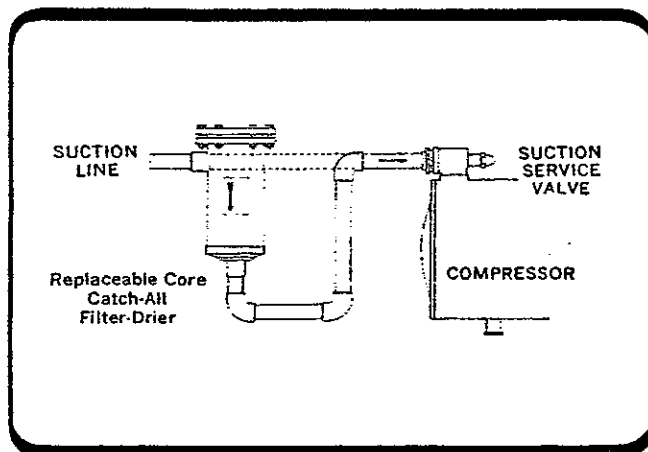
**INSTALLATION** — The Catch-All Filter-Drier can be installed directly in the suction line by removing a portion of the line. After cleanup, the Catch-All Filter-Drier is generally left in the line. The cores in the replaceable model should be replaced with filter elements (RPE-48 or RPE-100) to obtain the lowest possible pressure drop. A hermetic motor burnout produces large amounts of acid, moisture, sludge and all types of oil decomposition materials. To obtain the maximum ability to remove all these various types of contaminants, the Sporlan HH style charcoal core is preferred. If the HH style core is not available, the standard cores may be used.

**IMPORTANCE OF OIL AS A SCAVENGER** — OEM recommendations stress the importance of oil in cleaning up a system after a motor burnout. The oil acts as a scavenger, collecting the acid, sludge, and other contaminants. Therefore, the serviceman should check the **color** and **acid content** of the oil. It must be clean and acid free before the job is finished. The acid content can be checked with the Sporlan Acid Test Kit.

**OBTAINING AN OIL SAMPLE** — This is frequently a difficult task. An oil sample can usually be obtained from the burned out compressor. To obtain repeated samples after the system is started up, install a trap in the suction line with an access valve in the bottom of the trap. This permits collecting the small amount of oil required for running an acid test. Another method is to build a trap with valves on it, and connections for charging hoses. Then refrigerant vapor from the discharge service valve is run through this trap and put back into the suction service valve. In a short time sufficient oil collects in the trap for analysis. For more information request Sporlan Form SD-39.

**SUCTION LINE PRESSURE DROP** — Most hermetic motors rely on refrigerant vapor for cooling. Any large pressure drop in the suction line could result in reduced flow of suction gas, and thus improper cooling of the new hermetic motor. Field experience has shown that if the filter-drier is properly sized, the pressure drop across it should not exceed the values given in the table on Page 21. The pressure drop across the filter-drier should be checked during the first hour of operation to determine if the cores need to be changed.

Any pressure loss in the suction line also reduces system capacity significantly. When replaceable core type filter-driers are used, it is recommended that the cores be removed and filter elements installed when the cleanup job is complete. Obtaining a low pressure drop is particularly important for energy savings on supermarket refrigeration systems. Therefore, the suction line filter-driers should be sized generously on these systems.





## CLEAN-UP PROCEDURE

1. **DIAGNOSIS** — Make certain that a motor burnout has actually occurred by running the proper electrical tests. Determine the severity of the burnout by analyzing the acid content of the oil from the burned out compressor. This can be done on the job with the Sporlan AK-1 One Time acid test kit, or AK-3 acid test kit. Note the color of the oil, the smell of the refrigerant, and if any carbon deposits are present in the suction line.
2. **PLAN THE PROCEDURE** — Consider the following factors: If the oil is not acid and none of the other indications of severe burnout are present, then the system can be classified as a "mild burnout" and cleaned up accordingly. Under these circumstances, it is easier to save the refrigerant. If an oil sample is desired for checking the progress of the clean up, then a trap should be installed in the suction line (see Form SD-39). A semi-hermetic compressor can be examined by removing the head to check the severity of burnout, and for handwiping to clean up. A heat pump system will frequently require replacing the 4-way valve, or other special precautions. Systems with a critical charge must have that charge adjusted due to the added volume in the oversized filter-drier that is normally installed in the liquid line.
3. **MILD BURNOUT** — If the analysis of the oil shows no acidity, then the system can be classified as a mild burnout, and cleaned up simply by installing an oversized Catch-All Filter-Drier in the liquid line. If the oil is not analyzed, and the other factors indicate some doubt, then the burnout should be considered severe and cleaned up as described below.
 

**CAUTION** — Acid burns can result from touching the sludge in the burned out compressor. Rubber gloves should be worn when handling contaminated parts.
4. **SEVERE BURNOUTS** — These systems should be cleaned using the *suction line filter-drier method*. The refrigerant in the system can be saved, and should be removed using refrigerant recovery/recycling equipment. The exact method chosen depends upon the availability of shutoff valves, the amount of charge, and the other equipment available. See the section on "Saving the Refrigerant."
5. Remove the burned out compressor and install the new compressor.
6. Install a Catch-All suction line filter-drier (selected from page 22) ahead of the new compressor. The access valve on the drier permits the pressure drop to be checked by installing gauges on the access valve and at the gauge port on the suction service valve. For systems without service valves, install a line tap valve downstream of the Catch-All Filter-Drier for the second connection.
7. Remove the liquid line drier and install an oversized filter-drier (one size larger than the normal selection size). Check the expansion valve and other controls to see if cleaning or replacement is required. Install a See-All moisture and liquid indicator.
8. Evacuate the system according to the manufacturer's recommendations. Normally this will include the use of a high vacuum pump and a low vacuum micron gauge for measuring the vacuum obtained.
9. Recharge the system through the access valve on the suction line filter-drier. Then start up the system according to the manufacturer's instructions.
10. The use of a Catch-All Filter-Drier installed permanently in the suction line permits the cleanup of a small system to be completed with one service call. The pressure drop across the suction line filter-drier should be measured during the first hour's operation. If the pressure drop becomes excessive, then the suction line filter-drier should be replaced. If the equipment manufacturer's recommendations are not available, the following maximum pressure drop levels are suggested.

### MAXIMUM RECOMMENDED PRESSURE DROP—PSI FOR SUCTION LINE FILTER-DRIERS

SYSTEM	PERMANENT INSTALLATION		TEMPORARY INSTALLATION	
	R-22 & R-502	R-12 & R-134a	R-22 & R-502	R-12 & R-134a
Air Conditioning	3	2	8	6
Commercial	2	1½	4	3
Low Temperature	1	½	2	1

11. In 24 hours take an oil sample. Observe the color and test for acidity. If the oil is dirty or acidic, replace the suction line and liquid line filter-driers.

In two weeks re-check the color and acidity of the oil to see if another change of filter-driers is necessary. It may also be desirable to change the oil in the compressor. Before the job is complete, it is essential that the oil be clean and acid-free.

**SAVING THE REFRIGERANT** — The refrigerant is not damaged by the burnout, and can be reused, provided the contaminants are removed. When a mild burnout has occurred on a system with service valves, the refrigerant can be saved by closing the valves and trapping the refrigerant in the system, while changing the compressor. *The system can then be pumped down with the new compressor to save the refrigerant while installing an oversized Catch-All filter-drier in the liquid line.*

If a severe burnout has occurred, the above procedure might damage the new compressor. Therefore, it is preferred that the refrigerant be removed from the system for reclamation. If no service valves are available then the refrigerant *must* be removed from the system. Recovery, recycling or reclamation of the refrigerant must be performed in accordance with EPA regulations.

Sporlan recommends the use of our HH style cores for cleaning up all systems after a hermetic motor burnout. These cores contain a desiccant mix that is suitable for removing all types of system contaminants. Additional information on sizing of filter-driers for larger systems is available on Sporlan Form 40-109. Information on cleaning up centrifugal systems is given in Bulletin 240-10-3. Information on clean-up after a hermetic motor burnout is also given in Section 91 of the SAM Manual published by the Refrigeration Service Engineers Society.



**SUCTION LINE FILTER-DRIER RECOMMENDATIONS**  
for CLEAN-UP AFTER BURNOUT and NEW SYSTEMS

**System Capacity in Horsepower**

	TYPE NUMBER	CONNECTIONS Inches ODF Solder	NUMBER of Cores or Filter Elements	REFRIGERANT 22		REFRIGERANT 12, 134a & 502	
				TYPE OF INSTALLATION			
				PERMANENT With Cores	TEMPORARY Cores for clean-up; Filter Elements after clean-up	PERMANENT With Cores	TEMPORARY Cores for clean-up; Filter Elements after clean-up
<b>SEALED TYPE</b>	C-084-S-T-HH	1/2	Sealed type filter- driers	1	Select these types on basis of permanent installation	1/2	Select these types on basis of permanent installation
	C-164-S-T-HH	1/2		2		1	
	C-165-S-T-HH	3/8					
	C-166-S-T-HH	3/4					
	C-167-S-T-HH	7/8					
	C-305-S-T-HH	5/8		3		2	
	C-306-S-T-HH	3/4					
	C-307-S-T-HH	7/8					
	C-309-S-T-HH	1 1/8					
	C-417-S-T-HH	7/8		5		3	
	C-419-S-T-HH	1 1/8					
	C-437-S-T-HH	7/8		7 1/2		4	
	C-439-S-T-HH	1 1/8					
	C-4311-S-T-HH	1 3/8		10		5	
C-4313-S-T-HH	1 5/8						
C-607-S-T-HH	7/8	5	3				
C-609-S-T-HH	1 1/8						
<b>REPLACEABLE CORE TYPE</b>	C-487-G	7/8	1	10	10	3	5
	C-489-G	1 1/8		10	20	5	10
	C-4811-G	1 3/8					
	C-4813-G	1 5/8					
	C-967-G	7/8	2	10	10	5	5
	C-969-G	1 1/8		15	20	8	10
	C-9611-G	1 3/8					
	C-9613-G	1 5/8					
	C-1449-G	1 1/8	3	15	20	7 1/2	10
	C-14411-G	1 3/8		25	35	12	15
	C-14413-G	1 5/8					
	C-19211-G	1 5/8					
	C-19213-G	1 5/8	4	25	40	12	20
	C-19217-G	2 1/4					
	C-30013-G	1 5/8					
	C-30017-G	2 1/4	3	25	50	15	25
	C-40017-G	2 1/4					
	C-40021-G	2 5/8					
C-40025-G	3 1/8	4	30	60	20	30	
C-40029-G	3 3/8						
C-40033-G	4 1/8						

**CATCH-ALL SUCTION LINE FILTER-DRIER SELECTION INSTRUCTIONS**

Selection of the proper Catch-All suction line filter-drier will depend upon the intended usage. Either the "Permanent with Cores" or "Temporary Cores for Clean-up; Filter Elements after Clean-up" column may be used. When the best possible system protection is desired the "Permanent with Cores" column should be used for selection. These recommendations are made on the basis of a low pressure drop, and as a result the cores can be left in the shell for maximum drying and acid removal when the system returns to normal operation delivering its full rated capacity.

An alternate selection that is satisfactory and less expensive is to install cores temporarily for clean-up, and

then remove these cores and install filter elements after clean-up. Because of the larger system capacity, the pressure drop through the temporarily installed cores will be somewhat larger than normal, but still within the limits specified in the table on the previous page. After the cleanup is complete, the use of filter elements will assure a minimum pressure drop when the system is put back into normal operation. The low pressure drop through the filter elements assures maximum energy savings during normal operation. Clean-up of the system can be accomplished with either the standard cores (RC-4864 or RC-10098) or the charcoal cores (RC-4864-HH or RC-10098-HH).

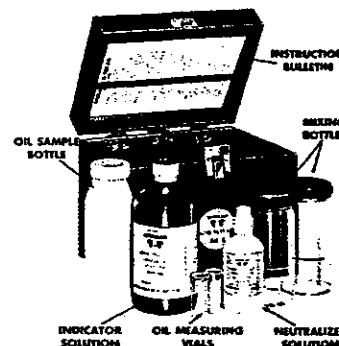
For a Simplified "Quick Selection Guide," request Form 40-109

## ACID TEST KITS

## AK-1 and AK-3



**Thoroughly Field Proven  
Takes the Guess Work  
Out of Service Work**



**The Acid Test Kits offer these outstanding benefits:**

- **BUILDS CUSTOMER CONFIDENCE** — Show the color change test results of the acid test kit to the customer, or perform the test in his presence. In this way he realizes you are using the most up-to-date scientific method for maintenance of his system. Showing him the test results will also help to convince him to spend the money necessary to do a proper clean-up job. A customer who is thoroughly confident of your abilities will be more interested in setting up a preventative maintenance program.
- **ACCURATE and RELIABLE** — A simple scientific principle is used to precisely measure the amount of acid in an oil sample taken from a contaminated system. The test procedure has been proven by extensive field experience.
- **CONVENIENT** — Both the AK-1 and AK-3 are convenient to use. The AK-1 has two pre-measured solutions supplied in bottles with screw caps for easy handling. The AK-3 has all solutions and bottles supplied in a small fitted case. Either kit may be used on the job site, or an oil sample can be saved and tested in the presence of the equipment owner.
- **OIL SAMPLE USED FOR TEST** — Since oil is the scavenger it gives the best indication of acid in the system. Less than an ounce of oil is required.
- **QUICK TO USE** — Once the oil sample is obtained . . . it will take only minutes to perform the test. Simply mix solutions and oil to be tested. Shake, and the resulting color tells the complete story.
- **COST** — The cost of the test is very inexpensive, regardless of which kit is used. The AK-1 kit is more convenient, but for repeated testing the AK-3 is less costly. The bottle of Indicator Solution (Part No. AKI-16) in the AK-3 Kit is sufficient for four tests, and the bottle of Neutralizer Solution (Part No. AKN-2) is sufficient for 150 tests.

**GENERAL INSTRUCTIONS** — Any refrigeration system suspected of an acidic oil condition should be tested to determine if it is within acceptable limits before extensive damage is done and/or hermetic motor burnout occurs. Oil samples can be obtained from welded hermetic systems by installing an oil trap (see Form SD-39).

The Acid Test Kits are simple and direct service tools that "take the guesswork out of service work." They can be used on oil taken from Refrigerant 12, 22, 40, 500 and 502 systems. The test can be made in the field, or service shop, to determine if the acid content of the oil is within safe operational limits.

After mixing the solutions and adding the oil, the color should be judged immediately. Allowing the solution to set an hour or more may give a false reading. The test kit solutions are very stable. No problems have been encountered with storage up to two years. However, the solutions are sensitive to light and heat. The box protects the solution

from direct sunlight. They should not be stored in a hot location. For example, storage over a month in a service truck in the summer should be avoided.

Both the AK-1 and AK-3 kits are normally used on a "pass or fail" basis. If the user desires an indication of the relative amount of acid in the oil, then the AK-3 kit should be selected. For more detailed technical information, request Bulletin 240-10-7.

**CENTRIFUGAL SYSTEMS** — Most of the oils used in centrifugal systems contain additives. These additives react like an acid even though the oil is not contaminated. Therefore, the AK-1 and AK-3 cannot be used to test most centrifugal oils. However, the kits can be used to test the refrigerants themselves. Refrigerant 11 or 113 from these systems can be tested directly. This permits routine maintenance and a check on the system following cleanup of a contaminated system.

Remember . . .  
It's the CORE  
that counts!



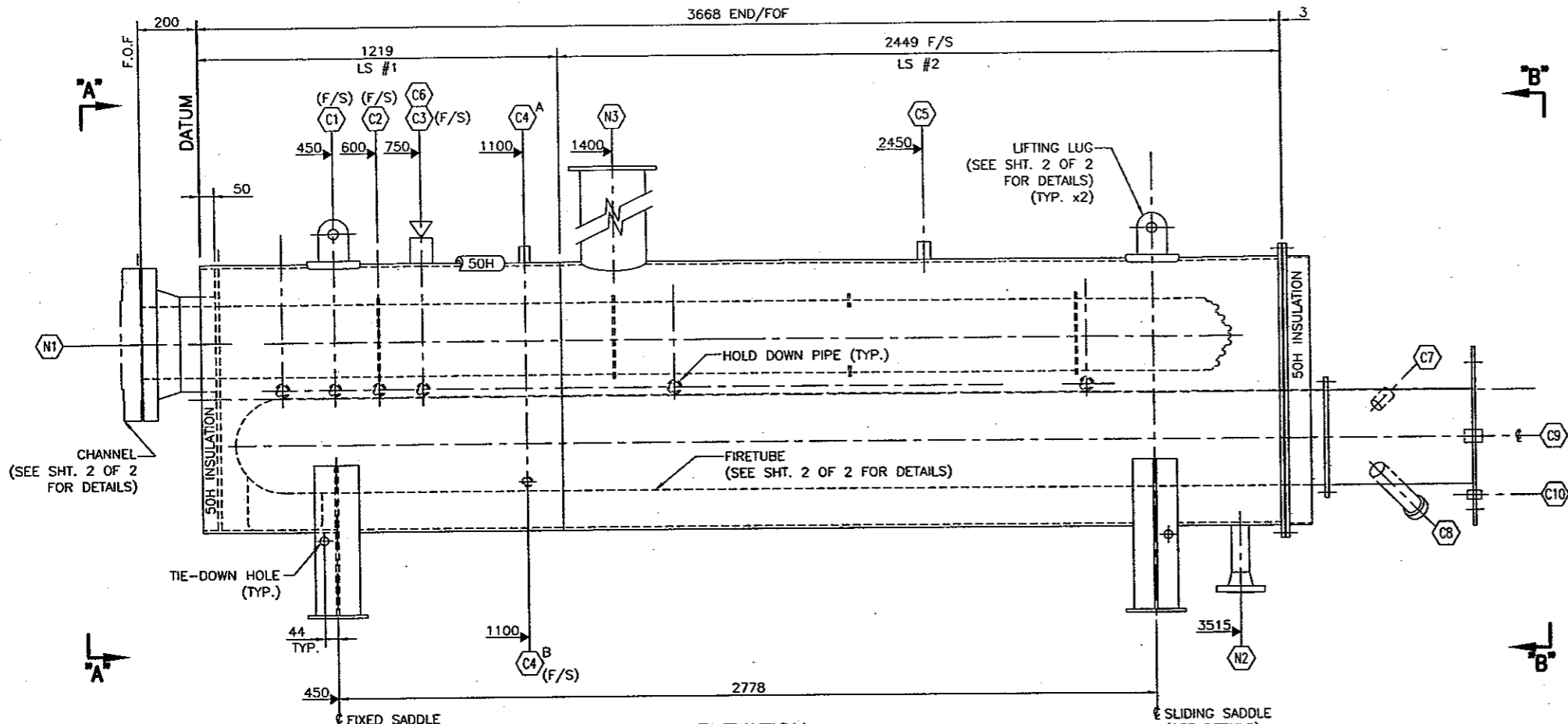
**SPORLAN VALVE COMPANY**  
LANGE DRIVE • WASHINGTON, MD 20786  
314-239-1111

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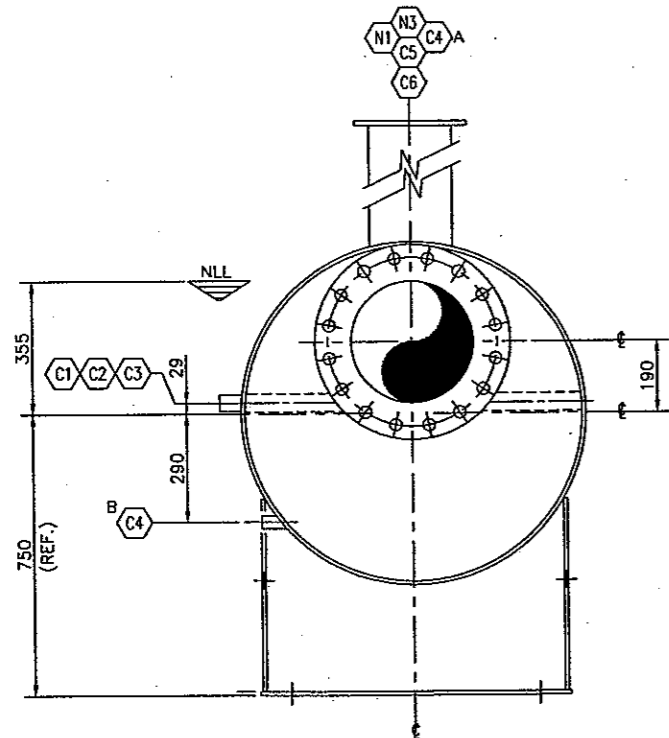
50-894

PROPAC SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SHELL & TUBE EXCHANGER				SHEET 1 OF 1		
CUSTOMER : XXXXXX PLANT : REFRIGERATION PLANT 8B SERVICE : DEETHANIZER REBOILER JOB NO. : XXXXXX TAG NO: H-633 MFR. : PSL MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION			
1 EXCHANGER SIZE: TYPE : HOR. BKU VERT. _____ CONNECTED IN PARALLEL 1 SERIES 1										
2 SURF / UNIT ( GROSS / EFF)		18.7		m2 SHELLS / UNITS :		SURF / UNIT ( GROSS / EFF)		m2		
3 PERFORMANCE OF ONE UNIT										
4 FLUID ALLOCATION			SHELL SIDE				TUBE SIDE			
5 FLUID NAME			SUN 21				HYDROCARBON			
6 FLUID QUANTITY . TOTAL kg/s			BATH							
7 VAPOR (IN / OUT)										
8 LIQUID										
9 STEAM										
10 WATER										
11 NON CONDENSATE										
12 TEMPERATURE ( IN / OUT ) ° C										
13 DENSITY kg/cu.m										
14 VISCOSITY . LIQUID cP										
15 MOLECULAR WEIGHT . LIQUID										
16 SPECIFIC HEAT . LIQUID J/kg C										
17 VISCOSITY . VAPOR cP										
18 MOLECULAR WEIGHT . VAPOR										
19 SPECIFIC HEAT . VAPOR J/kg C										
20 THERMAL COND. LIQ./VAP. W/m C										
21 LATENT HEAT kJ/kg @ C										
22 INLET PRESS. kpa (ab)										
23 VELOCITY m/s										
24 PRESS. DROP ALLOW / CALC kpa										
25 FOULING RESISTANCE ( MINIMUM )										
26 TRANSFER RATE (w/M2 C)			(SERVICE)		(DIRTY)		(CLEAN)			
27 HEAT EXCHANGED kW			MTD		° C (CORRECTED)		° C (UNCORRECTED)			
28 CONSTRUCTION OF ONE SHELL						SKETCH ( BUNDLE / NOZZLE ORIENTATION )				
29			SHELL SIDE		TUBE SIDE					
30 DESIGN / TEST PRESS. kpag			ATMOSPHERIC		3792					
31 DESIGN TEMP ° C			288		232					
32 NO. OF PASSES PER SHELL			1		2					
33 CORROSION ALLOWANCE mm			1.59		1.59					
34 CONNECTIONS :			IN (BATH)		89-300#RF					
35 QUANTITY , SIZE			OUT (BATH)		89-300#RF					
36 RATING & FACE			INTERMEDIATE							
37 TUBE NO		48		TUBE OUTSIDE DIA (OD) mm		19.05		THK ( MIN / AVG ) mm		14 GA
38 TUBE TYPE		PLAIN		TUBE LENGTH m		7.620		PITCH & (30°/60°/90°/45°)		23.81 / 60°
39 SHELL ( ID / OD ) (mm/mm)		894/914		SHELL MATERIAL		SA-516-70		SHELL COVER MATERIAL		CS
40 CHANNEL or BONNET		BONNET		CHANNEL COVER MATERIAL				TUBE MATERIAL		SA-179
41 STATIONARY TUBESHEET		SA-516-70N		FLOATING TUBESHEET						
42 FLOAT HEAD COVER				IMPINGMENT PROTECTION		NONE		PAINT SYSTEM		PNT-12
43 BAFFLES - CROSS		SA-36		TYPE		FULL BAFFLE		% CUT ( DIA / AREA )		0%
44 BAFFLES - LONG				SEAL TYPE				SPACING		806
45 SUPPORT TUBE				U BEND				TYPE		HORIZONTAL 'U'
46 SOUR SERVICE		NO		BYPASS SEAL ARRANGEMENT				TUBE - TUBESHEET JOINT		EXPANDED
47 EXPANSION JOINT				TYPE				X-RAY		CODE
48 pV2 INLET NOZZLE				pV2 BUNDLE IN / OUT				STRESS RELIEF		NO
49 GASKET - SHELL				GASKET - TUBE				GASKET - FLOAT HEAD		
50 CODE REQUIREMENT		ASME VIII DIV 1		STAMP REQUIRED		YES		TEMA CLASS		C
51 WEIGHT EMPTY kg		3290		SHELL WT WITH WATER kg		8320		BUNDLE WEIGHT kg		495
52										
53										
54										
55										
56 REMARKS:										
57										
58										

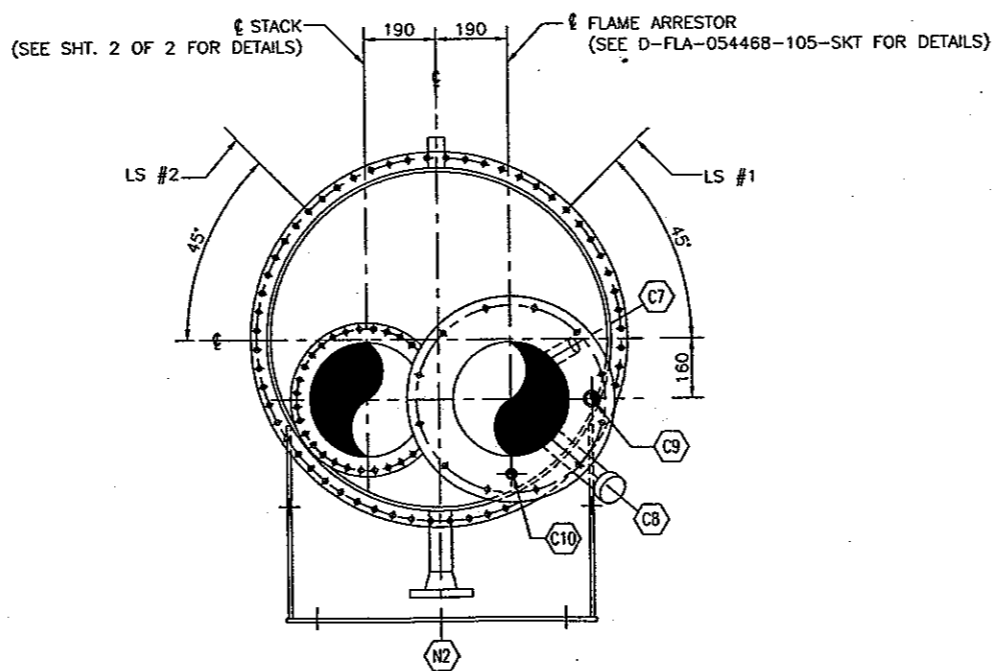
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**ELEVATION**  
SCALE 1:10

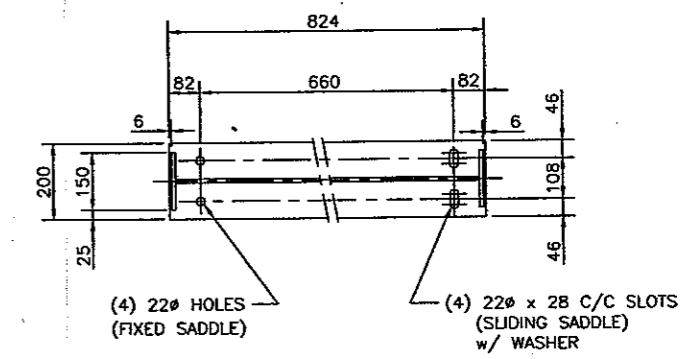


**VIEW 'A-A'**  
SCALE 1:10



**VIEW 'B-B'**  
SCALE 1:10

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD		
N1	12 NPS	300#	RFWN	STD	PROCESS BUNDLE				
N2	2 NPS	150#	RFWN	XH	DRAIN	230			
N3	8 NPS	-	-	STD	EXPANSION TANK/THIEF HATCH	460			
N4	3 NPS	300#	RFWN	XH	TUBESIDE INLET	SPEC			
N5	3 NPS	300#	RFWN	XH	TUBESIDE OUTLET	SPEC			
C1	3/4 NPS	3000#	CPLG	XL	TI	56 MIN			
C2	3/4 NPS	3000#	CPLG	XL	TC	56 MIN			
C3	3/4 NPS	3000#	CPLG	XL	HTSD	56 MIN			
C4A	3/4 NPS	3000#	CPLG	XL	LG	56 MIN			
C4B	3/4 NPS	3000#	CPLG	XL	LG	95 MIN			
C5	1 NPS	3000#	CPLG	-	BLANKET GAS	56 MIN			
C6	2 NPS	3000#	CPLG	-	FILL (PLUGGED)	56 MIN			
C7	1 NPS	3000#	CPLG	XL	FFSD				
C8	2 NPS	-	NPT	XH	LIGHTING PORT				
C9	1 NPS	3000#	CPLG	-	FUEL GAS TO BURNER				
C10	1/2 NPS	3000#	CPLG	-	PILOT				
C11	3/4 NPT	3000#	CPLG	-	TW (PLUGGED)				
C12	3/4 NPS	3000#	CPLG	XL	VENT (PLUGGED)	56 MIN			
C13	3/4 NPS	3000#	CPLG	XL	DRAIN (PLUGGED)	56 MIN			



**FIXED & SLIDING SADDLE PLATE DETAIL**  
SCALE 1:10

SERVICE: GLYCOL	SERIAL NO: 054468-105 CRN: N/A
CAPACITY: 2.27 m <sup>3</sup>	YEAR BUILT: 2005
WEIGHT EMPTY: 3290 kg	LSD #: -
WEIGHT FULL OF WATER: 8320 kg	CODE: NON-CODE
INSULATION: 50 THK CALCIUM SILICATE C/W ALUMINUM CLADDING	DESIGN PRESSURE: ATMOSPHERIC
	DESIGN TEMPERATURE: 285°C
	M.D.M.T.: -28.8 °C
	HYDROTEST PRESSURE: LEAKPROOF
	MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N
	RADIOGRAPHY: LONG: NIL CIRC: NIL
	P.W.H.T. MIN TEMP / TIME: NO
SHIP LOOSE: YES	CORR. ALLOWANCE: 1.59 mm
	TAG NO: H-633

MECH/STRUCT. APPROVED BY DATE ELECTRICAL CHECKED BY DATE PROJECT DATE SCALE AS NOTED

**FORT ENERGY CORP.**  
8B REFRIGERATION UNIT  
DEETHANIZER REBOILER (H-633)  
914 O/D X 3668 END/FOF

DWG. No.: D-REB-054468-105-SKT SHT. 1 OF 2 REV. SKT

440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3

NO.	BY	DATE	CKD	ENG
1	K. LU	05/09/30	VK	MZ

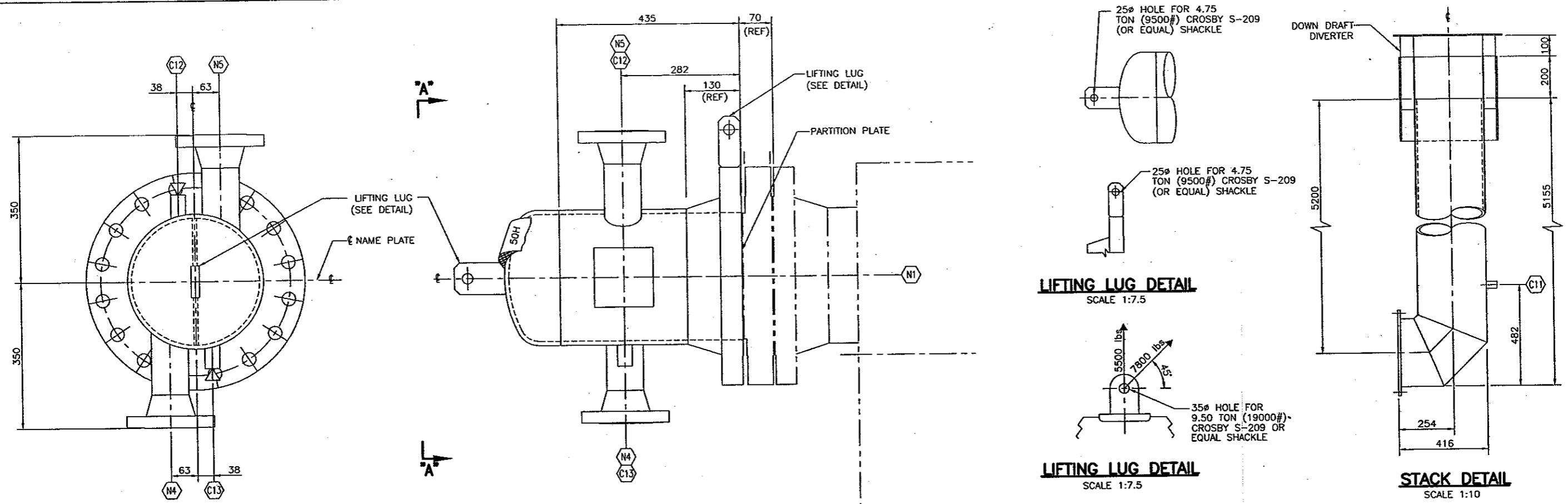
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REVISION

GENERAL NOTES

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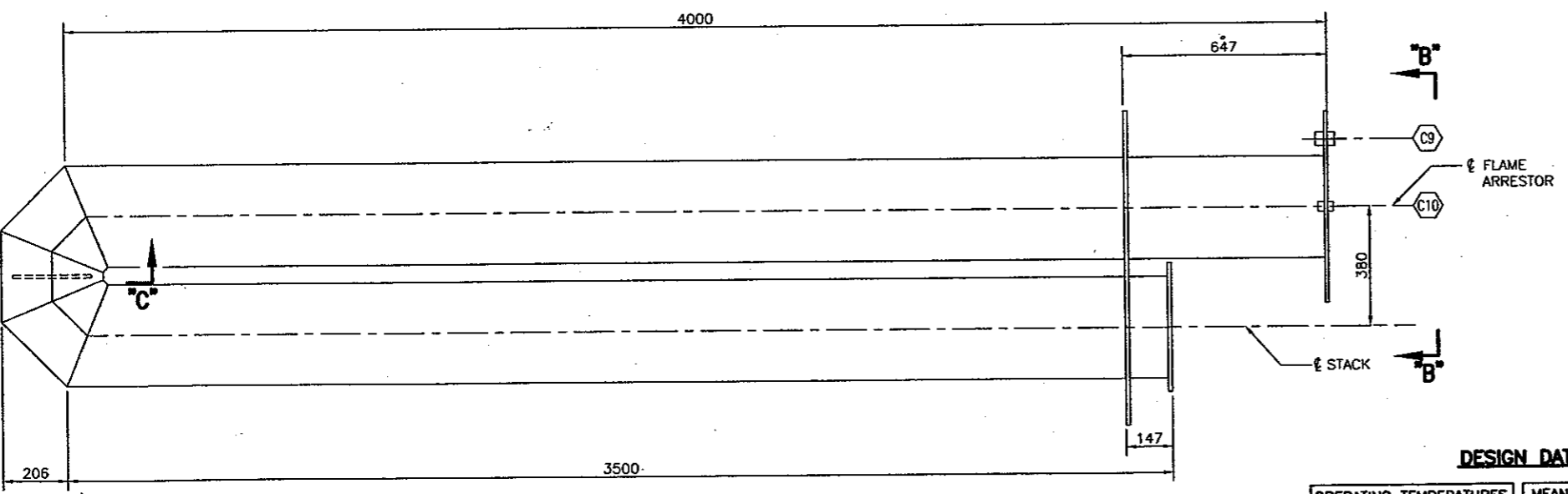
**VIEW 'A-A'**  
SCALE 1:10

**ELEVATION**  
SCALE 1:5

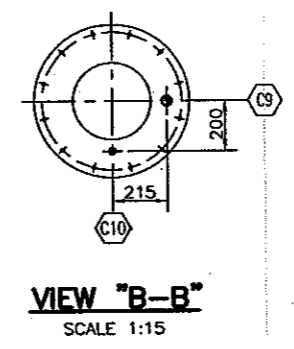
**LIFTING LUG DETAIL**  
SCALE 1:7.5

**LIFTING LUG DETAIL**  
SCALE 1:7.5

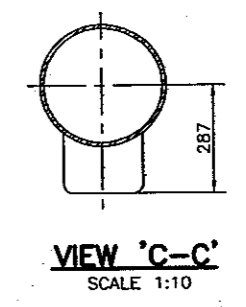
**STACK DETAIL**  
SCALE 1:10



**FIRETUBE PLAN VIEW**  
SCALE 1:10



**VIEW 'B-B'**  
SCALE 1:15



**VIEW 'C-C'**  
SCALE 1:10

**DESIGN DATA**

OPERATING TEMPERATURES		MEAN METAL TEMPERATURES	
SHELLSIDE IN	: 204.4°C	SHELL	: 204.4°C
SHELLSIDE OUT	: 204.4°C	TUBES	: 150.4°C
TUBESIDE IN	: 85.2°C	TUBESHEET	: 150.4°C
TUBESIDE OUT	: 107.7°C	BONNET	: 96.4°C

SERVICE: HYDROCARBONS	SERIAL NO: 054468-105A	CRN: R7178.2
LOADINGS PER UG 22(e) CONSIDERED GOVERNS: NO	YEAR BUILT: 2005	
PRODUCTION IMPACT TEST REQ'D: NO	LSO #:	
IMPACT TESTING:	CODE:	ASME SECT. VIII DIV I, '01, ADDENDA '03
VESSEL: NO - PER UG20(f)(1-5)	DESIGN PRESSURE	3792 kPag
TUBESHEET: NO - PER UCS 66(a)(1)(c) & FIG. UCS 66.	NOTE: DES. PRESS. IS MAWP	
CAPACITY: 0.043 m <sup>3</sup>	DESIGN TEMPERATURE	232°C
SURFACE AREA OF TUBES: 18.7 m <sup>2</sup>	M.D.M.T.	-28.8°C @ 3792 kPag
WEIGHT EMPTY: 250 kg	HYDROTTEST PRESSURE	4930 kPag
WEIGHT FULL OF WATER: 283 kg	MATERIAL: HEAD: SA-234-WPB SMLS	
APPROX. TUBE BUNDLE WEIGHT: 495 kg	SHELL: SA-106-B SMLS	
PAINT SPEC: PNT-12	RADIOGRAPHY: LONG: N/A	
INSULATION: 50 THK CALCIUM SILICATE C/W ALUMINUM CLADDING	CIRC: FULL UW 11(α)	
SHIP LOOSE: NO	P.W.H.T. MIN TEMP / TIME	NO
	CORR. ALLOWANCE	1.59 mm
	TAG NO: H-633	

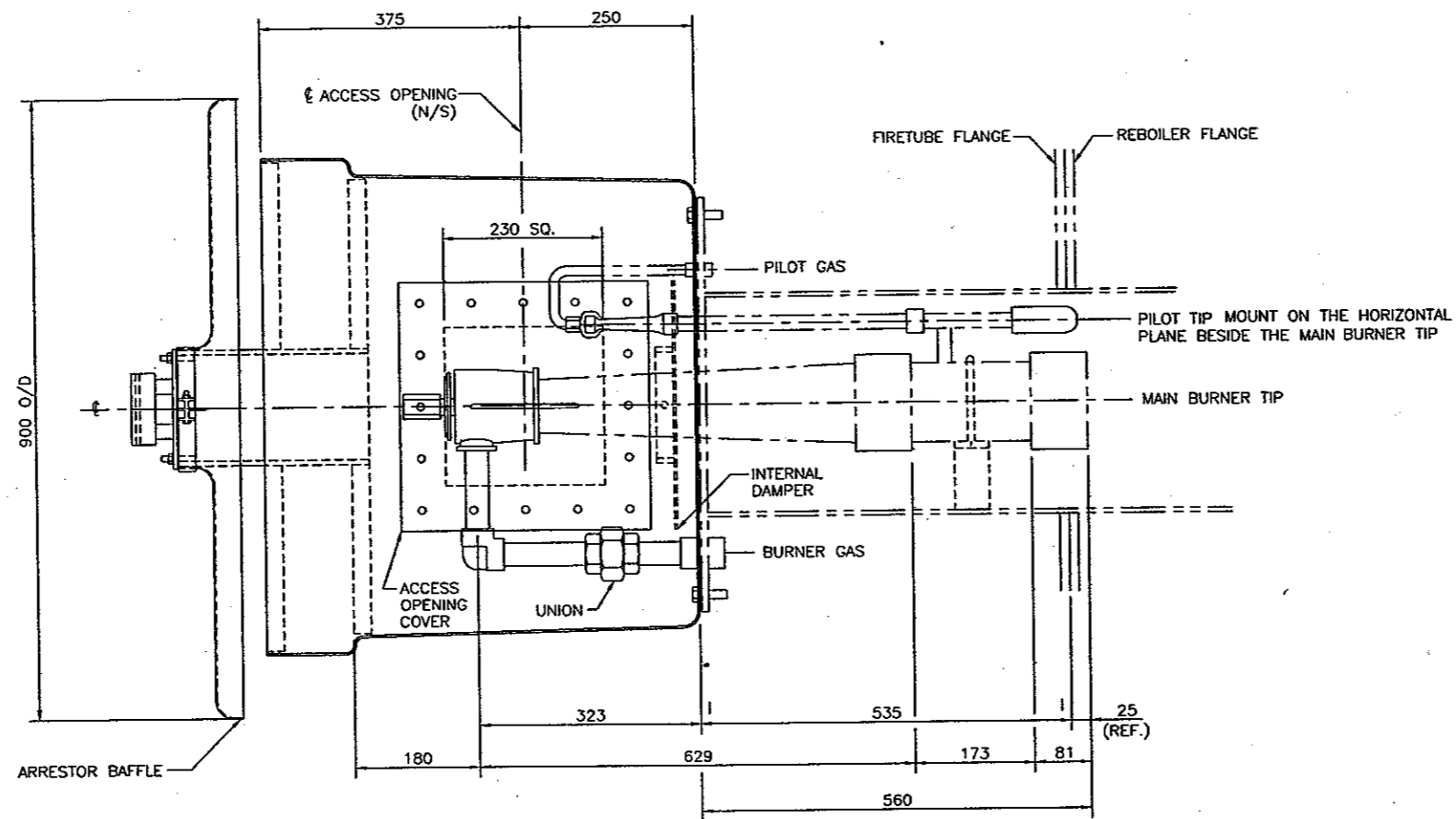
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				No.	REVISION	BY	DATE	CKD	ENG

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MECH/STRUCT.	BY
DATE	DATE
ELECTRICAL	CHECKED
DATE	BY
PROJECT	DATE
DATE	SCALE AS NOTED

<b>FORT ENERGY CORP.</b>	
8B REFRIGERATION UNIT	
DEETHANIZER REBOILER (H-633)	
CHANNEL HEAD DETAIL	
DWG. No.: D-REB-054468-105-SKT	SHT. 2 OF 2
REV. SKT	

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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**FLAME ARRESTOR ASSEMBLY DETAIL**  
SCALE 1:5

OUTPUT DUTY	
NOMINAL	158 KW
MAXIMUM (CLEAN FUEL)	176 KW
MAXIMUM (DIRTY FUEL)	141 KW
FUEL GAS	SWEET
BURNER DESIGN	ECLIPSE #23

					APPROVED		DRAWN		FORT ENERGY CORP.		440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3
					MECH/STRUCT.	BY		DATE	8B REFRIGERATION UNIT		
					DATE			DATE	DE-ETHANIZER REBOILER (H-633)		
					ELECTRICAL	BY	CHECKED		FLAME ARRESTOR FOR 12 NPS FIRETUBE		DWG. No.: D-FLA-054468-105-SKT SHT. 1 OF 1 REV. SKT
					DATE	DATE		DATE			
					PROJECT						
					DATE		SCALE	AS NOTED			
GENERAL NOTES DATE: 2005/09/30 10:05 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\FLA-054468-105-SKT-01.DWG hmeng			GENERAL NOTES SKT ISSUED FOR DOCUMENTATION No.		K. LU BY	05/09/30 DATE	VK CKD	MZ ENG			
REVISION											





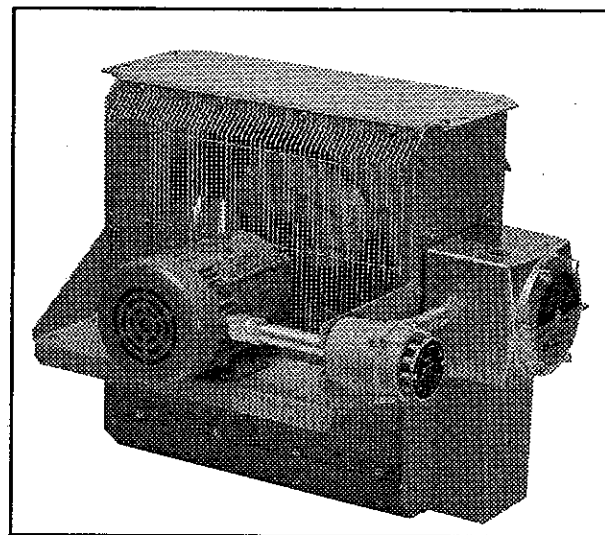
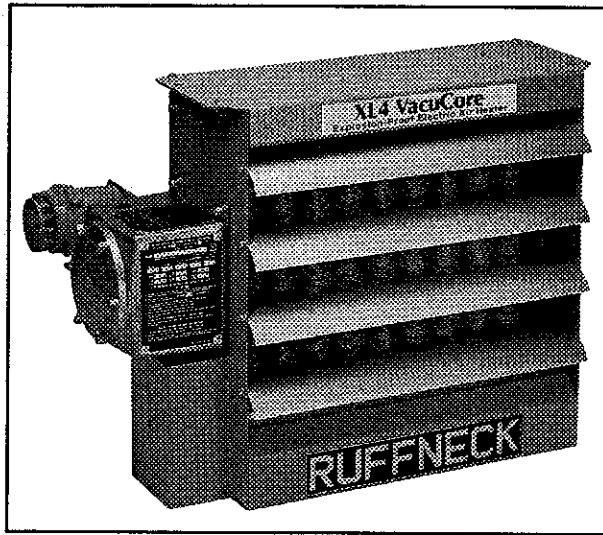
H-400A/B

Owner's Manual



# XL4 VacuCore® Series

Electric Air Heaters for Hazardous Locations



This manual covers the installation, maintenance, repair and parts for 50Hz and 60Hz RUFFNECK XL412, XL416, and XL420 models.

### APPROVED LOCATIONS

RUFFNECK XL4 VacuCore® Series Electric Air Heaters are CSA certified or UL listed for the following locations:

Class I, Divisions 1 & 2, Group D;  
Class II, Division 1, Groups E, F, & G;  
Class II, Division 2, Groups F & G;  
Class I, Zones 1 & 2, Group IIA  
Temperature Code T3B 165°C (329°F);  
(50 Hz & 60 Hz Models)

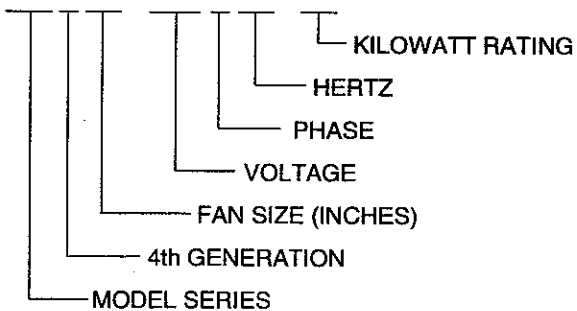
or

Class I, Divisions 1 & 2, Groups C & D;  
Class II, Divisions 1 & 2, Groups F & G;  
Class I, Zones 1 & 2, Groups IIA & IIB  
Temperature Code T3B 165°C (329°F);  
(60 Hz Models Only)

For details of hazardous locations with potential for explosion, refer to the Canadian Electrical Code, Part 1, Section 18 or National Electrical Code articles 500-516.

### MODEL CODING

XL 4 20 - 480 3 60 - 35



**WARNING!**  
READ ALL IMPORTANT NOTICES ON PAGE 3.



Part No 5031-8

Printed in Canada

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# XL4 HEATER MAINTENANCE CHECKLIST

Photocopy  
this page  
for reuse.

Heater Model: \_\_\_\_\_ Serial No.: \_\_\_\_\_

Date of Maintenance: \_\_\_\_\_ Maintenance Done By: \_\_\_\_\_

Comments: \_\_\_\_\_

## WARNING

Disconnect heater from the power supply before opening enclosures or servicing heater. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application. This heater should only be serviced by personnel with heating and hazardous location equipment experience.

### PERIODIC (before and as required during heating season)

- |          |                                       |          |   |
|----------|---------------------------------------|----------|---|
| 1. CLEAN | <input type="checkbox"/> Finned Tubes | 2. CHECK | <input type="checkbox"/> Motor for smooth, quiet operation        |
|          | <input type="checkbox"/> Fan          |          | <input type="checkbox"/> Louvers for proper angle and tightness   |
|          | <input type="checkbox"/> Fan Guard    |          | <input type="checkbox"/> All explosion-proof covers for tightness |
|          | <input type="checkbox"/> Motor        |          |   |
|          | <input type="checkbox"/> Louvers      |          |   |

Remove dust using compressed air. Do not spray with water or solvents.  
Do not immerse in water or solvents.

### ANNUAL (before heating season)

- ELECTRICAL
  - Check all terminal connections and conductors. Tighten loose connections. Conductors with damaged insulation must be replaced.
  - Inspect contactor contacts. If badly pitted, burned or welded shut, replace with factory supplied contactor.
  - Check fuses. Fuse rating and type are on printed circuit board. Correct fuse must be in the active fuse clip. It is recommended that a spare fuse be stored in the spare fuse clip.
  - Check all explosion-proof conduits. Replace damaged conduits. To ensure 5 turns of engagement, threaded ends of conduits must produce a minimum of 1/16" (1.6mm) into enclosures.
  - Check electrical resistance on all load side legs. Reading should be balanced ( $\pm 5\%$ ).
- MECHANICAL
  - Check for fluid leakage. The heater core is vacuum charged and contains ethylene glycol which is **poisonous**. If any fluid leakage occurs from the heater, disconnect it from the power supply and have the core replaced. A factory supplied exchange core can be shipped immediately from stock. Refer to the "Repair and Replacement" section for details.
  - Check all enclosures. Inside of enclosures must be clean, dry and free of foreign materials. Threaded covers must be completely on and hand tight.  
**Note:** Enclosure joints are metal to metal. Do not use gasket material or sealant in joints. A grease is applied to the joints at the factory and should be left in place.
  - Check motor shaft bearing play. Replace motor if play is excessive, or if motor does not run quietly and smoothly. Motor bearings are permanently lubricated.
  - Check fan. Replace immediately if cracked or damaged.
  - Check louvers. Louver screws should be tight. Louvers shall not be fully closed or override stops.
  - Check the tightness of all hardware. All nuts and bolts, including mounting hardware, must be tight.
  - Turn heater on for a minimum of five minutes. Check for warm air exiting heater through louvers. Crackling or pinging noises within heater during start-up are normal.



Before repairing, please call  
Toll Free: 1-800-661-8561 (24 hrs)  
U.S. & Canada

# IMPORTANT NOTICES

## WARNING

Read and adhere to the following. Failure to do so may result in severe or fatal personal injury.

1. Read and follow the instructions in this manual.
2. Heater is to be used only in atmospheres having an ignition temperature higher than the heater's maximum rated operating temperature as shown on the heater data plate. Refer to applicable electrical codes for additional information.
3. Heater to be used only in the hazardous locations indicated on the heater data plate.
4. Heater is for dry indoor use only. Do not immerse in water. Do not store or use in areas exposed to rain or snow.
5. Heater is to be connected and serviced only by a qualified electrician experienced with hazardous location equipment.
6. Installation and wiring to power supply must adhere to all applicable codes.
7. Before opening any enclosures, disconnect the heater from the power supply. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application.
8. This heater is equipped with a single bimetal overtemperature high-limit. It is of the automatic reset type and therefore the heater may restart without warning. The heater is not to be operated with the high-limit disabled or disconnected from the control circuit.
9. Operate the heater only while permanently mounted in an upright position. Refer to the "Installation - Mechanical" section for details.
10. Heater must be kept clean. When operating in a dirty environment, regularly clean the finned tubes, fan, and fan guard. Follow the recommended maintenance procedures. Refer to the "Heater Maintenance Checklist" section for details.
11. The heater core is vacuum charged and contains ethylene glycol which is **poisonous**. If any fluid leakage occurs from the heater, disconnect it from the power supply and have the core replaced with a factory supplied core. Refer to the "Repair and Replacement" section for details.
12. Do not operate the heater with any of the louvers fully closed or overriding stops.
13. Do not operate the heater in atmospheres corrosive to steel or aluminum.
14. Use factory approved replacement parts only.
15. Conduit seals are not required in the heater's factory installed conduits. See applicable electrical codes for seal requirements in field installed conduits.
16. Crackling or pinging noises within the heater core during start up may occur. This is normal.
17. Air discharge near the bottom of the heater may be warmer than the top. This is normal.
18. If there are any questions or concerns regarding the heater, contact the factory. Refer to the back cover of this manual for details.

**WARRANTY WILL BE VOID  
IF INSTRUCTIONS ARE NOT FOLLOWED**

## INSTALLATION

The installation instructions provide a general guideline for the installation and wiring of the heater. All applicable codes must be adhered to.

### MECHANICAL

#### LOCATION

For optimum heating, the heater should be installed as follows:

1. There are no obstructions that may impede the heater's air inlet or discharge.
2. The air discharge is directed into open areas and not at occupants.
3. The air discharge is not directed at a thermostat.
4. The air discharge is directed across areas of heat loss, such as doors and windows (see Figure 1).
5. The air discharge is directed along and at a slight angle towards exterior walls (see Figure 1).
6. If equipment freeze protection is of importance, direct air discharge at equipment.
7. Air discharge streams support each other and create a circular air flow. It is not required that the heater's air throw reaches the next heater (see Figure 1).

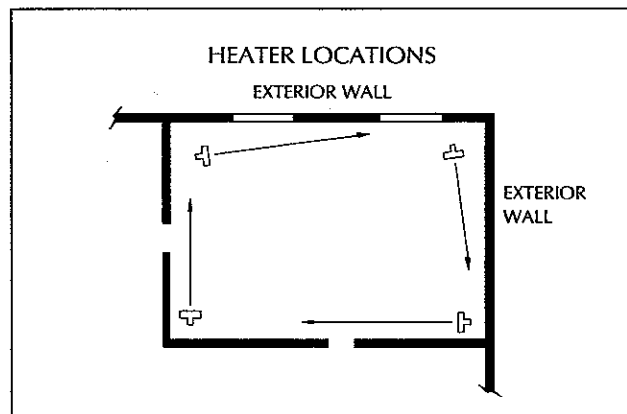


FIGURE 1

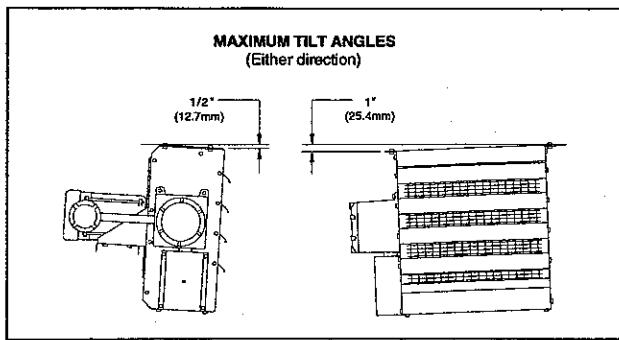


FIGURE 2

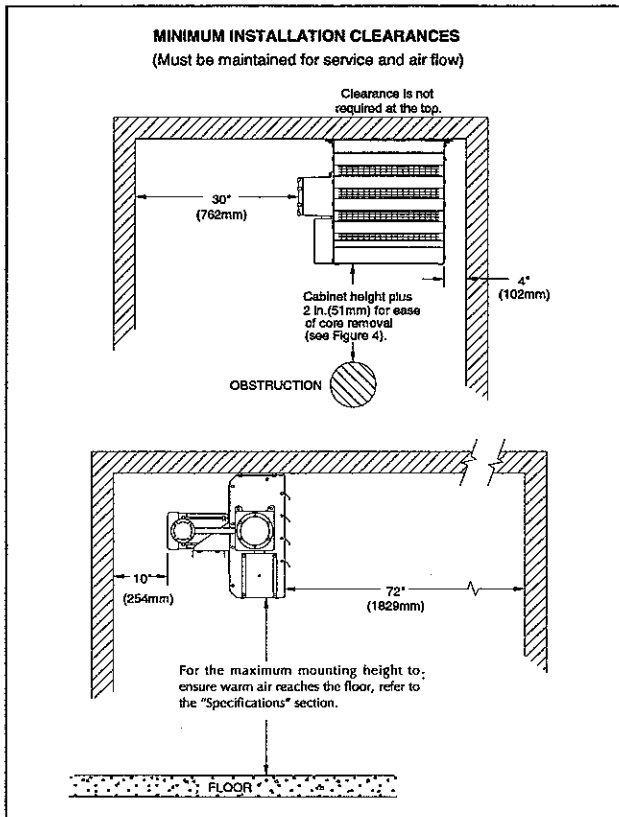


FIGURE 3

## MOUNTING

1. The heater must be permanently mounted in a level, upright position for operation. See Figures 2, 3, and 4 for maximum tilt angles, installation clearances, and physical dimensions.

For ease of installation, a variety of mounting kits are available from the factory.

2. The mounting structure must be strong enough to:
  - a. support the heater's weight, refer to the "Specifications" section,
  - b. provide sufficient stiffness to prevent excessive vibration, and
  - c. withstand harsh situations such as transportable installations.

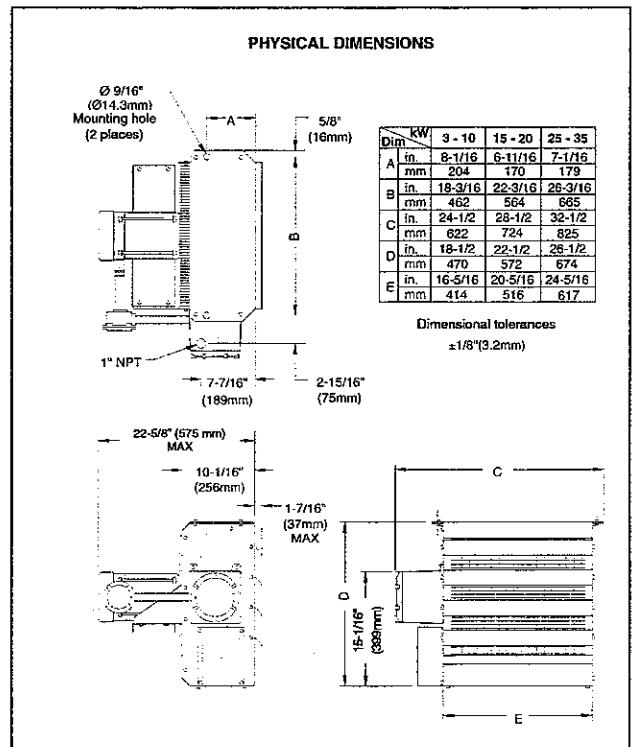


FIGURE 4

## ELECTRICAL

### WARNING

Disconnect the power supply before installation of the heater. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application. Installation and wiring of the heater must adhere to all applicable codes.

### GENERAL

1. Use only copper conductors and approved explosion-proof means of wiring to make connections to the heater. Refer to the "Technical Data" table and heater data plate for conductor rating.
2. External overcurrent protection is required. Refer to the "Technical Data" table and heater data plate for voltage, frequency, amperage, and phase. Supply voltage is to be within 10% of the data plate voltage.

### FIELD WIRING

1. Supply conductors, ground conductor, and room thermostat conductors (see point 2, page 5) pass through the 1" NPT opening (see Figure 5) and are to be wired into the control enclosure (see Figure 6).

(continued next page)

2. Heater may be supplied with a factory installed built-in room thermostat (see Figure 7). On heaters not supplied with this option, it is recommended that a remote room thermostat be used. When installing a remote room thermostat for a 600V Groups C, D, F, & G; IIA & IIB heater, the Motor Temperature High Limit must be connected in series with the control circuit (See Figure 8). On all other heaters, connect the remote room thermostat conductors to the printed circuit board terminal block marked "TSTAT". Any thermostat used with this heater must:
  - a. be of an explosion-proof type,
  - b. be rated 125 V minimum,
  - c. have a minimum 2 amp capacity, and
  - d. open on temperature rise.

Appropriate room thermostats are available from the factory.

## FINAL INSPECTION

1. Before application of electrical power:
  - a. check that all connections are secured and comply with the applicable wiring diagram (see Figure 8) and code requirements,
  - b. confirm that the power supply is compatible with the data plate rating of the heater,
  - c. remove any foreign objects from the heater,
  - d. install all covers and verify that all enclosures are well secured, and
  - e. ensure that the fan rotates freely. See Figure 5 for proper direction of fan rotation.

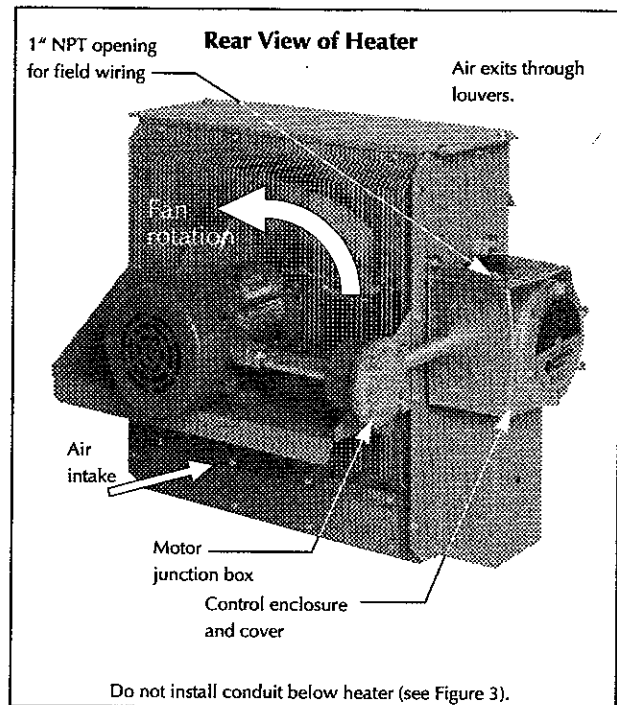


FIGURE 5

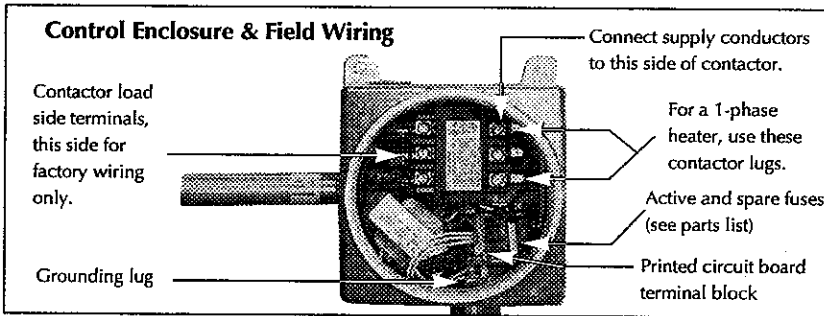


FIGURE 6

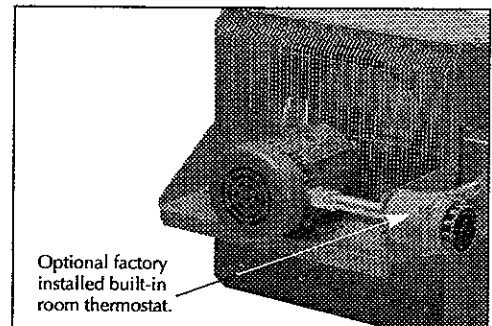


FIGURE 7

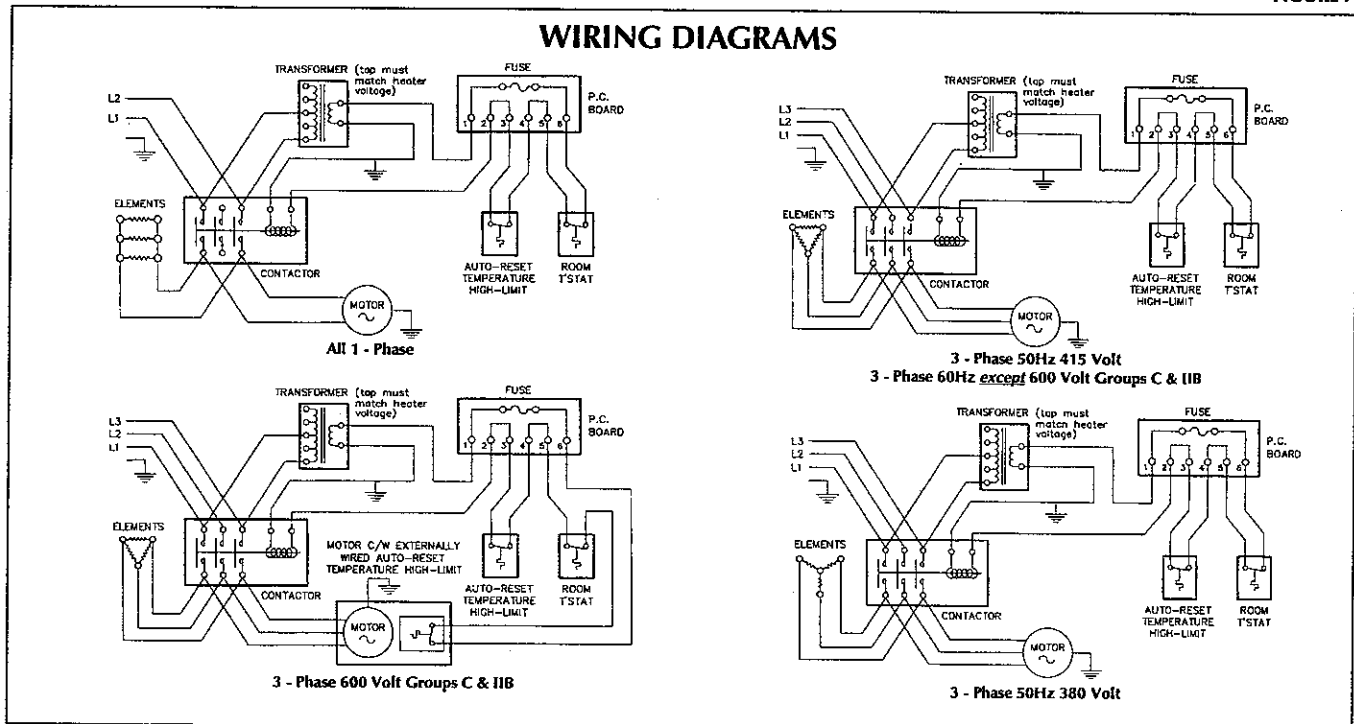


FIGURE 8

# REPAIR & REPLACEMENT

## WARNING

Disconnect power supply before opening enclosures or servicing heater. Lock the switch in the "OFF" (open) position and/or tag the switch to prevent unexpected power application. Heater surfaces may be hot.

1. After repairing any component:
  - a. check that electrical connections are correct and secure (see Figure 8),
  - b. remove any foreign material from enclosures,
  - c. install and secure all covers,
  - d. ensure that all fasteners are tight,
  - e. remove all foreign objects from heater, and
  - f. ensure air exits through louvers and fan rotates counterclockwise when viewed from rear of heater (see Figure 13).

## CORE

The heater core is vacuum charged and not field repairable. For core removal:

1. Remove cabinet bottom and element enclosure cover.
2. Disconnect all wires entering element enclosure (see Figure 9).
3. Slightly loosen all cabinet bolts shown in Figure 9, to prevent the core from binding.
4. With an assistant supporting the weight of the core, remove the 3 core mounting bolts. Carefully lower the core out of the cabinet (see Figure 10).
5. To return core, use crate supplied with exchange core to protect the element terminals and plate threads.
6. To reinstall, lift the core up into cabinet while an assistant guides the element wires into the element enclosure conduit.
7. Position the core and tighten the 3 core mounting bolts. Tighten the remaining cabinet bolts.

## TEMPERATURE HIGH-LIMIT

1. Remove temperature high-limit assembly and clean the inside of the thermowell (see Figure 11). A clean thermowell will ensure good thermal contact.
2. Use only a factory supplied temperature high-limit to ensure safe operation.
3. Apply a small drop, 3/32" (2mm) diameter, of heat sink compound to the center of the metal cap but do not spread. This is critical for proper thermal contact between the temperature high-limit and the thermowell (see Figure 11).
4. Reinstall the temperature high-limit assembly with the snap ring and spring into the thermowell without damaging the insulating tube. Secure in place with the cotter pin (see Figure 12).

## MOTOR, FAN & FAN GUARD

1. Remove bolts holding the motor to the motor mount. On units with a built-in thermostat, remove the bolts on the back of the thermostat enclosure.
2. Remove conduit #1 located between motor junction box and control enclosure by turning it in the direction illustrated (see Figure 13). Note conduits #1

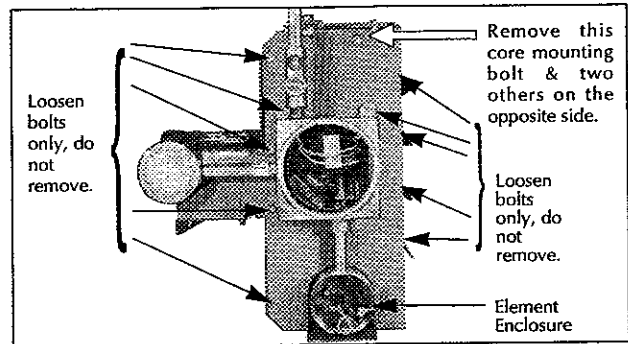


FIGURE 9

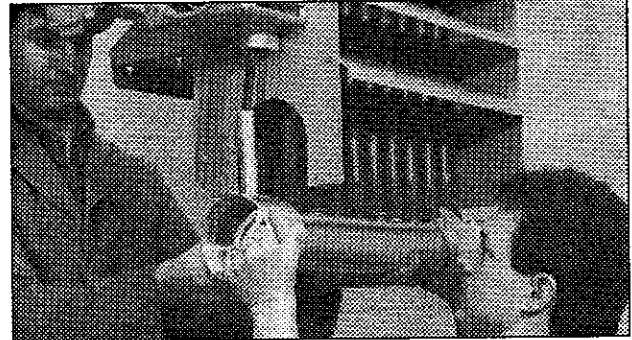


FIGURE 10

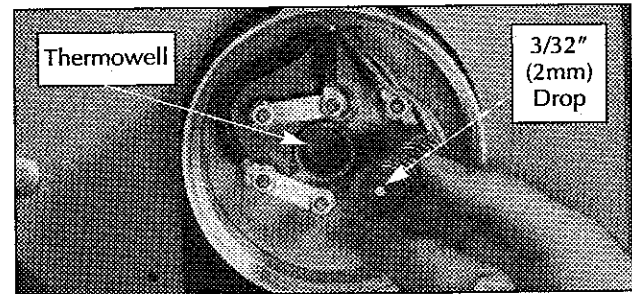


FIGURE 11

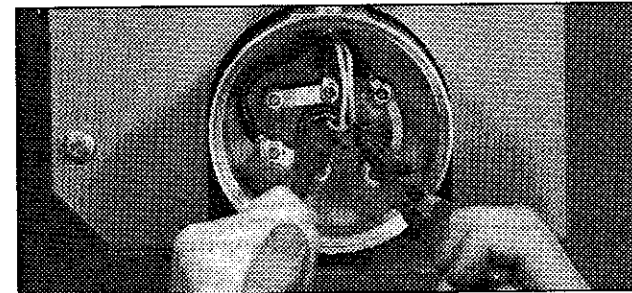


FIGURE 12

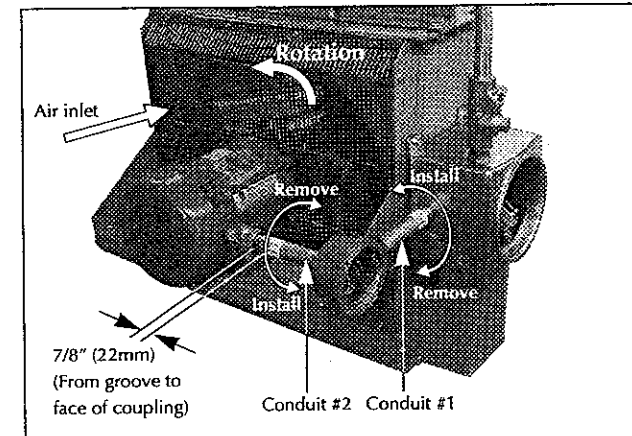


FIGURE 13

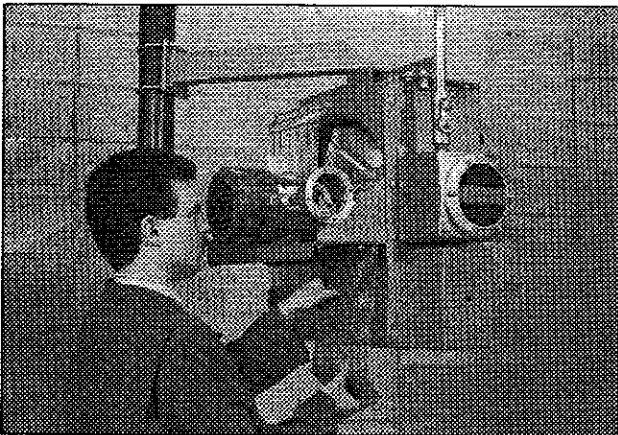


FIGURE 14

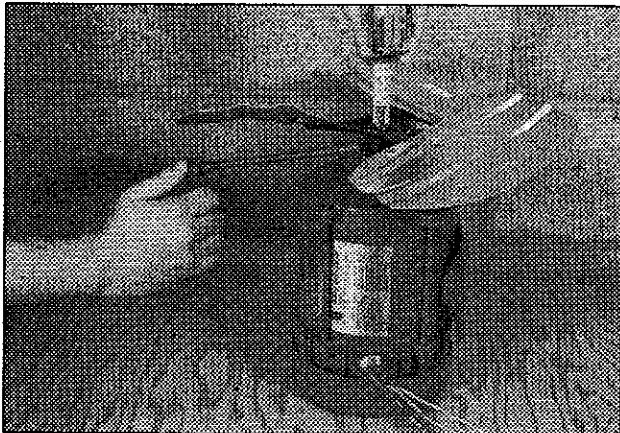


FIGURE 15

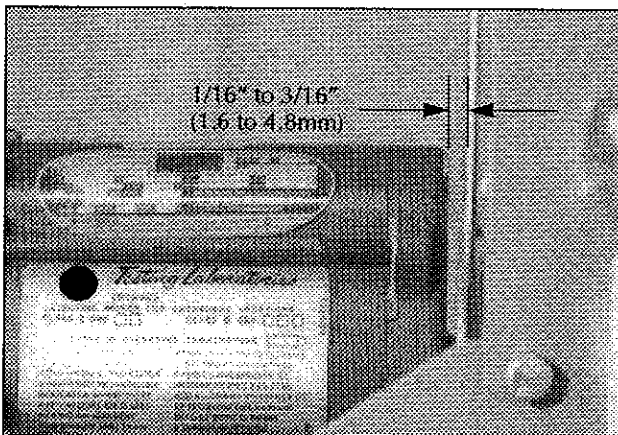


FIGURE 16

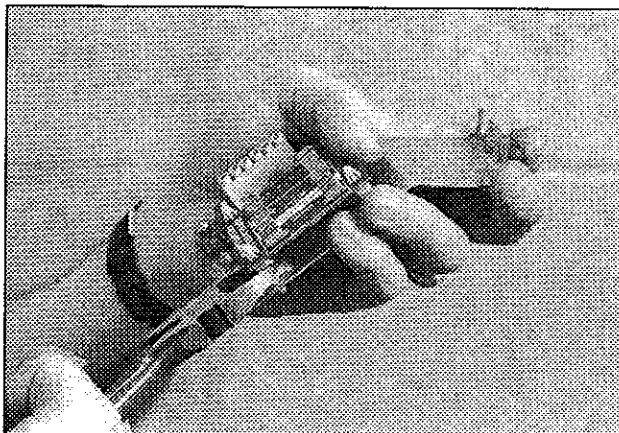


FIGURE 17

and #2 are not interchangeable and have left hand threads on one end, this end is indicated by a machined groove.

3. Remove the 2 piece fan guard assembly (see Figure 14).
4. Lift the motor assembly off the motor mount.
5. Before removing the fan, measure and record the location of the fan hub on the motor shaft (see Figure 15). If difficult to remove, use a gear puller on the fan hub.
6. To reassemble, place motor assembly onto motor mount and fasten the fan guard to cabinet.
7. Simultaneously engage and tighten both ends of conduit #1 into enclosures. Leave a 1/16" to 3/16" (1.6 to 4.8 mm) gap between the motor and fan guard (see Figure 16). Adjust conduit #2 to center the fan in the shroud.
8. To ensure a minimum 5 thread engagement, threaded ends of conduits must protrude a minimum of 1/16" (1.6mm) into enclosures. The groove on conduit #2 must not be more than 7/8" (22mm) from motor coupling (see Figure 13).
9. Bolt motor to motor mount. Manually spin the fan blade to ensure fan rotates freely.
10. Air must exit through louvers and fan must rotate counterclockwise when viewed from rear of heater (see Figure 13).

## PRINTED CIRCUIT BOARD

1. After removing the printed circuit board (P.C. Board) bracket assembly from the control enclosure, separate the P.C. Board from the bracket by cutting off the plastic spacers (see Figure 17).
2. Reinstall the P.C. Board onto the mounting bracket using new non-conducting spacers of the same length. Spacers are supplied with a new P.C. Board. Reinstall the control circuit ground wire to the printed circuit board bracket (see Wiring Diagram).

## CONTACTOR

1. Loosen, but do not remove contactor mounting screws. Slide contactor off mounting screws.
2. Replace with a factory supplied contactor of the same rating.

## TRANSFORMER

1. Replace with a factory supplied transformer of the same rating.
2. On the new transformer, select primary wires to match heater voltage. Ensure that the correct transformer secondary lead is grounded (see Wiring Diagram). Individually terminate all unused wires using closed end connectors.

## FUSE

Replace fuse with one of the same type and rating as indicated on P.C. Board or refer to parts list. An extra fuse should be stored in the clips marked "SPARE".

## HEATING ELEMENTS

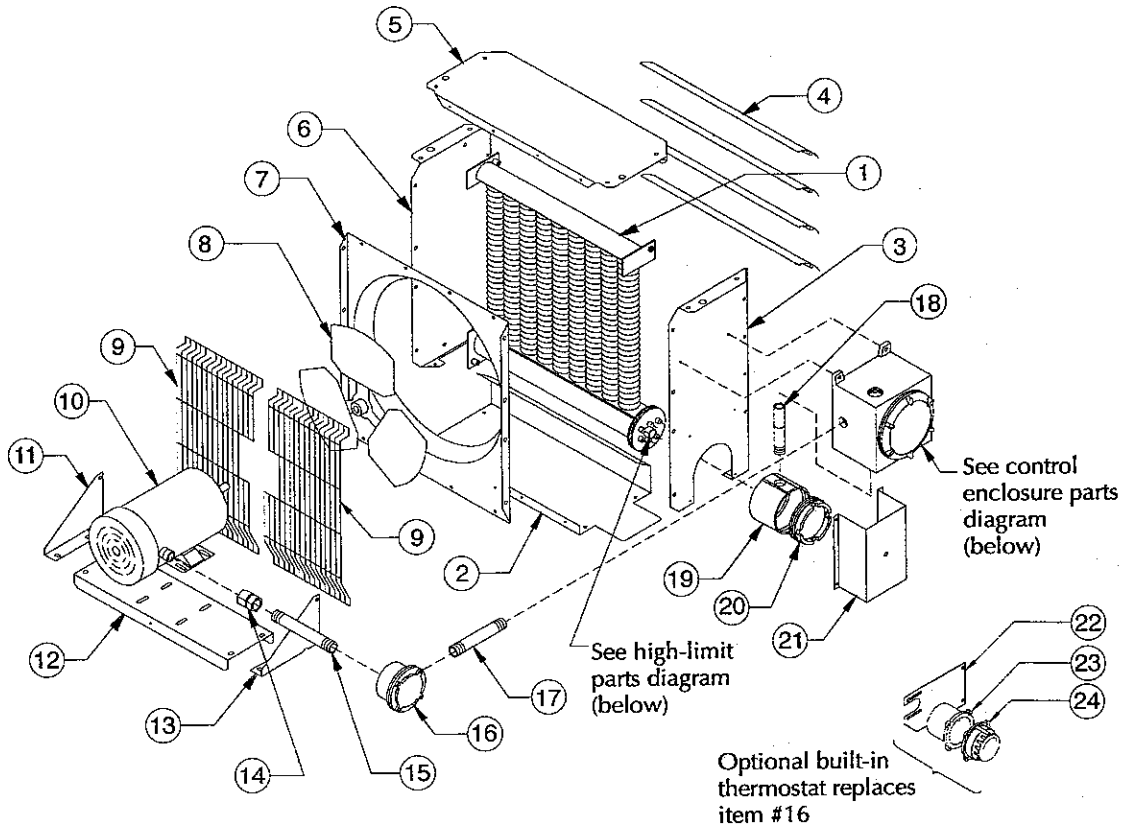
Heating elements are an integral part of the vacuum charged core. A factory exchange core can be shipped immediately from stock. Refer to "Core" section for details.

## CABINET PANELS

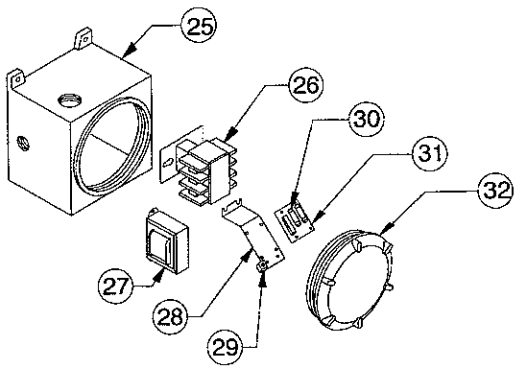
Bolt-on cabinet panels are individually replaceable.



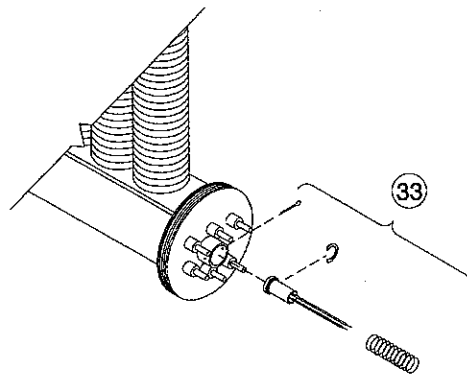
# PARTS DIAGRAM



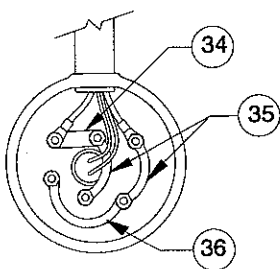
## CONTROL ENCLOSURE



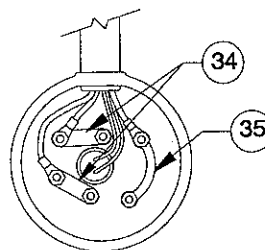
## HIGH LIMIT



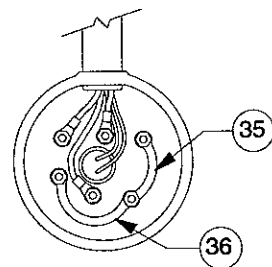
## BUS-BAR CONFIGURATION FOR ALL 1-PHASE



## BUS BAR CONFIGURATION FOR ALL 3-PHASE (EXCEPT 380 VOLT 50 HERTZ)



## BUS-BAR CONFIGURATION 3-PHASE 380 VOLT 50 HERTZ ONLY





# XL4 PARTS LIST

PART NUMBER				Please have model and serial number available before calling.
ITEM	XL412	XL416	XL420	DESCRIPTION
1	**	**	**	Core
2	3773	3774	3775	Panel, Bottom
3	3776	3777	3778	Panel, Left Side
4	4075	4076	4077	Louver Kit, c/w Screws
5	3770	3771	3772	Panel, Top
6	3779	3780	3781	Panel, Right Side
7	3782	3783	3784	Fan Shroud
8	2.5 - 5.0 kW: 4022 6.3 - 10 kW: 4023	12.5 - 20 kW: 4024	20.9-30 kW: 4025 35kW: 4026	Fan
9	4078	4079	4080	Fan Guard Kit
10	Groups D, E, F, & G; IIA 208/240V 60 HZ 1 PH: 1377 220V 50 HZ 1 PH: 1377 c/w 4953 480V 60 HZ 1 PH: 2396 208/240/480V 60HZ 3PH: 1862 380/415V 50 HZ 3 PH: 1862 600V 60HZ 3 PH: 1861  Groups C, D, F, & G; IIA & IIB 208/240V 60HZ 1 PH: 4593 208/240/480V 60HZ 3PH: 4594 600V 60 HZ 3 PH: 4595	1377 1377 c/w 4953 2396 1862 1862 1861	Groups D, E, F, & G; IIA 240/480V 60 HZ 3 PH: 1699 380/415V 50 HZ 3 PH: 1699 600V 60 HZ 3 PH: 2433  Groups C, D, F, & G; IIA & IIB 240/480V 60 HZ 3 PH: 4596 600V 60HZ 3 PH: 4597	Motor, Explosion-Proof
11	3789	3789	3789	Bracket, Motor Mount Right
12	3785	3786	3787	Channel, Motor Mount
13	3788	3788	3788	Bracket, Motor Mount Left
14	Groups D, E, F, & G; IIA : 3737    Groups C, D, F, & G; IIA & IIB: 4590			Coupling, Motor
15	3811	3812	3813	Conduit, Motor
16	Groups D, E, F, & G; IIA : 3838    Groups C, D, F, & G; IIA & IIB: 4983 CW 5027			Enclosure, Conduit Junction
17	Groups D, E, F, & G; IIA 208/240V 60 HZ 1PH: 3815 220V 50 HZ 1PH: 3815 480V 60 HZ 1PH: 3813 ALL 3PH: 3814  Groups C, D, F, & G; IIA & IIB ALL: 3815	3815 3815 3813 3814 3815	Groups D, E, F, & G; IIA ALL: 3813  Groups C, D, F, & G; IIA & IIB ALL: 3815	Conduit, Control Enclosure
18	3810	3810	3810	Conduit, Element Enclosure
19	3793	3793	3793	Enclosure, Element
20	3510	3510	3510	Cover, Element Enclosure
21	3790	3790	3790	Panel, Element Enclosure Guard
22	3791	3791	3791	Bracket, Thermostat
23	4983	4983	4983	Enclosure, Thermostat
24	5032	5032	5032	Thermostat, Built-in Kit
25	3524	3525	3526	Enclosure, Control
26	**	**	**	Contactor
27	60 HERTZ: 3612	50 HERTZ: 4416		Transformer
28	3809	3809	3809	Bracket, Printed Circuit Board
29	1876	1876	1876	Terminal, 6-14 ga. Screw Lug
30	3519	3519	3519	Fuse, Buss MDQ-1/4 Amp
31	3514	3514	3514	Printed Circuit Board Assembly
32	3516	3516	3516	Cover, Control Enclosure
33	4082	4082	4082	Temperature High-Limit Kit
34	3816	3816	3816	Bus-Bar, Straight
35	3817	3817	3817	Bus-Bar, Small Curved
36	3818	3818	3818	Bus-Bar, Large Curved

\*\* See technical data table for part numbers. NOTE: For items not shown, contact factory

# SPECIFICATIONS FOR ALL **60 HZ** MODELS

	Nominal kW	XL412				XL416		XL420		
		3	5	7.5	10	15	20	25	30	35
Max. Altitude	(ft.) (m)	12,000 3,658	8,000 2,438	10,000 3,048	7,000 2,134	10,000 3,048	7,000 2,134	10,000 3,048	7,000 2,134	6,000 1,829
Air Delivery @ 70°F @ 21°C	(CFM) (m <sup>3</sup> /hr.)	500 850		850 1444		1750 2973		3600 6116		3950 6711
Horizontal Throw	(ft.) (m)	15 4.6		30 9.1		40 12.2		70 21.3		
Max. Mounting Height (to underside)	(ft.) (m)	7 2.1		10 3.0		10 3.0		20 6.1		
Motor Power	(HP) (kW)		1/4 0.187			1/4 0.187		1/2 0.373		
Fan Diameter	(in.) (mm)		12 305			16 406		20 508		
Net Weight	(lbs.) (kg)		111 50			133 61		154 70		
Shipping Weight	(lbs.) (kg)		151 69			173 79		204 93		
Enclosures	NEMA Type 7 & 9. For dry, indoor use only. Do not immerse in water. Do not store or use in areas exposed to rain or snow.									
Motor Type	Explosion-proof. Thermally protected. Permanently lubricated ball bearings. 1725 RPM									
Fan	Aluminum blade. Steel spider and hub with 5/8 in. (15.875 mm) bore.									
Fan Guard	Split design with close wire spacing. 1/4 in. (6.3 mm) dia. probe will not enter.									
Mounting Holes	Two 9/16 in. (14.3 mm) diameter holes, at top of heater.									
Heating Elements	Three long-life, low watt-density, high grade metal-sheathed elements.									
Temperature High-Limit	Automatic reset type, snap-action bimetal, open on temperature rise. Rated 100,000 cycles at 10 amps, handles 0.128 amps.									
Control Circuit	120 Volts, 0.128 amps, 15VA. (Grounded)									
Optional Built-in Thermostat	Explosion-proof. 36°F to 82°F (2°C to 28°C)									
Control Transformer	Multi-tap primary, 120 V secondary, 25 VA.									
Contactors	40 or 75 amp. Rated for 500,000 mechanical operations. 120 Volts, 15VA coil (separately fuse-protected).									
Heat Transfer Fluid	Long life formulated ethylene glycol and water, freeze protected to -49°F (-45°C).									
Cabinet Material	14 ga. (0.075in.) (1.90 mm) steel. Epoxy coated with five-stage pretreatment, including iron phosphate.									
Core	Steel with integral aluminum fins, vacuum charged and hermetically sealed.									
Conduit Material	Heavy walled, 0.122 in. (3.1 mm), steel, cadmium plated.									
Overpressure Protection	Fusible alloy plug 170 psi (1.17 MPa).									
Temperature Code Rating	T3B 165°C (329°F) Class I & II.									
Temperature Limitations	-49°F to 104°F (-45°C to 40°C).									
Storage Limitations	-49°F to 176°F (-45°C to 80°C), short term to 248°F (120°C). Do not immerse in water. Do not store or use in areas exposed to rain or snow.									

# SPECIFICATIONS FOR ALL **50 HZ** MODELS

	Nominal kW	XL412				XL416		XL420	
		25	37&42	63&75	84	125&126	149&167	209	224
Max. Altitude	(ft.) (m)	12,000 3,658	8,000 2,438	10,000 3,048	7,000 2,134	10,000 3,048	7,000 2,134	10,000 3,048	7,000 2,134
Air Delivery @ 70°F @ 21°C	(CFM) (m <sup>3</sup> /hr.)	400 679		700 1189		1450 2463		3000 5096	
Horizontal Throw	(ft.) (m)	13 4.0		25 7.6		35 10.7		60 18.2	
Max. Mounting Height	(ft.) (m)	7 2.1		10 3.0		10 3.0		20 6.1	
Fan Diameter	(in.) (mm)	12 305				16 406		20 508	
Net Weight	(lbs.) (kg)	111 50				133 61		154 70	
Shipping Weight	(lbs.) (kg)	151 69				173 79		204 93	
Enclosures	NEMA Type 7 & 9. For dry, indoor use only. Do not immerse in water. Do not store or use in areas exposed to rain or snow.								
Motor Type	Explosion-proof. Thermally protected. Permanently lubricated ball bearings. 1425 RPM								
Fan	Aluminum blade. Steel spider and hub with 5/8 in. (15.875 mm) bore.								
Fan Guard	Split design with close wire spacing. 1/4 in. (6.3 mm) dia. probe will not enter.								
Mounting Holes	Two 9/16 in. (14.3 mm) diameter holes, at top of heater.								
Heating Elements	Three long-life, low watt-density, high grade metal-sheathed elements.								
Temperature High-Limit	Automatic reset type, snap-action bimetal, open on temperature rise. Rated 100,000 cycles at 10 amps, handles 0.130 amps.								
Control Circuit	115 Volts, 0.130 amps, 15VA. (Grounded)								
Optional Built-in Thermostat	Explosion-proof. 36°F to 82°F (2°C to 28°C)								
Control Transformer	Multi-tap primary, 115 V secondary, 25 VA.								
Contactors	40 or 75 amp. Rated for 500,000 mechanical operations. 120 Volts, 15VA coil (separately fuse-protected).								
Heat Transfer Fluid	Long life formulated ethylene glycol and water, freeze protected to -49°F (-45°C).								
Cabinet Material	14 ga. (0.075in.) (1.90 mm) steel. Epoxy coated with five-stage pretreatment, including iron phosphate.								
Core	Steel with integral aluminum fins, vacuum charged and hermetically sealed.								
Conduit Material	Heavy walled, 0.122 in. (3.1 mm), steel, cadmium plated.								
Overpressure Protection	Fusible alloy plug 170 psi (1.17 MPa).								
Temperature Code Rating	T3B 165°C (329°F) Class I & II.								
Temperature Limitations	-49°F to 104°F (-45°C to 40°C).								
Storage Limitations	-49°F to 176°F (-45°C to 80°C), short term to 248°F (120°C). Do not immerse in water. Do not store or use in areas exposed to rain or snow.								

# XL4 TECHNICAL DATA FOR ALL **CSA** CERTIFIED 60 HZ MODELS ONLY



MODEL	VOLTAGE (V)	NOMINAL WATTAGE (kW)	PHASE	TOTAL CURRENT (A)	TEMPERATURE RISE		MAXIMUM FUSE SIZE (A)	CORE PART NUMBER	CONTACTOR PART NUMBER
					°F	°C			
XL412-208160-3	208	3	1	14.4	19	10.5	20	4044	3618
XL412-240160-3	240	3	1	12.5	19	10.5	20	4045	3618
XL412-208360-3	208	3	3	8.3	19	10.5	15	4044	3618
XL412-240360-3	240	3	3	7.2	19	10.5	15	4045	3618
XL412-480160-3	480	3	1	6.3	19	10.5	15	4046	3618
XL412-480360-3	480	3	3	3.6	19	10.5	15	4046	3618
XL412-600360-3	600	3	3	2.9	19	10.5	15	4047	3618
XL412-208160-5	208	5	1	24	31.6	17.6	35	4048	3618
XL412-240160-5	240	5	1	20.8	31.6	17.6	30	4049	3618
XL412-208360-5	208	5	3	13.9	31.6	17.6	20	4048	3618
XL412-240360-5	240	5	3	12	31.6	17.6	20	4049	3618
XL412-480160-5	480	5	1	10.4	31.6	17.6	15	4050	3618
XL412-480360-5	480	5	3	6	31.6	17.6	15	4050	3618
XL412-600360-5	600	5	3	4.8	31.6	17.6	15	4051	3618
XL412-208160-7.5	208	7.5	1	36.1	27.9	15.5	50	4052	3619
XL412-240160-7.5	240	7.5	1	31.3	27.9	15.5	40	4053	3618
XL412-208360-7.5	208	7.5	3	20.8	27.9	15.5	30	4052	3618
XL412-240360-7.5	240	7.5	3	18	27.9	15.5	25	4053	3618
XL412-480160-7.5	480	7.5	1	15.6	27.9	15.5	20	4054	3618
XL412-480360-7.5	480	7.5	3	9	27.9	15.5	15	4054	3618
XL412-600360-7.5	600	7.5	3	7.2	27.9	15.5	15	4055	3618
XL412-208160-10	208	10	1	48.1	37.2	20.6	70	4056	3619
XL412-240160-10	240	10	1	41.7	37.2	20.6	60	4057	3619
XL412-208360-10	208	10	3	27.8	37.2	20.6	35	4056	3618
XL412-240360-10	240	10	3	24.1	37.2	20.6	35	4057	3618
XL412-480160-10	480	10	1	20.8	37.2	20.6	30	4058	3618
XL412-480360-10	480	10	3	12	37.2	20.6	20	4058	3618
XL412-600360-10	600	10	3	9.6	37.2	20.6	15	4059	3618
XL416-240160-15	240	15	1	62.5	27.1	15	80	4061	3619
XL416-208360-15	208	15	3	41.6	27.1	15	60	4060	3619
XL416-240360-15	240	15	3	36.1	27.1	15	50	4061	3619
XL416-480160-15	480	15	1	31.3	27.1	15	40	4062	3618
XL416-480360-15	480	15	3	18	27.1	15	25	4062	3618
XL416-600360-15	600	15	3	14.4	27.1	15	20	4063	3618
XL416-208360-20	208	20	3	55.5	36.1	20.1	70	4064	3619
XL416-240360-20	240	20	3	48.1	36.1	20.1	70	4065	3619
XL416-480160-20	480	20	1	41.7	36.1	20.1	60	4066	3619
XL416-480360-20	480	20	3	24.1	36.1	20.1	35	4066	3618
XL416-600360-20	600	20	3	19.2	36.1	20.1	25	4067	3618
XL420-240360-25	240	25	3	60.1	21.9	12.2	80	4068	3619
XL420-480360-25	480	25	3	30.1	21.9	12.2	40	4069	3618
XL420-600360-25	600	25	3	24.1	21.9	12.2	35	4070	3618
XL420-480360-30	480	30	3	36.1	26.3	14.6	50	4071	3619
XL420-600360-30	600	30	3	28.9	26.3	14.6	40	4072	3618
XL420-480360-35	480	35	3	42.1	28	15.6	60	4073	3619
XL420-600360-35	600	35	3	33.7	28	15.6	45	4074	3619

**NOTES:**

1. Heater is functioning normally if at rated voltage the amp draw is within 10% of the value in this table.
2. Operation at lower voltages will result in reduced heat output and amp draw.

# XL4 TECHNICAL DATA FOR ALL **CSA** CERTIFIED 50 HZ MODELS ONLY



MODEL	VOLTAGE (V)	NOMINAL WATTAGE (KW)	PHASE	TOTAL CURRENT (A)	TEMPERATURE RISE		MAXIMUM FUZE SIZE (A)	CORE PART NUMBER	CONTACTOR PART NUMBER
					°F	°C			
XL412-220150-2.5	220	2.5	1	11.4	19.7	11	15	4045	3618
XL412-220150-4.2	220	4.2	1	19.1	33.2	18.4	25	4049	3618
XL412-220150-6.3	220	6.3	1	28.6	28.4	15.8	40	4053	3618
XL412-220150-8.4	220	8.4	1	38.2	37.9	21.1	50	4057	3619
XL416-220150-12.6	220	12.6	1	57.3	27.5	15.3	80	4061	3619
XL412-380350-2.5	380	2.5	3	3.8	19.7	11	15	4045	3618
XL412-380350-4.2	380	4.2	3	6.4	33.2	18.4	15	4049	3618
XL412-380350-6.3	380	6.3	3	9.6	28.4	15.8	15	4053	3618
XL412-380350-8.4	380	8.4	3	12.8	37.9	21.1	20	4057	3618
XL416-380350-12.5	380	12.5	3	19	27.2	15.1	25	4061	3618
XL416-380350-16.7	380	16.7	3	25.4	36.4	20.2	35	4065	3618
XL420-380350-20.9	380	20.9	3	31.8	22	12.2	40	4068	3618
XL412-415350-3.7	415	3.7	3	5.1	29.2	16.2	15	4050	3618
XL412-415350-7.5	415	7.5	3	10.4	33.9	18.8	15	4058	3618
XL416-415350-14.9	415	14.9	3	20.7	32.5	18	30	4066	3618
XL420-415350-22.4	415	22.4	3	31.2	23.6	13.1	40	4071	3618

**NOTES:**

1. Heater is functioning normally if at rated voltage the amp draw is within 10% of the value in this table.
2. Operation at lower voltages will result in reduced heat output and amp draw.

# XL4 TECHNICAL DATA FOR UL LISTED 60 HZ, GROUPS D, E, F, & G; IIA MODELS

MODEL	VOLTAGE (V)	NOMINAL WATTAGE (kW)	PHASE	MOTOR CURRENT (A)	HEATER ELEMENT CURRENT (A)	TOTAL CURRENT (A)	MINIMUM CIRCUIT AMPACITY (A)	SUPPLY WIRE SIZE (AWG.)	MAX. CIRCUIT FUSE (A)	TEMPERATURE RISE		CORE PART NUMBER	CONTACTOR PART NUMBER
										°F	°C		
XL412-208160-3	208	3.0	1	2.3	13.0	15.3	19.1	12	20	19.0	10.5	4044	3618
XL412-240160-3	240	3.0	1	2.3	11.2	13.5	16.9	12	20	19.0	10.5	4045	3618
XL412-208360-3	208	3.0	3	1.4	7.5	8.9	11.1	14	15	19.0	10.5	4044	3618
XL412-240360-3	240	3.0	3	1.4	6.5	7.9	9.9	14	15	19.0	10.5	4045	3618
XL412-480360-3	480	3.0	3	0.7	3.2	3.9	4.9	14	15	19.0	10.5	4046	3618
XL412-208160-5	208	5.0	1	2.3	22.6	24.9	31.1	8	35	31.6	17.6	4048	3618
XL412-240160-5	240	5.0	1	2.3	19.6	21.9	27.4	10	30	31.6	17.6	4049	3618
XL412-208360-5	208	5.0	3	1.4	13.0	14.4	18.1	12	20	31.6	17.6	4048	3618
XL412-240360-5	240	5.0	3	1.4	11.3	12.7	15.9	12	20	31.6	17.6	4049	3618
XL412-480360-5	480	5.0	3	0.7	5.7	6.4	8.0	14	15	31.6	17.6	4050	3618
XL412-208160-7.5	208	7.5	1	2.3	34.6	36.9	46.1	8	50	27.9	15.5	4052	3619
XL412-240160-7.5	240	7.5	1	2.3	30.0	32.3	40.4	8	45	27.9	15.5	4053	3618
XL412-208360-7.5	208	7.5	3	1.4	20.0	21.4	26.8	10	30	27.9	15.5	4052	3618
XL412-240360-7.5	240	7.5	3	1.4	17.3	18.7	23.4	10	25	27.9	15.5	4053	3618
XL412-480360-7.5	480	7.5	3	0.7	8.7	9.4	11.8	14	15	27.9	15.5	4054	3618
XL412-240160-10	240	10.0	1	2.3	40.4	42.7	53.4	6	60	37.2	20.6	4057	3619
XL412-208360-10	208	10.0	3	1.4	26.9	28.3	35.4	8	40	37.2	20.6	4056	3618
XL412-240360-10	240	10.0	3	1.4	23.3	24.7	30.9	8	35	37.2	20.6	4057	3618
XL412-480360-10	480	10.0	3	0.7	11.7	12.4	15.5	12	20	37.2	20.6	4058	3618
XL416-208360-15	208	15.0	3	1.4	40.0	41.4	51.8	6	60	27.1	15.0	4060	3619
XL416-240360-15	240	15.0	3	1.4	34.6	36.0	45.0	8	45	27.1	15.0	4061	3619
XL416-480360-15	480	15.0	3	0.7	17.3	18.0	22.5	10	25	27.1	15.0	4062	3618
XL416-480360-20	480	20.0	3	0.7	23.3	24.0	30.0	10	30	36.1	20.1	4066	3618
XL420-480360-25	480	25.0	3	1.0	29.1	30.1	37.6	8	40	21.9	12.2	4069	3618
XL420-480360-30	480	30.0	3	1.0	35.1	36.1	45.1	8	50	26.3	14.6	4071	3619
XL420-480360-35	480	35.0	3	1.0	41.1	42.1	52.6	6	60	28.0	15.6	4073	3619

**NOTES:**

1. Minimum conductor size for 30°C (86°F) ambient. Derate conductor for ambient temperature. Use minimum 90°C (194°F) insulation.
2. Heater is functioning normally if at rated voltage the amp draw is within 10% of the value in this table.
3. Operation at lower voltages will result in reduced heat output and amp draw.



# — XL4 TECHNICAL DATA FOR UL LISTED 60 HZ, GROUPS C, D, F, & G; IIA & IIB MODELS —

MODEL	VOLTAGE (V)	NOMINAL WATTAGE (kW)	PHASE	MOTOR CURRENT (A)	HEATER ELEMENT CURRENT (A)	TOTAL CURRENT (A)	MINIMUM CIRCUIT AMPACITY (A)	SUPPLY WIRE SIZE (AWG.)	MAX. CIRCUIT FUSE (A)	TEMPERATURE RISE		CORE PART NUMBER	CONTACTOR PART NUMBER
										°F	°C		
XL412-208160-3	208	3.0	1	2.7	13.0	15.7	19.1	12	20	19.0	10.5	4044	3618
XL412-240160-3	240	3.0	1	2.7	11.2	13.9	16.9	12	20	19.0	10.5	4045	3618
XL412-208360-3	208	3.0	3	1.4	7.5	8.9	11.1	14	15	19.0	10.5	4044	3618
XL412-240360-3	240	3.0	3	1.4	6.5	7.9	9.9	14	15	19.0	10.5	4045	3618
XL412-480360-3	480	3.0	3	0.7	3.2	3.9	4.9	14	15	19.0	10.5	4046	3618
XL412-208160-5	208	5.0	1	2.7	22.6	25.3	31.1	8	35	31.6	17.6	4048	3618
XL412-240160-5	240	5.0	1	2.7	19.6	22.3	27.4	10	30	31.6	17.6	4049	3618
XL412-208360-5	208	5.0	3	1.4	13.0	14.4	18.1	12	20	31.6	17.6	4048	3618
XL412-240360-5	240	5.0	3	1.4	11.3	12.7	15.9	12	20	31.6	17.6	4049	3618
XL412-480360-5	480	5.0	3	0.7	5.7	6.4	8.0	14	15	31.6	17.6	4050	3618
XL412-208160-7.5	208	7.5	1	2.7	34.6	37.3	46.1	8	50	27.9	15.5	4052	3619
XL412-240160-7.5	240	7.5	1	2.7	30.0	32.7	40.4	8	45	27.9	15.5	4053	3618
XL412-208360-7.5	208	7.5	3	1.4	20.0	21.4	26.8	10	30	27.9	15.5	4052	3618
XL412-240360-7.5	240	7.5	3	1.4	17.3	18.7	23.4	10	25	27.9	15.5	4053	3618
XL412-480360-7.5	480	7.5	3	0.7	8.7	9.4	11.8	14	15	27.9	15.5	4054	3618
XL412-240160-10	240	10.0	1	2.7	40.4	43.1	53.4	6	60	37.2	20.6	4057	3619
XL412-208360-10	208	10.0	3	1.4	26.9	28.3	35.4	8	40	37.2	20.6	4056	3618
XL412-240360-10	240	10.0	3	1.4	23.3	24.7	30.9	8	35	37.2	20.6	4057	3618
XL412-480360-10	480	10.0	3	0.7	11.7	12.4	15.5	12	20	37.2	20.6	4058	3618
XL416-208360-15	208	15.0	3	1.4	40.0	41.4	51.8	6	60	27.1	15.0	4060	3619
XL416-240360-15	240	15.0	3	1.4	34.6	36.0	45.0	8	45	27.1	15.0	4061	3619
XL416-480360-15	480	15.0	3	0.7	17.3	18.0	22.5	10	25	27.1	15.0	4062	3618
XL416-480360-20	480	20.0	3	0.7	23.3	24.0	30.0	10	30	36.1	20.1	4066	3618
XL420-480360-25	480	25.0	3	1.0	29.1	30.1	37.6	8	40	21.9	12.2	4069	3618
XL420-480360-30	480	30.0	3	1.0	35.1	36.1	45.1	8	50	26.3	14.6	4071	3619
XL420-480360-35	480	35.0	3	1.0	41.1	42.1	52.6	6	60	28.0	15.6	4073	3619

**NOTES:**

1. Minimum conductor size for 30°C (86°F) ambient. Derate conductor for ambient temperature. Use minimum 90°C (194°F) insulation.
2. Heater is functioning normally if at rated voltage the amp draw is within 10% of the value in this table.
3. Operation at lower voltages will result in reduced heat output and amp draw.





# RUFFNECK® Heaters

2827 Sunridge Blvd. N.E.  
Calgary, Alberta  
Canada  
T1Y 6G1

Phone: (403) 291-5488  
Fax: (403) 291-7042



## PLEASE CALL BEFORE REPAIRING

It will save time and money. Failure to do so may be dangerous and may void certain provisions of your warranty. For information regarding installation, operations, repair, or purchase, please call:

# 24 Hr. Hotline: 1-800-661-8561

(U.S.A. and Canada)

Please have model and serial numbers available before calling.



## LIMITED 3 YEAR WARRANTY

RUFFNECK Heaters warrants all RUFFNECK XL4 VacuCore® Series Electric Air Heaters for Hazardous Locations against defects in materials and workmanship for a period of three (3) years from date of purchase on the following terms:

1. We will provide replacement parts free of charge as necessary to restore any unit to operating condition, provided that the inoperative parts be returned to us freight prepaid and that the replacement parts be accepted freight collect.
2. The complete heater may be returned to our plant for repair or replacement (at our discretion), provided that all related freight costs be borne by the customer.
3. Corrosion and contamination by dirt, dust, etc. will not be considered as defects and therefore, not warrantable.
4. The heater must not be modified in any way.
5. The heater must be installed, used and stored only in accordance with the owner's manual and placarded information.

This warranty shall be limited to the actual equipment involved and, under no circumstances, shall include or extend to installation or removal costs, or to consequential losses or damages.





2827 Sunridge Blvd. N.E.

Calgary, Alberta

Canada T1Y 6G1

Ph: (403) 291-5488

Fax: (403) 291-7042

### AVANT DE RÉPARER, VEUILLEZ NOUS TÉLÉPHONER

Cela vous permettra de sauver du temps et de l'argent. Dans le cas contraire, cela peut être dangereux et risquer d'annuler certaines clauses de la garantie. Pour avoir plus d'information au sujet de l'installation, du fonctionnement, de la réparation ou de l'achat, veuillez composer le numéro de notre:

ligne sans frais: **1-800-661-8561**

(É.U. et Canada)

Lorsque vous appelez, veuillez avoir à portée de la main les numéros de modèle et de série.



## GARANTIE LIMITÉE DE 3 ANS

RUFFNECK Heaters garantit tous les aérothermes électriques pour endroits dangereux de la série XL4 VacuCore contre les défauts matérielles et de fabrication pour une période de trois (3) ans à compter de la date d'achat, comme suit:

1. Nous fournirons les pièces de remplacement sans frais, si nécessaire, afin de remettre tout appareil en état de fonctionnement normal à condition que les pièces défectueuses nous soient retournées fret payé d'avance et que les pièces de remplacement soient acceptées port dû.
  2. L'aérotherme complet peut être retourné à notre usine en vue d'être réparé ou remplacé, à notre choix, à condition que tous les frais d'expédition reliés soient assumés par le client.
  3. La corrosion et la contamination dues à la saleté, à la poussière, etc. ne seront pas considérées comme des défauts et, par conséquent, ne sont pas couverts par la présente garantie.
  4. L'aérotherme ne doit être modifié d'aucune façon.
  5. L'aérotherme doit être installé et utilisé uniquement selon l'information affichée ou indiquée dans le guide d'utilisation.
- La présente garantie se limite à l'équipement courant concerné et, en aucun cas, ne s'étend ou n'inclut les coûts d'installation ou de retrait, ou tous dommages ou pertes encourus.

# DONNÉES TECHNIQUES POUR TOUTS LES AÉROTHERMES XL4 HOMOLOGUÉS UL

## MODÈLES À 60 HERTZ, GROUPES C, D, F, & G; IIA & IIB

MODÈLE	TENSION (V)	PUISSANCE NOMINALE (kW)	PHASE	COURANT DU MOTEUR (A)	COURANT DES ÉLÉMENTS (A)	COURANT TOTAL (A)	ADMISSIBLE MINIMAL DU CIRCUIT (A)	CABRE DES FILS D'ALIMENTATION N	AMPÉRAGE MAXIMAL DU FUSIBLE DU CIRCUIT (A)	HAUSSE DE TEMPÉRATURE RISE		NO DE PIÈCE DU FAISCEAU	NO DE PIÈCE DU CONTACTEUR
XL4U 03008	208	3.0	1	2.7	13.0	15.7	19.1	12	20	19.0	10.5	4044	3618
XL4U 03000	240	3.0	1	2.7	11.2	13.9	16.9	12	20	19.0	10.5	4045	3618
XL4U 03038	208	3.0	3	1.4	7.5	8.9	11.1	14	15	19.0	10.5	4044	3618
XL4U 03030	240	3.0	3	1.4	6.5	7.9	9.9	14	15	19.0	10.5	4045	3618
XL4U 03034	480	3.0	3	0.7	3.2	3.9	4.9	14	15	19.0	10.5	4046	3618
XL4U 05008	208	5.0	1	2.7	22.6	25.3	31.1	8	35	31.6	17.6	4048	3618
XL4U 05000	240	5.0	1	2.7	19.6	22.3	27.4	10	30	31.6	17.6	4049	3618
XL4U 05038	208	5.0	3	1.4	13.0	14.4	18.1	12	20	31.6	17.6	4048	3618
XL4U 05030	240	5.0	3	1.4	11.3	12.7	15.9	12	20	31.6	17.6	4049	3618
XL4U 05034	480	5.0	3	0.7	5.7	6.4	8.0	14	15	31.6	17.6	4050	3618
XL4U 07508	208	7.5	1	2.7	34.6	37.3	46.1	8	50	27.9	15.5	4052	3619
XL4U 07500	240	7.5	1	2.7	30.0	32.7	40.4	8	45	27.9	15.5	4053	3618
XL4U 07538	208	7.5	3	1.4	20.0	21.4	26.8	10	30	27.9	15.5	4052	3618
XL4U 07530	240	7.5	3	1.4	17.3	18.7	23.4	10	25	27.9	15.5	4053	3618
XL4U 07534	480	7.5	3	0.7	8.7	9.4	11.8	14	15	27.9	15.5	4054	3618
XL4U 10000	240	10.0	1	2.7	40.4	43.1	53.4	6	60	37.2	20.6	4057	3619
XL4U 10038	208	10.0	3	1.4	26.9	28.3	35.4	8	40	37.2	20.6	4056	3618
XL4U 10030	240	10.0	3	1.4	23.3	24.7	30.9	8	35	37.2	20.6	4057	3618
XL4U 10034	480	10.0	3	0.7	11.7	12.4	15.5	12	20	37.2	20.6	4058	3618
XL4U 15038	208	15.0	3	1.4	40.0	41.4	51.8	6	60	27.1	15.0	4060	3619
XL4U 15030	240	15.0	3	1.4	34.6	36.0	45.0	8	45	27.1	15.0	4061	3619
XL4U 15034	480	15.0	3	0.7	17.3	18.0	22.5	10	25	27.1	15.0	4062	3618
XL4U 20034	480	20.0	3	0.7	23.3	24.0	30.0	10	30	36.1	20.1	4066	3618
XL4U 25034	480	25.0	3	1.0	29.1	30.1	37.6	8	40	21.9	12.2	4069	3618
XL4U 30034	480	30.0	3	1.0	35.1	36.1	45.1	8	50	26.3	14.6	4071	3619
XL4U 35034	480	35.0	3	1.0	41.1	42.1	52.6	6	60	28.0	15.6	4073	3619

### NOTAS :

- Dimensions minimales du conducteur à 30 °C (86 °F) de température ambiante. Réduire la valeur nominale du contacteur à la température ambiante. Employer une isolation valable pour au moins 90 °C (194 °F).
- L'aérotherme fonctionne de façon normale si, à la tension nominale, l'ampérage est  $\pm 10\%$  la valeur indiquée au tableau ci-dessus.
- Le fonctionnement à une tension moindre entraînera une moins grande production de chaleur, ainsi qu'un ampérage réduit.



# DONNÉES TECHNIQUES POUR TOUS LES AÉROTHERMES XL4 HOMOLOGUÉS UL

## MODÈLES À 60 HERTZ, GROUPES D, E, F, & G; IIA

MODÈLE	TENSION (V)	PUISSANCE NOMINALE (kW)	PHASE	COURANT DU MOTEUR (A)	COURANT DES ÉLÉMENTS (A)	COURANT TOTAL (A)	ADMISSIBLE MINIMAL DU CIRCUIT (A)	CALIBRE DES FILS D'ALIMENTATION (AWG)	AMPÉRAGE MAXIMAL DU FUSIBLE DU CIRCUIT (A)	HAUSSE DE TEMPÉRATURE RISE		No DE PIÈCE DU FAISCEAU	No DE PIÈCE DU CONTACTEUR
										°F	°C		
XL4U 03008	208	3.0	1	2.3	13.0	15.3	19.1	12	20	19.0	10.5	4044	3618
XL4U 03000	240	3.0	1	2.3	11.2	13.5	16.9	12	20	19.0	10.5	4045	3618
XL4U 03038	208	3.0	3	1.4	7.5	8.9	11.1	14	15	19.0	10.5	4044	3618
XL4U 03030	240	3.0	3	1.4	6.5	7.9	9.9	14	15	19.0	10.5	4045	3618
XL4U 03034	480	3.0	3	0.7	3.2	3.9	4.9	14	15	19.0	10.5	4046	3618
XL4U 05008	208	5.0	1	2.3	22.6	24.9	31.1	8	35	31.6	17.6	4048	3618
XL4U 05000	240	5.0	1	2.3	19.6	21.9	27.4	10	30	31.6	17.6	4049	3618
XL4U 05038	208	5.0	3	1.4	13.0	14.4	18.1	12	20	31.6	17.6	4048	3618
XL4U 05030	240	5.0	3	1.4	11.3	12.7	15.9	12	20	31.6	17.6	4049	3618
XL4U 05034	480	5.0	3	0.7	5.7	6.4	8.0	14	15	31.6	17.6	4050	3618
XL4U 07508	208	7.5	1	2.3	34.6	36.9	46.1	8	50	27.9	15.5	4052	3619
XL4U 07500	240	7.5	1	2.3	30.0	32.3	40.4	8	45	27.9	15.5	4053	3618
XL4U 07538	208	7.5	3	1.4	20.0	21.4	26.8	10	30	27.9	15.5	4052	3618
XL4U 07530	240	7.5	3	1.4	17.3	18.7	23.4	10	25	27.9	15.5	4053	3618
XL4U 07534	480	7.5	3	0.7	8.7	9.4	11.8	14	15	27.9	15.5	4054	3618
XL4U 10000	240	10.0	1	2.3	40.4	42.7	53.4	6	60	37.2	20.6	4057	3619
XL4U 10038	208	10.0	3	1.4	26.9	28.3	35.4	8	40	37.2	20.6	4056	3618
XL4U 10030	240	10.0	3	1.4	23.3	24.7	30.9	8	35	37.2	20.6	4057	3618
XL4U 10034	480	10.0	3	0.7	11.7	12.4	15.5	12	20	37.2	20.6	4058	3618
XL4U 15038	208	15.0	3	1.4	40.0	41.4	51.8	6	60	27.1	15.0	4060	3619
XL4U 15030	240	15.0	3	1.4	34.6	36.0	45.0	8	45	27.1	15.0	4061	3619
XL4U 15034	480	15.0	3	0.7	17.3	18.0	22.5	10	25	27.1	15.0	4062	3618
XL4U 20034	480	20.0	3	0.7	23.3	24.0	30.0	10	30	36.1	20.1	4066	3618
XL4U 25034	480	25.0	3	1.0	29.1	30.1	37.6	8	40	21.9	12.2	4069	3618
XL4U 30034	480	30.0	3	1.0	35.1	36.1	45.1	8	50	26.3	14.6	4071	3619
XL4U 35034	480	35.0	3	1.0	41.1	42.1	52.6	6	60	28.0	15.6	4073	3619

### NOTAS :

- Dimensions minimales du conducteur à 30 °C (86 °F) de température ambiante. Réduire la valeur nominale du contacteur à la température ambiante. Employer une isolation valable pour au moins 90 °C (194 °F).
- L'aérotherme fonctionne de façon normale si, à la tension nominale, l'ampérage est  $\pm 10\%$  la valeur indiquée au tableau ci-dessus.
- Le fonctionnement à une tension moindre entraînera une moins grande production de chaleur, ainsi qu'un ampérage réduit.



# DONNÉES TECHNIQUES POUR TOUTS LES AÉROTHERMES XL4 CERTIFIÉS PAR CSA MODÈLES À 50 HERTZ UNIQUEMENT

MODÈLE	TENSION (V)	PUISSANCE NOMINALE (kW)	PHASE	COURANT TOTAL (A)	HAUSSES DE TEMPÉRATURE		AMPERAGE MAXIMAL DU FUSIBLE (AMP)	NO PIÈCE FAISCEAU	NO PIÈCE CONTACTEUR
					° F	° C			
XL412-220150-2.5	220	2.5	1	11.4	19.7	11	15	4045	3618
XL412-220150-4.2	220	4.2	1	19.1	33.2	18.4	25	4049	3618
XL412-220150-6.3	220	6.3	1	28.6	28.4	15.8	40	4053	3618
XL412-220150-8.4	220	8.4	1	38.2	37.9	21.1	50	4057	3619
XL416-220150-12.6	220	12.6	1	57.3	27.5	15.3	80	4061	3619
XL412-380350-2.5	380	2.5	3	3.8	19.7	11	15	4045	3618
XL412-380350-4.2	380	4.2	3	6.4	33.2	18.4	15	4049	3618
XL412-380350-6.3	380	6.3	3	9.6	28.4	15.8	15	4053	3618
XL412-380350-8.4	380	8.4	3	12.8	37.9	21.1	20	4057	3618
XL416-380350-12.5	380	12.5	3	19	27.2	15.1	25	4061	3618
XL416-380350-16.7	380	16.7	3	25.4	36.4	20.2	35	4065	3618
XL420-380350-20.9	380	20.9	3	31.8	22	12.2	40	4068	3618
XL412-415350-3.7	415	3.7	3	5.1	29.2	16.2	15	4050	3618
XL412-415350-7.5	415	7.5	3	10.4	33.9	18.8	15	4058	3618
XL416-415350-14.9	415	14.9	3	20.7	32.5	18	30	4066	3618
XL420-415350-22.4	415	22.4	3	31.2	23.6	13.1	40	4071	3618

**NOTAS:**

1. L'aérotherme fonctionne de façon normale si, à la tension nominale, l'ampérage est  $\pm 10\%$  la valeur indiquée au tableau ci-dessus.
2. Le fonctionnement à une tension moindre entraînera une moins grande production de chaleur, ainsi qu'un ampérage réduit.

# DONNÉES TECHNIQUES POUR TOUTES LES AÉROTHERMES XL4 CERTIFIÉES PAR CSA MODÈLES À 60 HERTZ UNIQUEMENT

MODÈLE	TENSION (V)	PUISSANCE NOMINALE (kW)	PHASE	COURANT TOTAL (AMP)	HAUSSES DE TEMPÉRATURE		AMPERAGE MAXIMAL DU FUSIBLE (AMP)	NO PIÈCE DU FAISCEAU	NO PIÈCE DU CONTACTEUR
					°C	°F			
XL412-208160-3	208	3	1	14,4	19	10,5	20	4044	3618
XL412-240160-3	240	3	1	12,5	19	10,5	20	4045	3618
XL412-208360-3	208	3	3	8,3	19	10,5	15	4044	3618
XL412-240360-3	240	3	3	7,2	19	10,5	15	4045	3618
XL412-480160-3	480	3	1	6,3	19	10,5	15	4046	3618
XL412-480360-3	480	3	3	3,6	19	10,5	15	4046	3618
XL412-600360-3	600	3	3	2,9	19	10,5	15	4047	3618
XL412-208160-5	208	5	1	24	31,6	17,6	35	4048	3618
XL412-240160-5	240	5	1	20,8	31,6	17,6	30	4049	3618
XL412-208360-5	208	5	3	13,9	31,6	17,6	20	4048	3618
XL412-240360-5	240	5	3	12	31,6	17,6	20	4049	3618
XL412-480160-5	480	5	1	10,4	31,6	17,6	15	4050	3618
XL412-480360-5	480	5	3	6	31,6	17,6	15	4050	3618
XL412-600360-5	600	5	3	4,8	31,6	17,6	15	4051	3618
XL412-208160-7,5	208	7,5	1	36,1	27,9	15,5	50	4052	3619
XL412-240160-7,5	240	7,5	1	31,3	27,9	15,5	40	4053	3618
XL412-208360-7,5	208	7,5	3	20,8	27,9	15,5	30	4052	3618
XL412-240360-7,5	240	7,5	3	18	27,9	15,5	25	4053	3618
XL412-480160-7,5	480	7,5	1	15,6	27,9	15,5	20	4054	3618
XL412-480360-7,5	480	7,5	3	9	27,9	15,5	15	4054	3618
XL412-600360-7,5	600	7,5	3	7,2	27,9	15,5	15	4055	3618
XL412-208160-10	208	10	1	48,1	37,2	20,6	70	4056	3619
XL412-240160-10	240	10	1	41,7	37,2	20,6	60	4057	3619
XL412-208360-10	208	10	3	27,8	37,2	20,6	35	4056	3618
XL412-240360-10	240	10	3	24,1	37,2	20,6	35	4057	3618
XL412-480160-10	480	10	1	20,8	37,2	20,6	30	4058	3618
XL412-480360-10	480	10	3	12	37,2	20,6	20	4058	3618
XL412-600360-10	600	10	3	9,6	37,2	20,6	15	4059	3618
XL416-240160-15	240	15	1	62,5	27,1	15	80	4061	3619
XL416-208360-15	208	15	3	41,6	27,1	15	60	4060	3619
XL416-240360-15	240	15	3	36,1	27,1	15	50	4061	3619
XL416-480160-15	480	15	1	31,3	27,1	15	40	4062	3618
XL416-480360-15	480	15	3	18	27,1	15	25	4062	3618
XL416-600360-15	600	15	3	14,4	27,1	15	20	4063	3618
XL416-208360-20	208	20	3	55,5	36,1	20,1	70	4064	3619
XL416-240360-20	240	20	3	48,1	36,1	20,1	70	4065	3619
XL416-480160-20	480	20	1	41,7	36,1	20,1	60	4066	3619
XL416-480360-20	480	20	3	24,1	36,1	20,1	35	4066	3618
XL416-600360-20	600	20	3	19,2	36,1	20,1	25	4067	3618
XL420-240360-25	240	25	3	60,1	21,9	12,2	80	4068	3619
XL420-480360-25	480	25	3	30,1	21,9	12,2	40	4069	3618
XL420-600360-25	600	25	3	24,1	21,9	12,2	35	4070	3618
XL420-480360-30	480	30	3	36,1	26,3	14,6	50	4071	3619
XL420-600360-30	600	30	3	28,9	26,3	14,6	40	4072	3618
XL420-480360-35	480	35	3	42,1	28	15,6	60	4073	3619
XL420-600360-35	600	35	3	33,7	28	15,6	45	4074	3619

**NOTAS:**

- L'aérotherme fonctionne de façon normale si, à la tension nominale, l'amperage est  $\pm 10\%$  la valeur indiquée au tableau ci-dessus.
- Le fonctionnement à une tension moindre entraînera une moins grande production de chaleur, ainsi qu'un amperage réduit.

# — SPÉCIFICATIONS POUR TOUTS LES MODÈLES DE 50 HZ —

Altitude Max. (pi)		Débit de @ 70°F (CFM)		Soufflage @ 21°C (m <sup>3</sup> /hr.)		Portée d'air (pi)		Hauteur maximale (pi)		Diamètre du ventilateur (po)		Poids net (lb)		Poids à l'expédition (lb)	
12,000		400		679		13		7		12		111		151	
8,000		700		1189		25		10		305		133		204	
7,000		1450		2463		35		3.0		406		61		79	
3,048		3,048		3,048		60		20		508		154		93	
2,438		1189		5096		18.2		6.1		20		70		204	
25		2.1		3.0		3.0		3.0		3.0		3.0		3.0	
37&42		63&75		84		125&126		149&167		209		224		224	
XL412		XL416		XL420		XL412		XL416		XL420		XL412		XL416	
<p>Boîtiers NEMA Type 7 &amp; 9. Uniquement pour utilisation à l'intérieur, au sec. Ne pas immerger dans l'eau. Ne pas entreposer ou utiliser dans des endroits exposés à la pluie ou à la neige.</p>															
<p>Type de moteur Antidéflagrant. À protection thermique. Roulements à billes à lubrification permanente. 1 425 tr/mn.</p>															
<p>Ventilateur Pales d'aluminium. Grillage en acier et moyeu avec alésage de 5/8 po (15,875 mm). 1/4 po (6,3mm) de diamètre.</p>															
<p>Grille de protection Séparable, à faible écartement entre les broches; impossible d'y faire passer un objet de Deux trous de 9/16 po (14,3 mm) de diamètre sur le dessus de l'aérotherme.</p>															
<p>Éléments chauffants Trois éléments à gaine de métal de haut calibre, à faible puissance, à durée de vie prolongée.</p>															
<p>Limiteur de température à maximum Du type à réenclenchement automatique, avec bimétal à rupture, à ouverture de contact lorsqu'il y a hausse de température. Évalué à 100 000 cycles à 10 A, tolère 0,130 A.</p>															
<p>Circuit de commande 115 volts, 0,130 A, 15 VA (mis à la masse).</p>															
<p>Thermostat intégré facultatif Antidéflagrant. 36°F à 82°F (2°C à 28°C).</p>															
<p>Transformateur de commande À sortie multiples, primaire 115V, secondaire 25VA.</p>															
<p>Contacteur 40 ou 75 A. Calculé pour 500 000 opérations mécaniques. Bobine de 120 Volts, 15 VA (à protection par fusible séparée).</p>															
<p>Fluide de transfert de chaleur Mélange d'éthylène glycol et eau formulé pour une durée de vie prolongée, protection contre le gel jusqu'à -49°F (-45°C).</p>															
<p>Boîtier En acier de calibre 14 (0,075 po) (1,90 mm). À revêtement d'époussé avec prétraitement en cinq étapes, y compris au phosphate de fer.</p>															
<p>Faisceau En acier avec ailettes complètement en aluminium, chargé à vide et scellé hermétiquement.</p>															
<p>Matériel de conduit À paroi épaisse en acier de 0,122 po (3,1 mm) à revêtement de cadmium.</p>															
<p>Protection contre la surpression Bouchon alliage fusible de 170 psi (1,17 MPa).</p>															
<p>Code de température T3B - 165°C (329°F), Classes I &amp; II</p>															
<p>Limites de température -49°F à 104°F (-45°C à 40°C).</p>															
<p>Limites d'entreposage -49°F à 176°F (-45°C à 80°C), courte durée jusqu'à 248°F (120°C). Ne pas immerger dans l'eau. Ne pas entreposer ou utiliser dans des endroits exposés à la pluie ou à la neige.</p>															

# SPÉCIFICATIONS POUR TOUTS LES MODÈLES DE 60 HZ

Puissance nominale		XL4																	
Altitude max. (pi.)	(m)	3		5		7.5		10		15		20		25		30		35	
		12,000	8,000	2,438	3,048	7,000	2,134	3,048	7,000	2,134	3,048	7,000	2,134	3,048	7,000	2,134	3,048	6,000	1,829
Débit de soufflage		500		850		1444		1750		2973		3600		6116		3950			
@ 70°F (PCM)		@ 21°C (m <sup>3</sup> /hr.)																	
Portée d'air horizontale (pi.)		15		30		40		12.2		21.3		70		21.3		70			
(PCM)		(m)																	
Hauteur maximale (pi.)		7		10		10		3.0		6.1		20		6.1		20			
(jusqu'à la face inférieure)		(m)																	
Puissance du moteur (HP)		1/4		0.187		1/4		0.187		1/2		0.373		1/2		0.373			
(kW)		(m)																	
Diamètre du ventilateur (po)		12		305		16		406		20		508		20		508			
(mm)		(lbs.)		111		133		61		154		70		154		70			
(kg)		(lbs.)		151		173		79		204		93		204		93			
(kg)		(kg)																	
Boîtiers		NEMA Type 7 & 9. Uniquement pour utilisation à l'intérieur, au sec. Ne pas immerger dans l'eau. Ne pas entreposer ou utiliser dans des endroits exposés à la pluie ou à la neige.																	
Type de moteur		Antidéflagrant. À protection thermique. Roulements à billes à lubrification permanente. 1725tr/mn																	
Ventilateur		Pales d'aluminium. Grillage en acier et moyeu avec alésage de 5/8 po (15,875 mm). (6,3 mm) de diamètre.																	
Grille de protection		Séparable, à faible écartement entre les broches; impossible d'y faire passer un objet de 1/4 po (6,3 mm) de diamètre.																	
Trous de montage		2 trous de 9/16 po (14,3 mm) de diamètre sur le dessus de l'aérotherme.																	
Éléments chauffants		3 éléments à gaine de métal de haut calibre, à faible puissance, à durée de vie prolongée.																	
Limiteur de température		Du type à réenclenchement automatique, avec bimétal à rupture, à ouverture de contact lorsqu'il y a hausse de température. Évalué à 100,000 cycles à 10 A, tolère 0, 128 A. à maximum																	
Circuit de commande		120 Volts, 0.128 A, 15VA. (mis à la masse).																	
Thermostat intégré facultatif		Antidéflagrant. 36°F à 82°F (2°C à 28°C)																	
Transformateur de commande		À sorties multiples, primaire 120 Volts, secondaire 25 VA.																	
Contacteur		40 ou 75 A. Calculé pour 500 000 opérations mécaniques. Bobine de 120 Volts, 15 VA (à protection par fusible séparé).																	
Fluide de transfert de chaleur		Mélange d'éthylène glycol et eau formulé pour une durée de vie prolongée, protection contre le gel jusqu'à -49°F (-45°C) min.																	
Boîtier		En acier de calibre 14 (0,075 po (1,90 mm)). À revêtement d'époxide avec prétraitement en cinq étapes, y compris au phosphate de fer.																	
Faisceau		En acier avec ailettes complètement en aluminium, chargé à vide et scellé hermétiquement.																	
Matériel du conduit		À paroi épaisse en acier de 0,122 po (3,1 mm) à revêtement de cadmium.																	
Protection contre surpressions		Bouchon alliage fusible de 170 psi (1,17 MPa).																	
Code de température		T3B 165°C (329°F) Classes I & II.																	
Limites de température		-49°F à 104°F (-45°C à 40°C).																	
Limites d'entreposage		-49°F à 176°F (-45°C à 80°C), courte durée jusqu'à 248°F (120°C). Ne pas immerger dans l'eau. Ne pas entreposer ou utiliser dans des endroits exposés à la pluie ou à la neige.																	

# LISTE DES PIÈCES DU X14

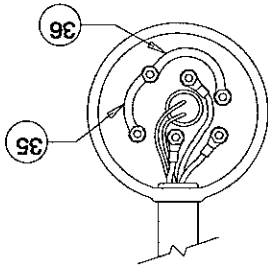
Veuillez avoir le numéro de modèle et de série avant de téléphoner.

## NUMÉRO DE PIÈCE

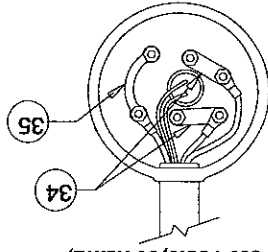
ARTICLE	X1412	X1416	X1420	DESCRIPTION
1	**	**	**	Faisceau
2	3773	3774	3775	Panneau, dessous
3	3776	3777	3778	Panneau, côté gauche
4	4075	4076	4077	Persiennes (vis incluses)
5	3770	3771	3772	Panneau, dessus
6	3779	3780	3781	Panneau, côté droit
7	3782	3783	3784	Tuyère de ventilateur
8	2.5 - 5.0 kW: 4022 6.3 - 10 kW: 4023	12.5 - 20 kW: 4024	20.9-30 kW: 4025 35kW: 4026	Ventilateur
9	4078	4079	4080	Grille de protection
10	Groupe D, E, F, & G; IIA 208/240V 60 HZ 1 PH: 220V 50 HZ 1 PH: 480V 60 HZ 1 PH: 208/240V 60HZ 3PH: 380/415V 50 HZ 3 PH: 600V 60HZ 3 PH: Groupe C, D, F, & G; IIA & IIB 208/240V 60HZ 1 PH: 208/240/480V 60HZ 3PH: 4594 4595 1377 1377 w/ 4953 2396 1862 1862 380/415V 50 HZ 3 PH: 1699 600V 60 HZ 3 PH: 2433 Groupe C, D, F, & G; IIA & IIB 240/480V 60 HZ 3 PH: 4596 600V 60HZ 3 PH: 4597	Groupe D, E, F, & G; IIA 1377 1377 w/ 4953 2396 1862 1862 380/415V 50 HZ 3 PH: 1699 600V 60 HZ 3 PH: 2433 Groupe C, D, F, & G; IIA & IIB 240/480V 60 HZ 3 PH: 4596 600V 60HZ 3 PH: 4597	Groupe D, E, F, & G; IIA 1377 1377 w/ 4953 2396 1862 1862 380/415V 50 HZ 3 PH: 1699 600V 60 HZ 3 PH: 2433 Groupe C, D, F, & G; IIA & IIB 240/480V 60 HZ 3 PH: 4596 600V 60HZ 3 PH: 4597	Moteur (antidéflagrant)
11	3789	3789	3789	Support de fixation du moteur, droit
12	3785	3786	3787	Profilé en U, support du moteur
13	3788	3788	3788	Support de fixation du moteur, gauche
14	Groupe D, E, F, & G; IIA: 3737 Groupe C, D, F, & G; IIA & IIB: 4590			Raccord du moteur
15	3811	3812	3813	Conduit du moteur
16	Groupe D, E, F, & G; IIA: 3838 Groupe C, D, F, & G; IIA & IIB: 4983 CW 5027			Boîtier, jonction des conduits
17	Groupe D, E, F, & G; IIA208/240V 60 HZ 1PH: 3815 220V 50 HZ 1PH: 3815 480V 60 HZ 1PH: 3813 TOUS: 3815 Groupe D, E, F, & G; IIA TOUS: 3813	Groupe C, D, F, & G; IIA & IIB TOUS 3PH: 3814 TOUS 3PH: 3814 480V 60 HZ 1PH: 3813 TOUS: 3815	Groupe C, D, F, & G; IIA & IIB TOUS: 3815 TOUS: 3815	Conduit du boîtier de commande
18	3810	3810	3810	Conduit du boîtier d'éléments
19	3793	3793	3793	Boîtier, éléments chauffants
20	3510	3510	3510	Couvercle, boîtier des éléments
21	3790	3790	3790	Panneau de protection, boîtier des éléments
22	3791	3791	3791	Support du thermostat
23	4983	4983	4983	Boîtier du thermostat
24	5032	5032	5032	Thermostat intégré
25	3524	3525	3526	Boîtier du commande
26	**	**	**	Contacteur
27	60 HERTZ: 3612	50 HERTZ: 4416		Transformateur
28	3809	3809	3809	Support de carte à circuits imprimés
29	1876	1876	1876	Cosse à vis, calibre 6-14
30	3519	3519	3519	Fusible, Buss MDQ - 1/4 A
31	3514	3514	3514	Carte à circuits imprimés
32	3516	3516	3516	Couvercle du boîtier de commande
33	4082	4082	4082	Limiteur de température à maximum
34	3816	3816	3816	Barre omnibus, droite
35	3817	3817	3817	Barre omnibus, petite, courbée
36	3818	3818	3818	Barre omnibus, grande, courbée

\*\* Pour connaître les numéros de pièces, consulter le tableau des données techniques. NOTA: Pour les articles qui ne sont pas illustrés, communiquer avec le personnel de l'usine.

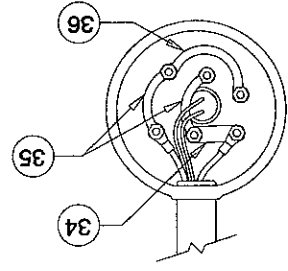




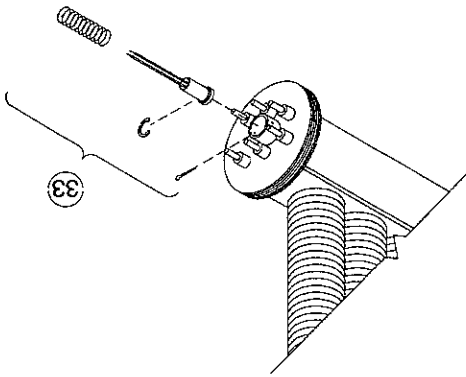
CONFIGURATION DE LA BARRE OMNIBUS  
TRIPHASÉS, 380 VOLTS, 50 HERTZ UNIQUEMENT



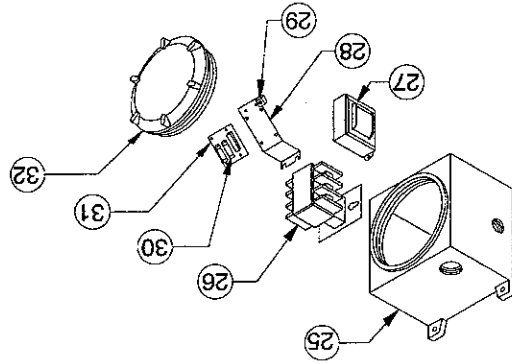
CONFIGURATION DE LA BARRE OMNIBUS  
POUR TOUTS LES TRIPHASÉS  
(SAUF 380 VOLTS, 50 HERTZ)



CONFIGURATION DE LA BARRE OMNIBUS  
POUR TOUTS LES MONOPHASÉS



LIMITEUR DE TEMPÉRATURE



BOÎTIER DE COMMANDE

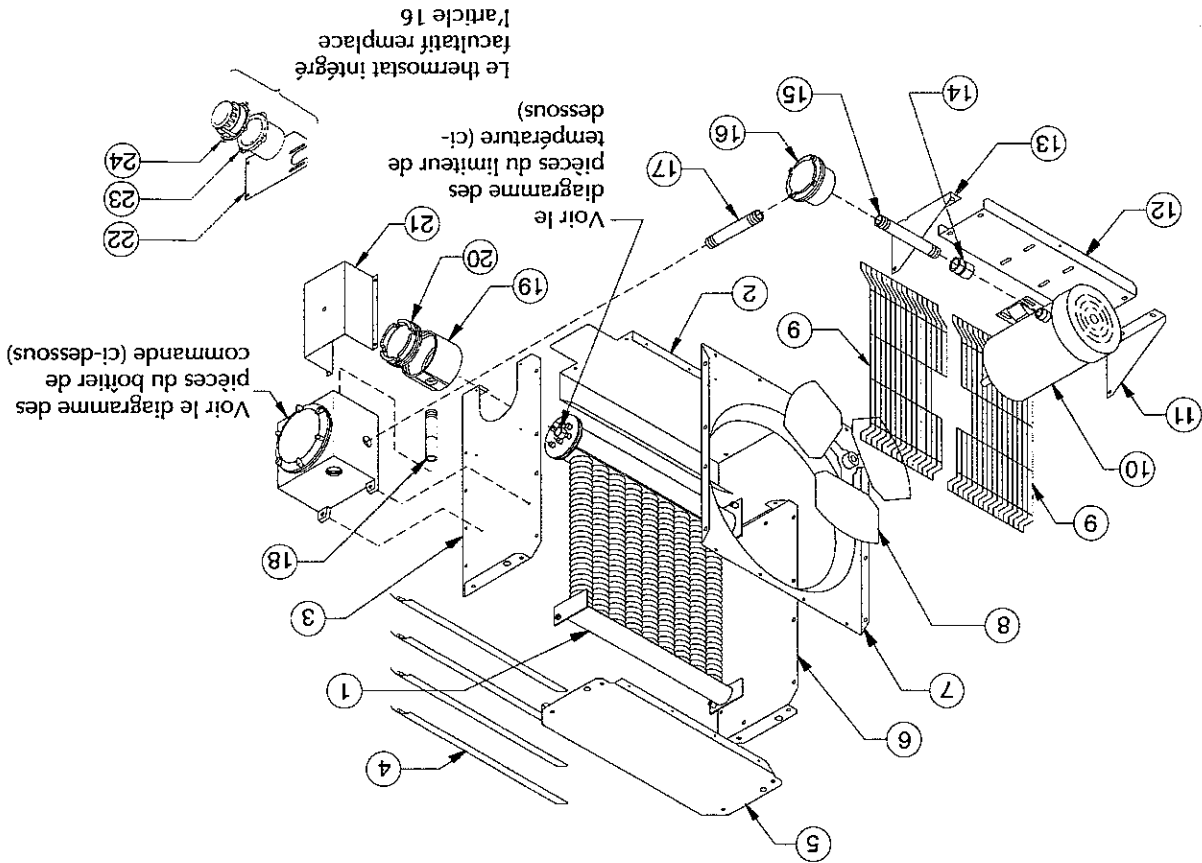


DIAGRAMME DES PIÈCES

## PANNEAUX DE L'ARMOIRE

On peut remplacer chacun des panneaux d'armoire à boulonner.

## ÉLÉMENTS CHAUFFANTS

Remplacer le fusible par un autre du même type et de la même valeur, tel qu'indiqué sur la carte à circuits imprimés, ou consulter la liste des pièces "SPARE".  
Un fusible de rechange devrait être mis dans le porte-fusible identifié.

## FUSIBLE

1. Remplacer par un transformateur de la même valeur fourni en usine. Sur le nouveau transformateur, repérer les fils primaires de manière qu'ils correspondent à la tension de l'aérotherme. S'assurer que le bon conducteur secondaire du transformateur soit mis à la masse (voir le schéma de câblage). Faire des terminaisons pour chacun des fils inutilisés à l'aide de connecteurs à bout fermé.

## TRANSFORMATEUR

1. Desserrer, mais ne pas enlever, les vis de fixation du contacteur. Glisser le contacteur des vis de fixation.  
2. Remplacer par un contacteur fourni en usine ayant la même valeur.

## CONTACTEUR

2. Remettre la carte à circuits imprimés en place sur le support de montage à l'aide de nouvelles entretoises non conductrices de la même longueur. Les entretoises sont fournies avec une nouvelle carte à circuits imprimés. Remettre en place le fil de mise à la masse du circuit de commande sur le support de la carte à circuits imprimés (voir le schéma de câblage).

## CARTE À CIRCUITS IMPRIMÉ

1. Après avoir retiré l'ensemble support de la carte à circuits imprimés du boîtier de commande, dégager la carte à circuits imprimés du support en coupant les entretoises de plastique (voir figure 17).  
2. Remettre la carte à circuits imprimés en place sur le support de montage à l'aide de nouvelles entretoises non conductrices de la même longueur. Les entretoises sont fournies avec une nouvelle carte à circuits imprimés. Remettre en place le fil de mise à la masse du circuit de commande sur le support de la carte à circuits imprimés (voir le schéma de câblage).  
3. Enlever les deux parties de l'ensemble grille de protection (voir figure 14).  
4. Soulever l'ensemble moteur du support moteur.  
5. Avant d'enlever le ventilateur, mesurer et prendre note de l'emplacement du moyeu du ventilateur sur l'arbre moteur (voir figure 15). S'il est difficile à enlever, utiliser un arrache-pignons sur le moyeu du ventilateur.  
6. Pour remettre en place, mettre l'ensemble moteur sur le support moteur et fixer la grille de protection au boîtier.  
7. En même temps, insérer et serrer chaque extrémité du conduit no. 1 dans les boîtiers. Laisser un espace de 1/16 po à 3/16 po (1,6mm à 4,8 mm) entre le moteur et la grille de protection (voir figure 16). Ajuster le conduit no. 2 de manière à centrer le ventilateur dans la tuyère.  
8. Afin d'avoir au moins 5 tours de visées, les extrémités vissées des conduits doivent dépasser d'au moins 1/16 po (1,6 mm) dans les boîtiers. La rainure du conduit no. 2 ne doit pas dépasser de plus de 7/8 po (22 mm) du raccord du moteur (voir figure 13).  
9. Boulonner le moteur au support moteur. Faire tourner à la main les pales du ventilateur afin de s'assurer qu'elles tournent librement.  
10. L'air doit sortir par les persiennes et les pales du ventilateur doivent tourner dans le sens contraire des aiguilles d'une montre lorsqu'on regarde par l'arrière de l'aérotherme (voir figure 13).

FIGURE 17

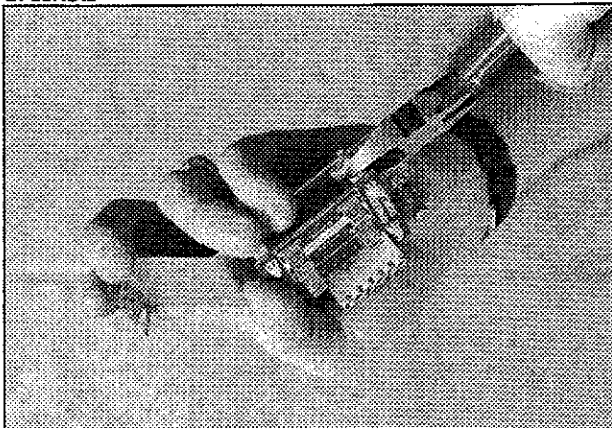


FIGURE 16

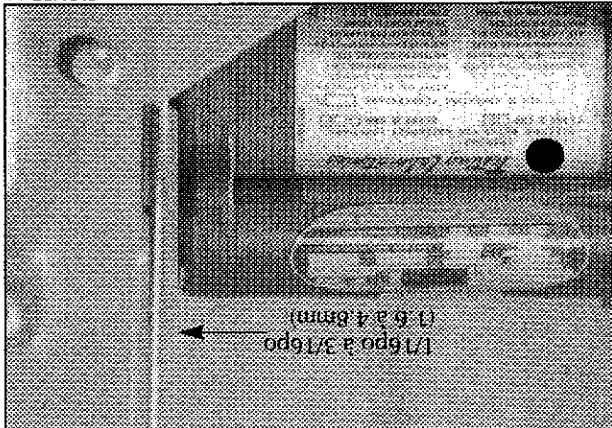
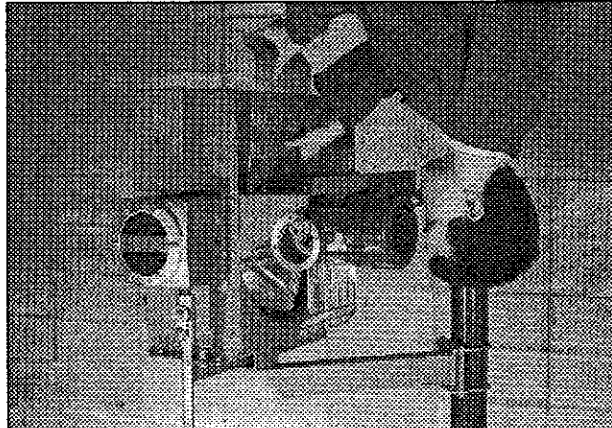


FIGURE 15



FIGURE 14



# RÉPARATION ET REMPLACEMENT

## AVERTISSEMENT

Débrancher la source d'alimentation de l'aérotherme avant d'ouvrir les boîtiers ou d'en faire l'entretien. Bloquer le commutateur en position "OFF" (circuit ouvert) et/ou y mettre une étiquette afin d'éviter que l'appareil ne soit mis en marche par inadvertance. L'aérotherme peut être chaud.

1. Après avoir réparé un composant:
    - a. Vérifier si les connexions électrique sont bien faites et serrées (voir figure 8);
    - b. retirer tout corps étranger à l'intérieur des boîtiers;
    - c. installer et bien fixer en place tous les couvercles;
    - d. s'assurer que toutes les attaches soient bien serrées;
    - e. retirer tous les corps étrangers à l'intérieur de l'aérotherme; et
    - f. s'assurer que l'air sorte par les persiennes et que les pales du ventilateur tournent dans le sens contraire des aiguilles d'une montre lorsqu'on regarde à l'arrière de l'aérotherme (voir figure 13).
- Le faisceau de l'aérotherme est chargé à vide et ne peut être réparé sur place. Pour retirer le faisceau:

## FAISCEAU

1. Enlever le bas de l'unité et le couvercle du boîtier.
2. Débrancher tour les fils qui pénètrent dans le boîtier des éléments (voir figure 9).
3. Desserrer légèrement tous les boulons de l'unité, tel qu'illustré à la figure 9, afin d'éviter que le faisceau plie. Avec l'aide d'une autre personne qui soutient le faisceau, enlever les trois boulons de fixation du faisceau. Retirer délicatement le faisceau de l'enceinte par le bas (voir figure 10).
5. Retourner le faisceau à l'usine en utilisant la boîte fournie avec le faisceau de recharge afin de protéger les bornes des éléments et les fils de la plaque.
6. Pour remettre en place, soulever le faisceau jusque dans l'unité pendant qu'une autre personne fait passer les fils dans le trou du boîtier destinés à cet usage.
7. Place le faisceau et serrer les trois boulons de fixation. Serrer les autres boulons de l'unité.

## LIMITEUR DE TEMPÉRATURE À MAXIMUM

1. Retirer l'ensemble limiteur de température à maximum et nettoyer l'intérieur de la sonde thermométrique (voir figure 11) afin d'assurer un bon contact thermique.
2. N'utiliser qu'un limiteur de température à maximum fourni en usine afin d'assurer un fonctionnement sûr.
3. Mettre une petite goutte de 3/32 po (2 mm) de diamètre de graisse thermococonductrice au centre du capuchon de métal, mais sans l'étendre. Cela est important afin d'assurer un bon contact thermique entre le limiteur de température à maximum et la sonde thermométrique.
4. Remettre en place l'ensemble limiteur de température à maximum, en mettant le clip et le ressort dans la sonde thermométrique sans endommager le tube isolant. Fixer en place à l'aide de la goupille fendue (voir figure 12).

## MOTEUR, VENTILATEUR ET GRILLE DE PROTECTION

1. Enlever les boulons qui fixent la moteur au support du moteur. Pour les modèles avec thermostat intégré, enlever les boulons à l'arrière du boîtier du thermostat.
2. Enlever le conduit n° 1 situé entre la boîte de jonction du moteur et le boîtier de commande en tournant dans le sens

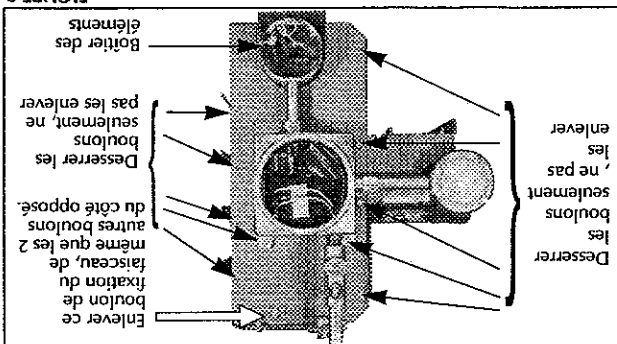


FIGURE 9

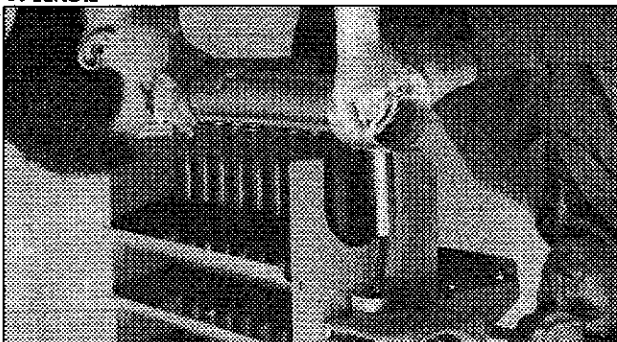


FIGURE 10

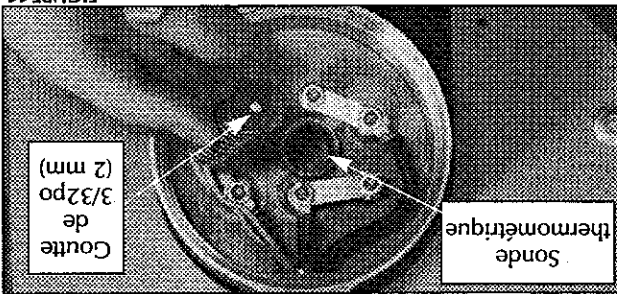


FIGURE 11

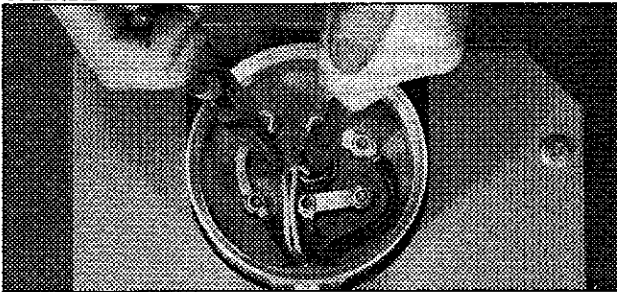


FIGURE 12

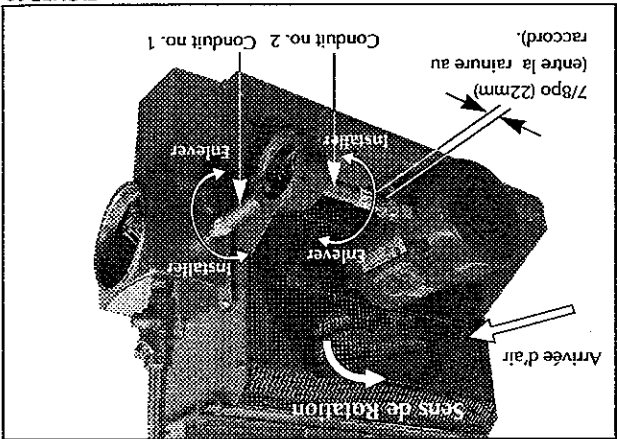
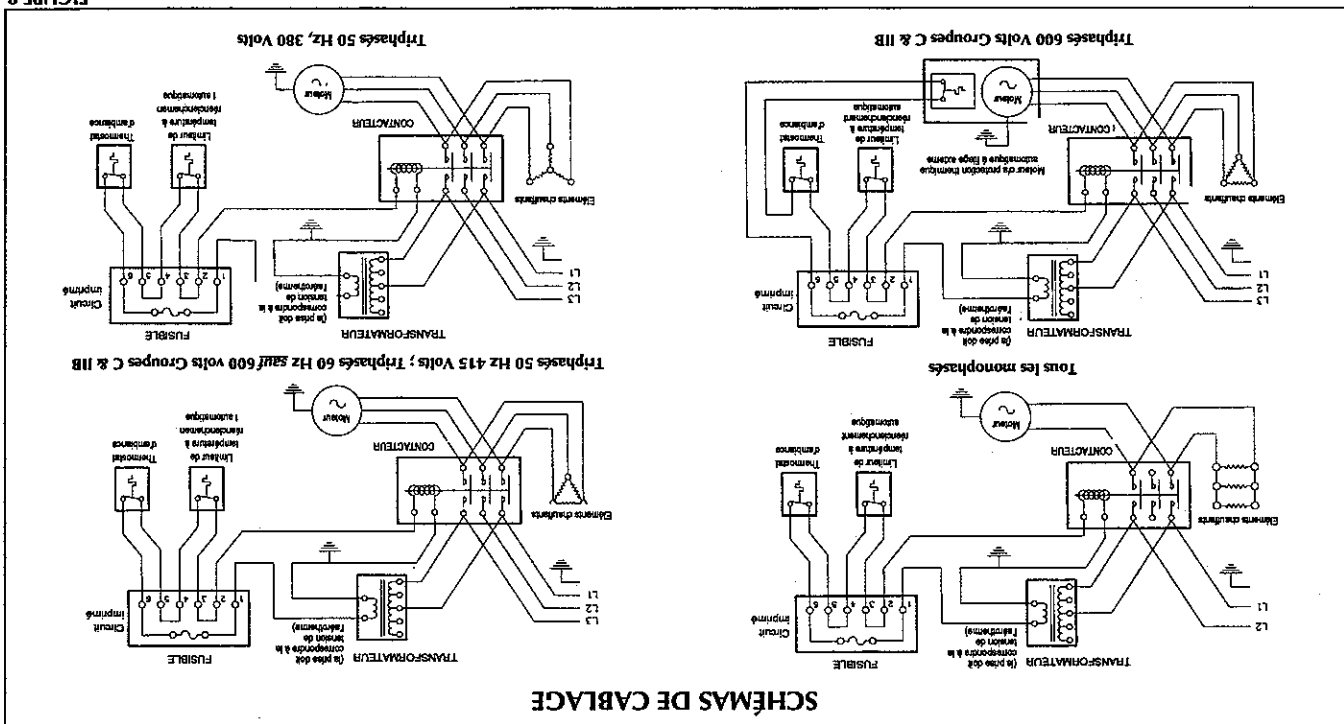


FIGURE 13

FIGURE 8



SCHEMAS DE CABLAGE

FIGURE 7

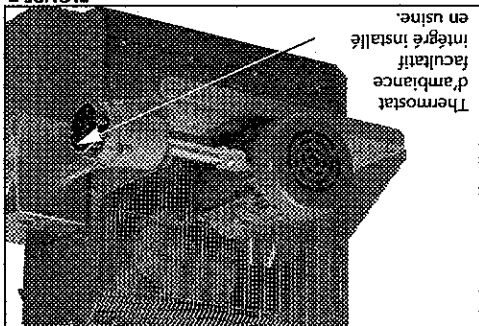
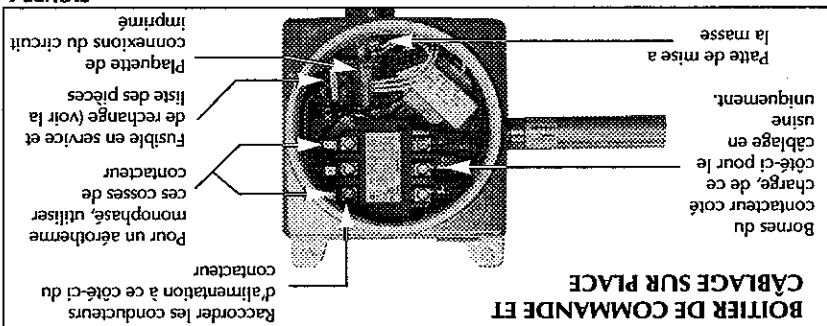
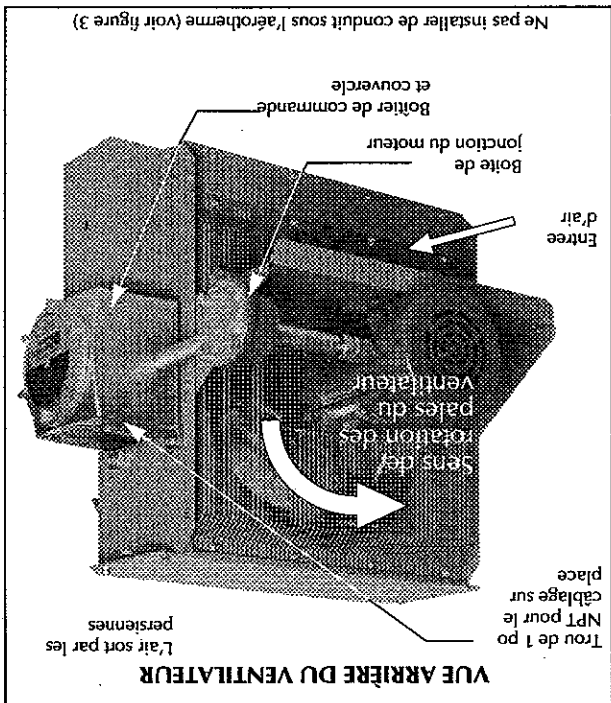


FIGURE 6



BOTIER DE COMMANDE ET CABLAGE SUR PLACE

FIGURES 5



VUE ARRIERE DU VENTILATEUR

1. Avant de mettre sous tension:
  - a) vérifier si toutes les connexions sont bien faites et correspondent au schéma de câblage applicable (voir figure 8) et aux codes en vigueur;
  - b) s'assurer que l'alimentation électrique soit compatible avec la puissance de l'aérotherme indiquée sur la plaque signalétique; enlever tout corps étranger à l'intérieur de l'aérotherme;
  - c) installer tous les couvercles et vérifier si tous les boîtiers sont bien fermés et;
  - d) s'assurer que le ventilateur tourne librement. Voir la figure 5 pour connaître le sens de rotation des pales du ventilateur.

INSPECTION FINALE

- On peut se procurer des thermostats d'ambiance appropriés en usine. température.
- d) fonctionner avec ouverture de contact lorsqu'il y a hausse de température.
  - c) avoir une capacité minimale de 2 A; et
  - b) avoir une tension nominale d'au moins 125 V;
  - a) être du type antiéclaboussure.
- L'aérotherme peut être fourni avec un thermostat d'ambiance intégré (voir figure 7). Pour les aérothermes qui ne sont pas dotés de cette option, on recommande d'utiliser un thermostat d'ambiance à distance. Pour installer celui-ci avec un aérotherme de 600 V des groupes C, D, F et G; IIA & IIB, il faut raccorder en série le limiteur de température à maximum du moteur au circuit de commande (voir figure 8). Pour tous les autres aérothermes, raccorder les conducteurs du thermostat d'ambiance à distance à la plaque de connexions du circuit imprimé portant l'inscription "TSTAT". Tout thermostat utilisé avec cet aérotherme doit:

1. Les conducteurs d'alimentation, les conducteurs de mise à la masse et les conducteurs du thermostat d'ambiance (voir 2. ci-dessous) passent dans le trou de 1 po NPT (voir figure 5) et sont raccordés dans le boîtier de commande (voir figure 6).

### CÂBLAGE SUR PLACE

fréquence, l'ampérage et la phase. La tension d'alimentation doit être  $\pm 10\%$  la tension indiquée sur la plaque signalétique.

1. Pour raccorder l'aérotherme, n'utiliser que des conducteurs de cuivre et des méthodes de câblage approuvées antidéflagration. Consulter le tableau "Données techniques" et la plaque signalétique de l'aérotherme pour connaître la valeur du conducteur.
2. Une protection externe de surintensité est requise. Consulter le tableau "Données techniques" et la plaque signalétique de l'aérotherme pour connaître la tension, la

### GÉNÉRALITÉS

**AVERTISSEMENT**

Débrancher la source d'alimentation avant d'installer l'aérotherme. Bloquer le commutateur en position "OFF" (circuit ouvert) et/ou y mettre une étiquette afin d'éviter que l'appareil ne soit mis en marche par inadvertance. L'installation et le câblage de l'aérotherme doivent être conformes à tous les codes en vigueur.

## ÉLECTRIQUE

FIGURE 4

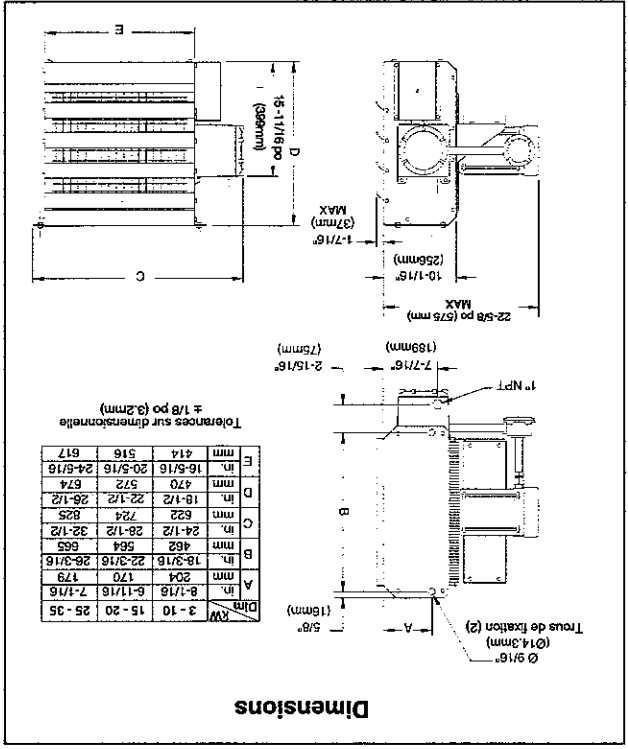


FIGURE 3

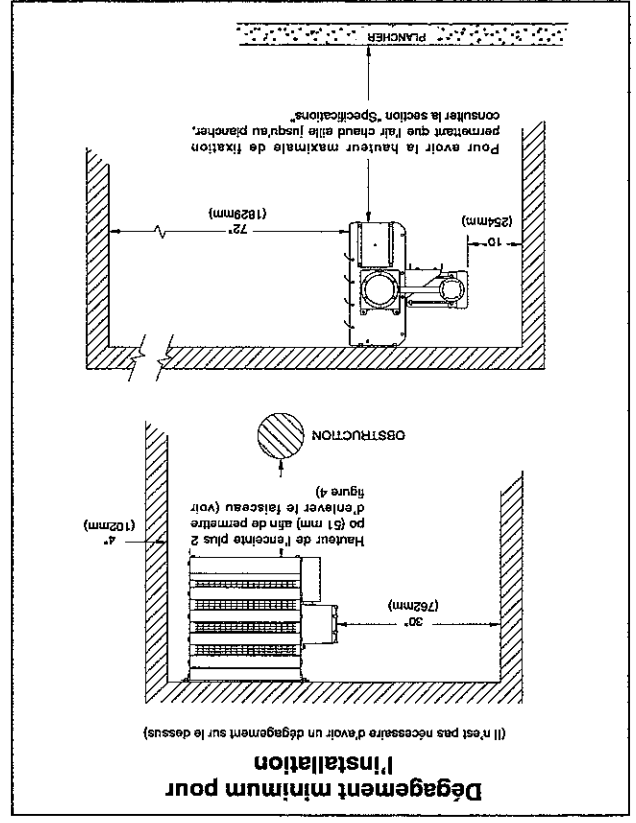
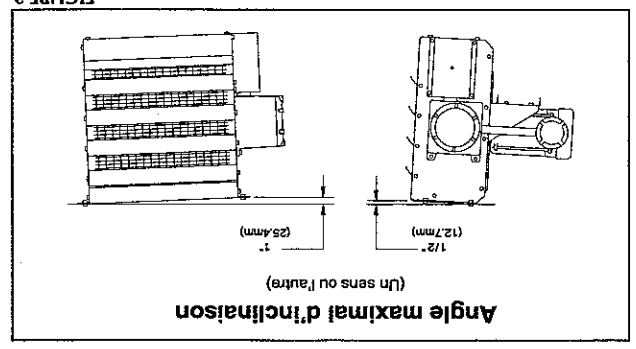


FIGURE 2



- ### MONTAGE
1. Pour le fonctionnement, l'aérotherme doit être installé de façon permanente en position verticale et de niveau. Voir les figures 2, 3 et 4 pour connaître l'angle d'inclinaison maximal, le dégagement maximal, ainsi que les dimensions. Afin de faciliter l'installation, on peut se procurer en usine divers types de nécessaires de montage.
  2. La structure de montage doit être suffisamment forte pour:
    - a. supporter les poids de l'aérotherme; se reporter à la section "Specifications";
    - b. offrir suffisamment de rigidité pour éviter les vibrations excessives; et
    - c. résister aux situations difficiles comme les installations démontables.

# AVIS IMPORTANT

## AVERTISSEMENT

Bien lire attentive les avis suivants et s'y conformer, sinon il y a risque de blessures graves ou même mortelles.

1. Lire les instructions du guide et les suivre.
  2. N'utiliser l'aérotherme que dans des endroits où la température d'allumage est supérieure à la température nominale maximale de l'aérotherme, tel qu'indiqué sur la plaque signalétique. Se reporter aux codes électriques en vigueur pour avoir plus de renseignements.
  3. N'utiliser l'aérotherme que dans les endroits dangereux qui sont indiqués sur la plaque signalétique de l'aérotherme.
  4. L'aérotherme ne doit être utilisé qu'à l'intérieur, au sec. Ne pas immerger dans l'eau. Ne pas entreposer ou utiliser dans les endroits exposés à la pluie ou à la neige.
  5. Seul un électricien qualifié et expérimenté avec l'équipement destiné aux endroits dangereux peut faire le raccordement et l'entretien de l'aérotherme.
  6. Pour l'installation et le raccordement à la source d'alimentation, il faut respecter tous les codes en vigueur.
  7. Avant d'ouvrir un boîtier, débrancher l'aérotherme de sa source d'alimentation. Bloquer le commutateur en position "OFF" (circuit ouvert) et/ou y mettre une étiquette afin d'éviter que l'appareil ne soit mis en marche par inadvertance.
  8. Cet aérotherme est muni d'un seul bimétal limiteur de température à maximum. Il est du type à réenclenchement automatique ce qui signifie que l'aérotherme peut se remettre en marche sans avertissement. Il ne faut pas faire fonctionner l'aérotherme lorsque le bimétal à maximum est hors service ou débranché du circuit de commande.
  9. Ne faire fonctionner l'aérotherme que lorsqu'il est installé de façon permanente en position verticale. Consulter la section "Installation mécanique" pour avoir plus de détails.
10. L'aérotherme doit toujours être propre. Lorsqu'il fonctionne dans un environnement où il y a beaucoup de saletés, nettoyer régulièrement les tubes à ailettes, le ventilateur et la grille de protection. Suivre les procédures de maintenance recommandées. Consulter la section "Liste de contrôle pour la maintenance de l'aérotherme" pour avoir plus de détails.
  11. Le faisceau de l'aérotherme est chargé à vide et contient de l'éthylène glycol, lequel est toxique. S'il y a une fuite de fluide de l'aérotherme, le débrancher de sa source d'alimentation et remplacer le faisceau par un faisceau fourni en usine. Se reporter à la section "Réparation et remplacement" pour avoir plus de détails.
  12. Ne pas faire fonctionner l'aérotherme si des personnes sont complètement fermées ou dépassent des butées.
  13. Ne pas faire fonctionner l'aérotherme dans des milieux où il y a risque de corrosion de l'acier ou de l'aluminium.
  14. N'utiliser que les pièces de remplacement approuvées en usine. Des joints de conduits ne sont pas requis pour les conduits de l'aérotherme installés en usine. Se reporter aux codes électriques en vigueur relativement aux exigences des joints pour les conduits installés sur place.
  15. Lors de la mise en marche de l'aérotherme, on peut entendre des bruits de cognement ou de craquement à l'intérieur du faisceau, ce qui est normal.
  16. L'air qui sort près du bas de l'aérotherme peut être plus chaud que celui qui sort par le haut, ce qui est normal.
  17. Si vous avez des questions en ce qui concerne l'aérotherme, communiquez avec le personnel de l'usine. Veuillez consulter la dernière page de ce guide pour avoir plus de renseignements.

## LA GARANTIE SERA ANNULÉE SI LES INSTRUCTIONS NE SONT PAS SUIVIES

## INSTALLATION

Les instructions d'installation servent de directives générales pour l'installation et le câblage de l'aérotherme. Tous les codes en vigueur doivent être respectés.

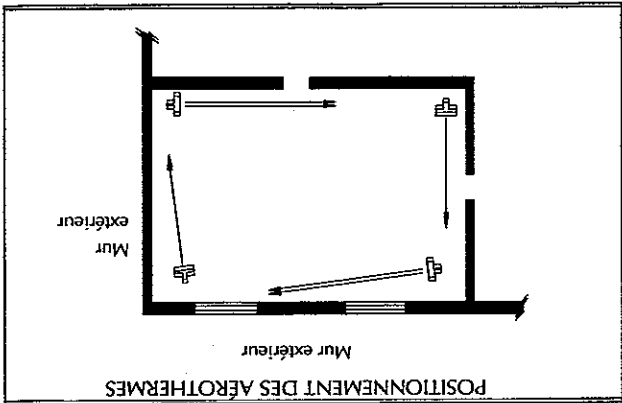
## MÉCANIQUE

## POSITIONNEMENT

Pour un chauffage optimum, l'aérotherme doit être installé de manière:

1. qu'il n'y ait aucune obstruction empêchant l'arrivée ou la sortie d'air de l'aérotherme;
2. que la sortie d'air soit dirigée dans les espaces vastes et non vers les personnes;
3. que la sortie d'air ne soit pas dirigée sur un thermostat.
4. que la sortie d'air soit dirigée directement vers les endroits où il y a des pertes de chaleur, comme les portes ou les fenêtres (voir figure 1);
5. que la sortie d'air soit dirigée le long des murs extérieurs, avec un angle légèrement vers l'extérieur (voir figure 1);
6. que si on vise d'abord à protéger l'équipement contre le gel, la sortie d'air soit dirigée vers l'équipement;
7. que les courants de sortie d'air soient complémentaires et créent une circulation d'air. Il n'est pas nécessaire que la portée d'air de l'aérotherme se rende jusqu'à l'autre aérotherme (voir figure 1).

FIGURE 1



# LISTE DE CONTRÔLE POUR LA MAINTENANCE DE L'AÉROTHERME X14

Photocopier  
cette page  
pour la  
réutiliser.

No. modèle d'aérotherme: \_\_\_\_\_ No. de série: \_\_\_\_\_

Date de maintenance: \_\_\_\_\_ Entretien par: \_\_\_\_\_

Commentaires: \_\_\_\_\_

**AVERTISSEMENT**

Débrancher l'aérotherme de la source d'alimentation avant d'ouvrir les boîtiers ou d'en faire la maintenance. Bloquer le commutateur en position Off et/ou y mettre une étiquette afin d'éviter que l'appareil ne soit mis en marche par inadvertance. L'entretien de cet aérotherme ne doit être fait que par du personnel expérimenté avec l'équipement de chauffage pour les endroits dangereux.

## PERIODIQUE (avant la saison froide et lorsque nécessaire au cours de la saison)

- 1. NETTOYER**
- Tube à ailettes
  - Ventilateur
  - Gille de protection
  - Moteur
  - Persiennes
- 2. VÉRIFIER**
- Si le moteur fonctionne bien
  - Si l'angle des persiennes est bon et si elles tiennent bien en place
  - Si tous les couvercles antidéflagrants sont bien vissés

Enlever la poussière à l'aide d'air comprimé. Ne pas vaporiser d'eau ou de solvants.  
Ne pas immerger dans l'eau ou les solvants.

## ANNUELLE (avant la saison froide)

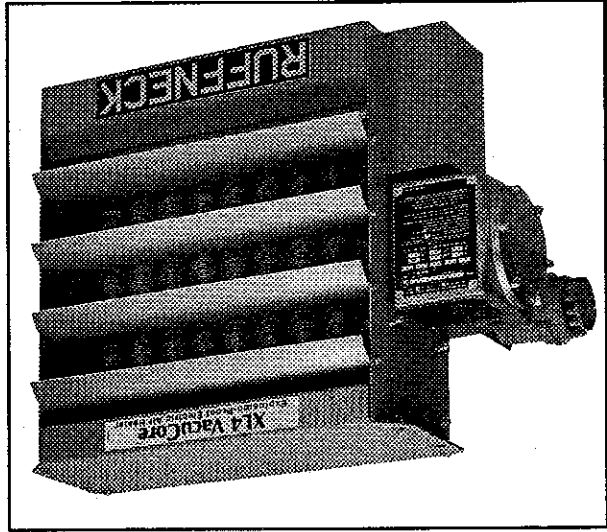
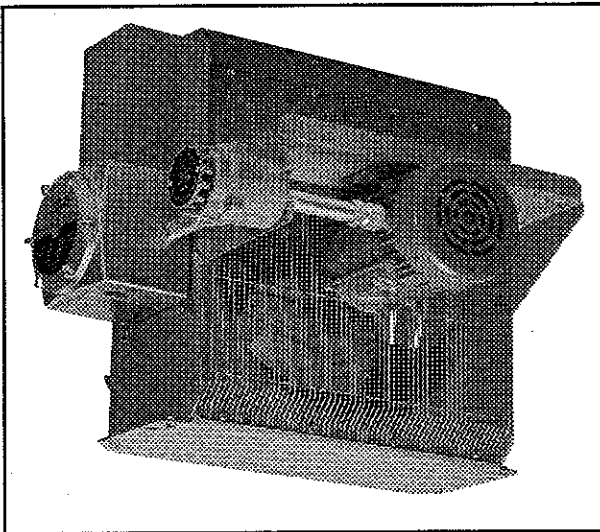
- 1. ELECTRIQUE**
- Vérifier tous les conducteurs et les bornes de connexion. Serrer les connexions lâches. Remplacer les conducteurs dont l'isolation est endommagée.
  - Inspecter les contacts des contacteurs. S'ils sont très corrodés, brûlés ou si la soudure est en mauvais état, les remplacer par des contacteurs fournis en usine.
  - Vérifier les fusibles. La capacité et le type du fusible sont indiqués sur la plaque à circuits imprimés. Le bon fusible doit se trouver dans le porte-fusible en service. On recommande de garder un fusible en bon état dans le porte-fusible de rechange.
  - Vérifier tous les conduits antidéflagrants. Remplacer les conduits endommagés. Afin d'être certains que les conduits soient vissés sur cinq filets, le bout vissé des conduits doit dépasser d'au moins 1/16 po (1,6 mm) dans les boîtiers.
  - Vérifier la résistance électrique de toutes les bornes du côté charge. La lecture doit être la même (±5%).
- 2. MÉCANIQUE**
- Vérifier s'il y a des fuites de fluide. Le faisceau de l'aérotherme est chargé à vide et contient de l'éthylène glycol, lequel est toxique. S'il y a une fuite de fluide de l'aérotherme, débrancher ce dernier de la source d'alimentation et faire remplacer le faisceau. Un faisceau fourni en usine peut être expédié immédiatement à partir des stocks. Consulter la section "Réparation et remplacement" pour avoir plus de détails.
  - Vérifier tous les boîtiers. L'intérieur des boîtiers doit être propre, sec et exempt de corps étrangers. Les couvercles vissés doivent être bien en place et serrés à la main.
  - Nota: Les joints des boîtiers sont métal. Ne pas utiliser de joints d'étanchéité ou de scellants. De la graisse est mise aux joints en usine et il ne faut pas l'enlever.
  - Vérifier les roulements à billes de l'arbre moteur. Remplacer le moteur s'il y a trop de jeu ou si le moteur ne fonctionne pas bien et silencieusement. Les roulements à billes du moteur sont lubrifiés de façon permanente.
  - Vérifier le ventilateur. Le remplacer aussitôt s'il est fissuré ou endommagé.
  - Vérifier les persiennes. Les vis des persiennes doivent être serrées. Les persiennes ne doivent pas être complètement fermées ou dépasser des butées.
  - Vérifier si toutes les pièces sont bien serrées. Tous les écrous et les boulons, y compris les pièces de support, doivent être bien serrés.
  - Faire fonctionner l'aérotherme pendant au moins cinq minutes. Vérifier si de l'air chaud sort par les persiennes. Il est normal d'entendre des bruits de craquement ou de cognement au démarrage.

Avant de réparer, veuillez composer le numéro de la ligne sans frais: 1-800-661-8561 (24 hr) Canada et E.-U.



# XL4 Série VacuCore®

Aérothermes électriques pour endroits dangereux



Le présent guide comprend l'information relative à l'installation, à la maintenance, à la réparation et aux pièces de rechange.

## ENDROITS APPROUVÉS

Les aérothermes électriques RUFFNECK XL4 de la série VacuCore sont certifiés par le CSA ou homologués UL pour les endroits ci-dessous:

Classe I, Divisions 1 & 2, Groupe D;

Classe II, Division 1, Groupes E, F, & G;

Classe II, Division 2, Groupes F & G;

Classe I, Zones 1 & 2, Groupe IIA

Code de température T3B 165°C (329°F);

(modèles de 50 Hz et 60 Hz)

ou

Classe I, Zones 1 & 2, Groupes IIA & IIB

Code de température T3B 165°C (329°F);

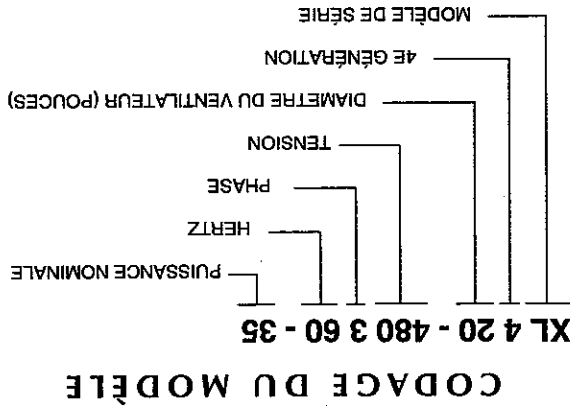
(modèles de 60 Hz uniquement)

Pour avoir plus de détails sur les endroits dangereux avec risque

d'explosion, consulter le Code canadien de l'électricité,

première partie, section 18 ou le

Code national de l'électricité, articles 500 - 516.



## AVERTISSEMENT

LIRE TOUS LES AVIS IMPORTANTS DE LA PAGE 3.



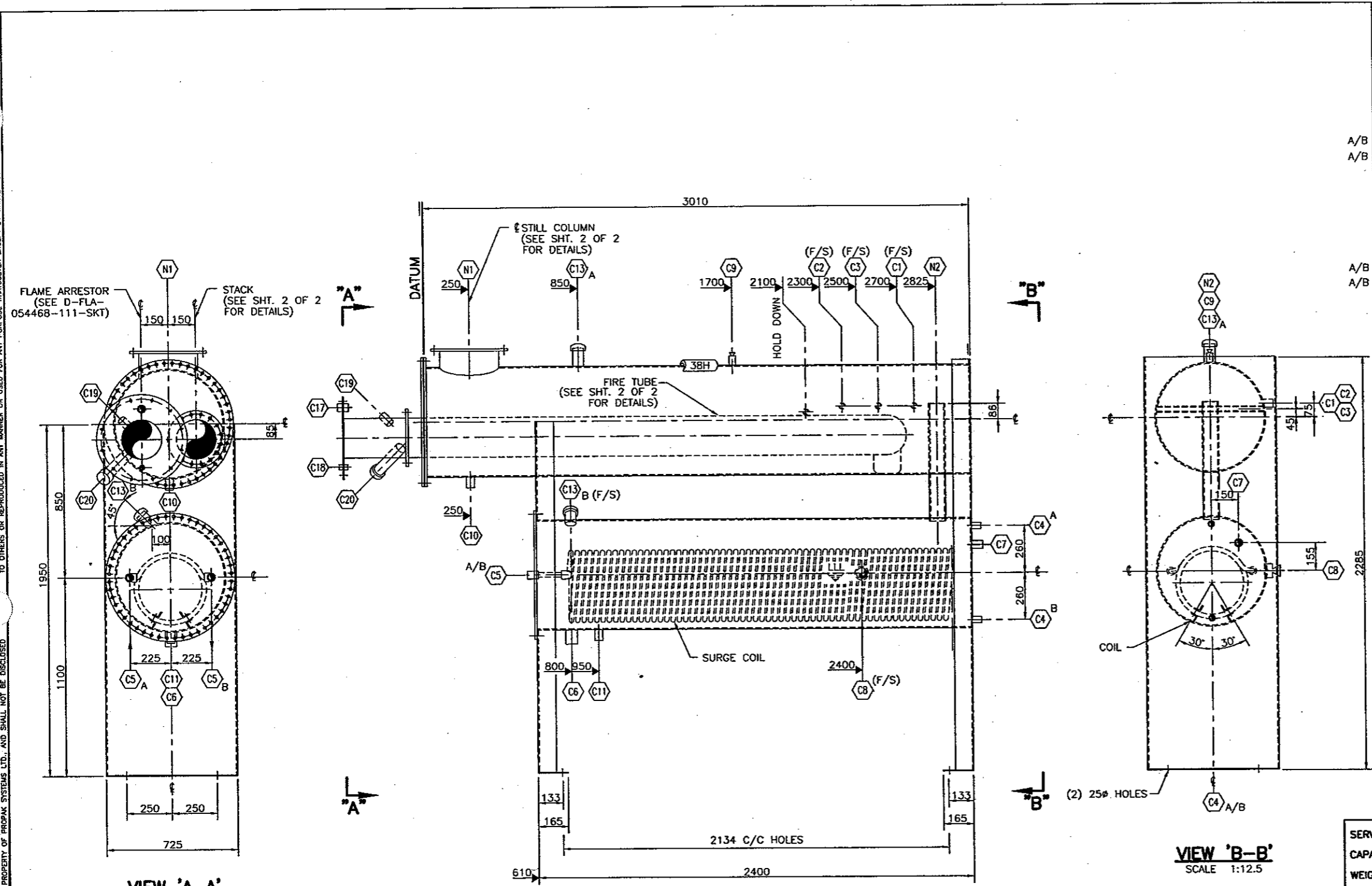
Part No 5031-8

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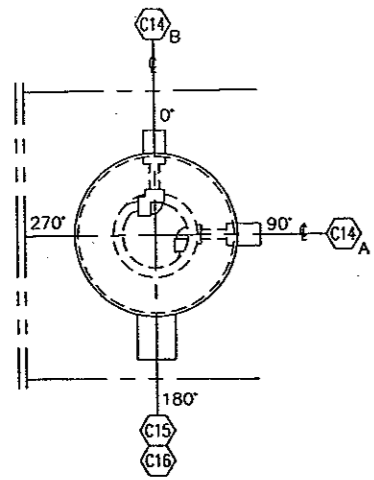


NOZZLE SCHEDULE							
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD
N1	12 NPS	FAB	FF	20	STILL COLUMN	100	-
N2	3 NPS	-	PIPE	40	STAND PIPE	-	-
N3	8 NPS	-	FF	-	THIEF HATCH	-	-
C1	3/4 NPS	3000#	CPLG	-	TI	45 MIN	-
C2	3/4 NPS	3000#	CPLG	-	TC	45 MIN	-
C3	3/4 NPS	3000#	CPLG	-	HTSD	45 MIN	-
A/B C4	1/2 NPS	3000#	CPLG	-	LG	-	-
A/B C5	1 NPS x 3/4 NPS	3000#	RED CPLG	NPTxSW	SURGE COIL	-	-
C6	1 1/2 NPS	3000#	CPLG	-	GLYCOL OUTLET	-	-
C7	1 NPS	3000#	CPLG	-	HC SKIMMER	-	-
C8	2 NPS	3000#	1/2 CPLG	-	FUTURE LSL (PLUGGED)	-	-
C9	1 1/2 NPS	3000#	CPLG	-	FUTURE PSV (PLUGGED)	45 MIN	-
C10	1 NPS	3000#	CPLG	-	REBOILER DRAIN	45 MIN	-
C11	1 NPS	3000#	CPLG	-	SURGE DRAIN	-	-
A/B C13	2 NPS	FAB	PIPE	XH	FILL w/CAP	SPEC	-
A/B C14	1 NPS x 1/2 NPS	3000#	RED CPLG	NPTxSW	STILL COLUMN COIL	45 MIN	-
C15	1 NPS	3000#	CPLG	NPTxSW	GLYCOL INLET	SPEC	-
C16	2 NPS	3000#	CPLG	-	STEAM OUTLET	45 MIN	-
C17	1 NPS	3000#	CPLG	-	FUEL GAS TO BURNER	-	-
C18	1/2 NPS	3000#	CPLG	-	PILOT	-	-
C19	1 NPS	3000#	CPLG	XL	FFSD	-	-
C20	2 NPS	3000#	NPT	XH	LIGHTING PORT	-	-
C21	3/4 NPS	3000#	CPLG	-	TW (PLUGGED)	-	-

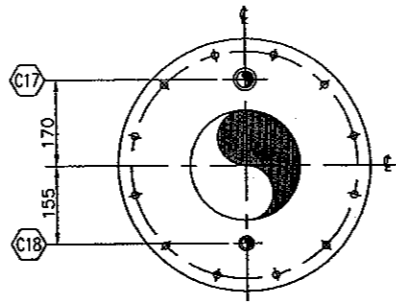
SERVICE: GLYCOL	SERIAL NO: 054468-111	CRN: N/A
CAPACITY: 1.43 m <sup>3</sup>	YEAR BUILT: 2005	LSD #: -
WEIGHT EMPTY: 1675 kg	CODE: NON-CODE	DESIGN PRESSURE: ATMOSPHERIC
WEIGHT FULL OF WATER: 3100 kg	DESIGN TEMPERATURE: 204°C	M.D.M.T.: -28.8°C
PAINT SPEC: PNT-12	HYDROTEST PRESSURE: LEAK PROOF	MATERIAL: HEAD: SA-36
STACK: PNT-13	MATERIAL: SHELL: SA-53-B ERW	RADIOGRAPHY: LONG: N/A
INSULATION: 38 THK CALCIUM SILICATE c/w ALUMINUM CLADDING	P.W.H.T. MIN TEMP / TIME: NO	CIRC: NIL
SHIP LOOSE: NO	HYDROTEST SURGE COIL: 2586 kPa	CORR. ALLOWANCE: NONE
HYDROTEST STILL COIL: 2586 kPa	TAG NO: H-650	

VIEW 'A-A' SCALE 1:12.5		ELEVATION SCALE 1:12.5		VIEW 'B-B' SCALE 1:12.5	
GENERAL NOTES		GENERAL NOTES		REVISION	
DATE: 2005/09/30 10:13 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\REG-054468-111-SKT-01.DWG hmeng		SKT ISSUED FOR DOCUMENTATION		F. DEL 05/09/30 YK MZ	
No.		REVISION		BY DATE CKD ENG	
APPROVED		DRAWN		MECH/STRUCT.	
DATE		DATE		ELECTRICAL	
DATE		DATE		PROJECT	
DATE		DATE		SCALE AS NOTED	
DWD. No.: D-REG-054468-111-SKT		SHT. 1 OF 2		REV. SKT	
FORT ENERGY CORP.				88 REFRIGERATION UNIT	
GLYCOL REGENERATOR - 100 KW (H-650)				610 O/D x 3010 LC	
440 East Lake Road,				Postal Bag #2	
Airdrie, Alberta				Canada T4B 2C3	

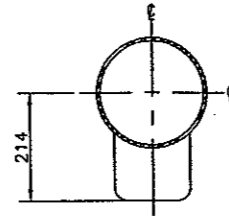
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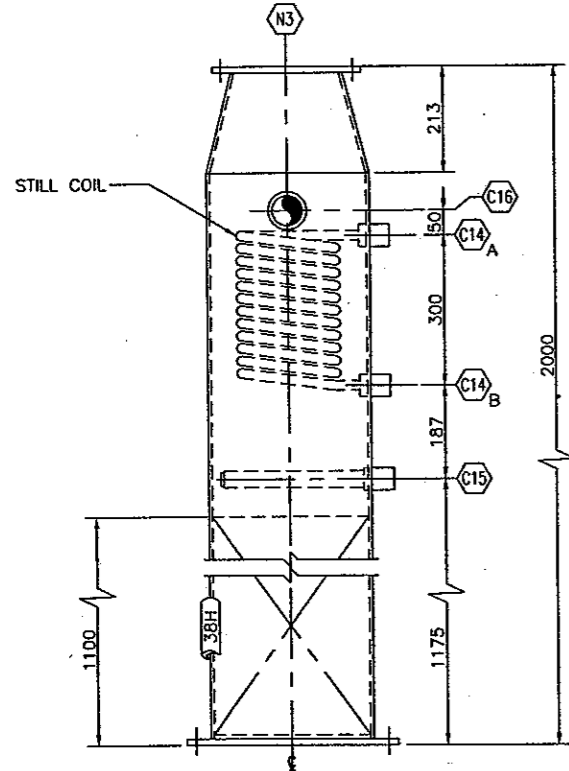
**STILL COLUMN ORIENTATION**  
SCALE 1:7.5



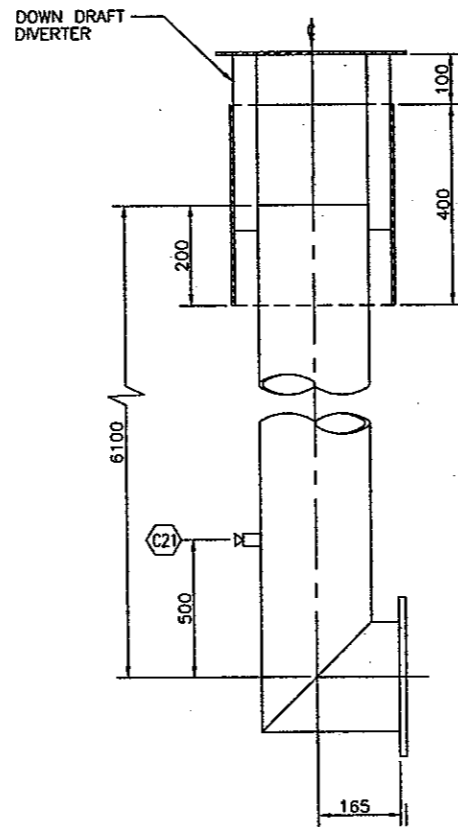
**VIEW 'A-A'**  
SCALE 1:7.5



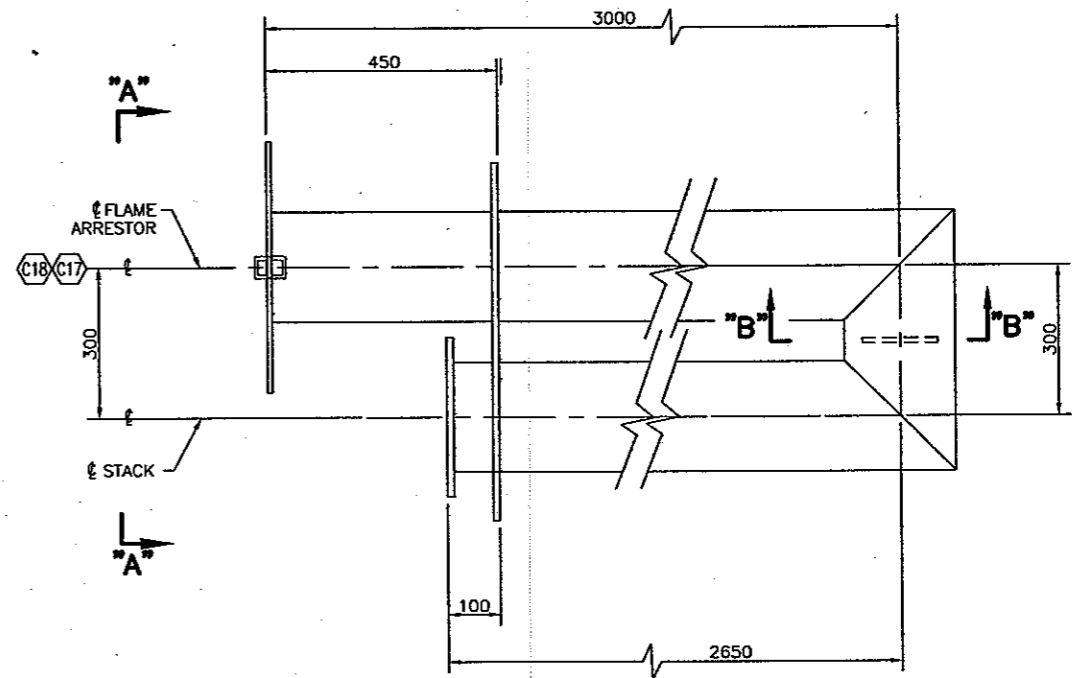
**SECTION 'B-B'**  
SCALE 1:7.5



**STILL COLUMN DETAIL**  
SCALE 1:7.5

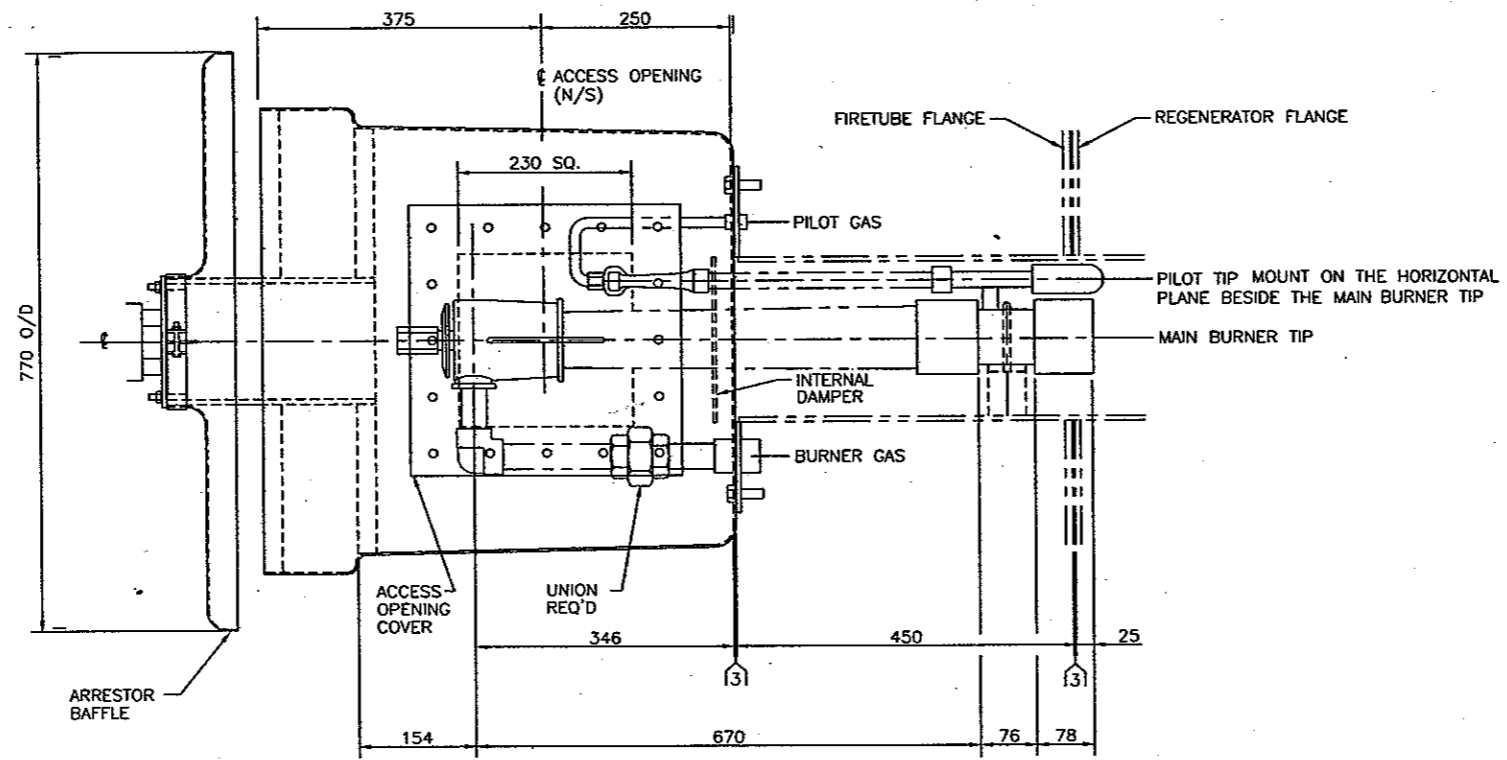


**STACK DETAIL**  
SCALE 1:7.5



**FIRETUBE DETAIL**  
SCALE 1:7.5

<b>GENERAL NOTES</b> DATE: 2005/09/30 10:06 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\REG-054468-111-SKT-02.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION		F. DEL 05/09/30 VK MZ		<b>APPROVED</b> MECH/STRUCT. BY DATE ELECTRICAL BY CHECKED PROJECT BY DATE DATE SCALE AS NOTED		<b>DRAWN</b> BY DATE CHECKED BY DATE DATE SCALE AS NOTED		<b>FORT ENERGY CORP.</b> 8B REFRIGERATION UNIT GLYCOL REGENERATOR - 100 KW (H-650) DETAILS		<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
No. REVISION		No.		BY DATE CKD ENG		DWG. No.: D-REG-054468-111-SKT SHT. 2 OF 2		REV. SKT					



**FLAME ARRESTOR ASSEMBLY DETAIL**

SCALE 1:5

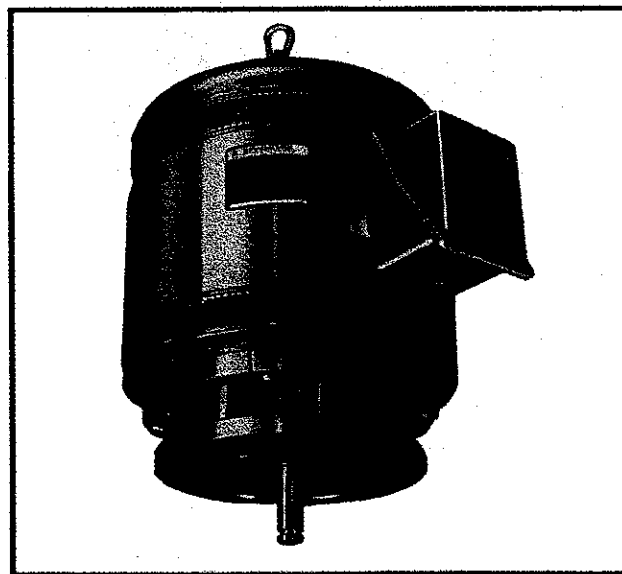
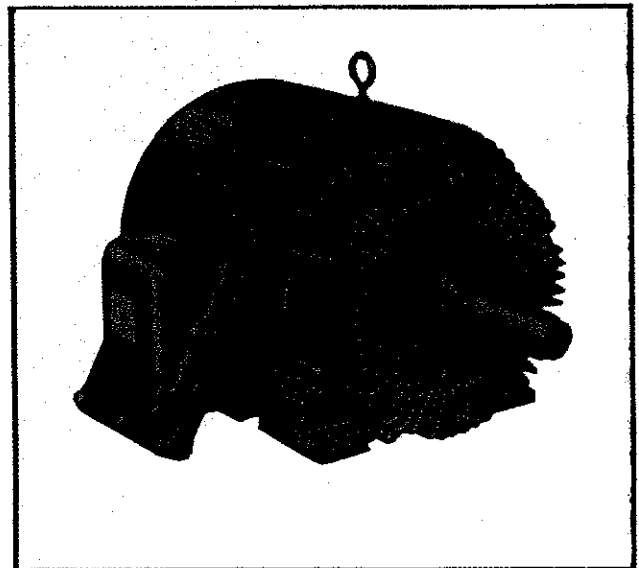
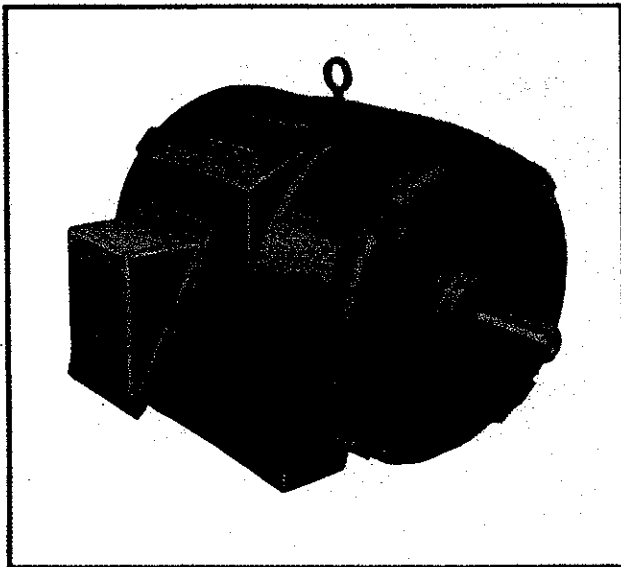
<b>OUTPUT DUTY</b>	
NOMINAL	112 KW
MAXIMUM (CLEAN FUEL)	125 KW
MAXIMUM (DIRTY FUEL)	100 KW
<b>FUEL GAS</b>	SWEET
<b>BURNER DESIGN</b>	ECLIPSE #16

<b>GENERAL NOTES</b>		<b>GENERAL NOTES</b>		SKT	ISSUED FOR DOCUMENTATION	F. DEL	05/09/30	VK	MZ	<b>APPROVED</b>		<b>DRAWN</b>		<b>FORT ENERGY CORP.</b>		
DATE: 2005/09/30 10:07 AM	J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\FLA-054468-111-SKT-01.DWG	hmeng		No.	REVISION	BY	DATE	CKD	ENG							88 REFRIGERATION UNIT GLYCOL REGENERATOR (H-650) FLAME ARRESTOR
										MECH/STRUCT.	BY	DATE			DWG. No.: D-FLA-054468-111-SKT SHT. 1 OF 1 REV. SKT	
										DATE	DATE	CHECKED				
										ELECTRICAL	BY	DATE				
										PROJECT	DATE					
										DATE	SCALE	AS NOTED				

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3				MEDIUM VOLTAGE INDUCTION MOTOR		SHEET 1	OF 1
CUSTOMER : XXXXXX PLANT : REFRIGERATION PLANT 8B SERVICE : REFRIGERATION COMPRESSOR JOB NO. : XXXXXX TAG NO: KD-670 MFR. : MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION
1	RATED POWER / MANUFACTURING	hp	150				
2	FULL LOAD RPM		1200				
3	DIRECTION OF ROTATION FROM N.D.E.		CCW				
4	RATED VOLTAGE/PHASE/HERTZ	(VOLT / PH / Hz)	480/3/60				
5	POWER FACTOR @	1	% OF FULL LOAD				
6		0.75	% OF FULL LOAD				
7		0.5	% OF FULL LOAD				
8	FULL LOAD CURRENT	AMP					
9	LOCKED ROTOR CURRENT	%FLC					
10	SERVICE FACTOR	( 1.0 / 1.15 )	1.15				
11	FULL LOAD TORQUE						
12	LOCKED ROTOR TORQUE	%FTL					
13	EEMAC TORQUE CLASSIFICATION						
14	EFFICIENCY	@FULL LOAD	%				
15		@75% LOAD	%				
16		@50% LOAD	%				
17	SAFE STALL TIME (75kW & ABOVE) -HOT	SEC					
18		-COLD	SEC				
19	WEIGHT	kg					
20	WORKING CONDITIONS:						
21	LOCATION	(INDOOR/OUTDOOR)	INDOORS				
22	ALTITUDE	ft	914.4m (3000 ft)				
23	MAXIMUM HUMIDITY	%	80				
24	MINIMUM TEMP	° C	-31.7°C (-25°F)				
25	MAXIMUM TEMP	° C	37.8°C (100°F)				
26	AREA CLASSIFICATION:	CLASS	1				
27		DIV	1				
28		GROUP	d				
29	FRAME & FRAME MATERIAL		449 T				
30	ENCLOSURE		XP - HORIZONTAL				
31	MOTOR MOUNT TYPE		XP FOOT				
32	INSULATION CLASS	( A / B / F / H )	F				
33	TEMPERATURE CLASS	( A / B / F / H )	B				
34	BEARING TYPE		BALL				
35	BEARING TEMP SENSOR REQD	( THERMISTER / RTD )	NO				
36		- NO. REQD / BEARING					
37	WINDING TEMP SENSOR REQD	( THERMISTER / RTD )	THERMISTER				
38		- NO. REQD / WINDING	1				
39	SPACE HEATER-	WATTS					
40		VOLT/HERTZ					
41							
42							
43	AT TRANSFORMER PRIMARY UTILITY	Z=					
44	TRANSFORMER	MVA					
45		%Z					
46	FLICKER LIMITED ON TRANSFORMER PRIMARY						
47							
48	STARTING METHOD						
49							
50							
51							
52							
53	NOTE: *** INFORMATION NORMALLY SUPPLIED BY OWNER						
54							
55							

# Standard Induction Motors

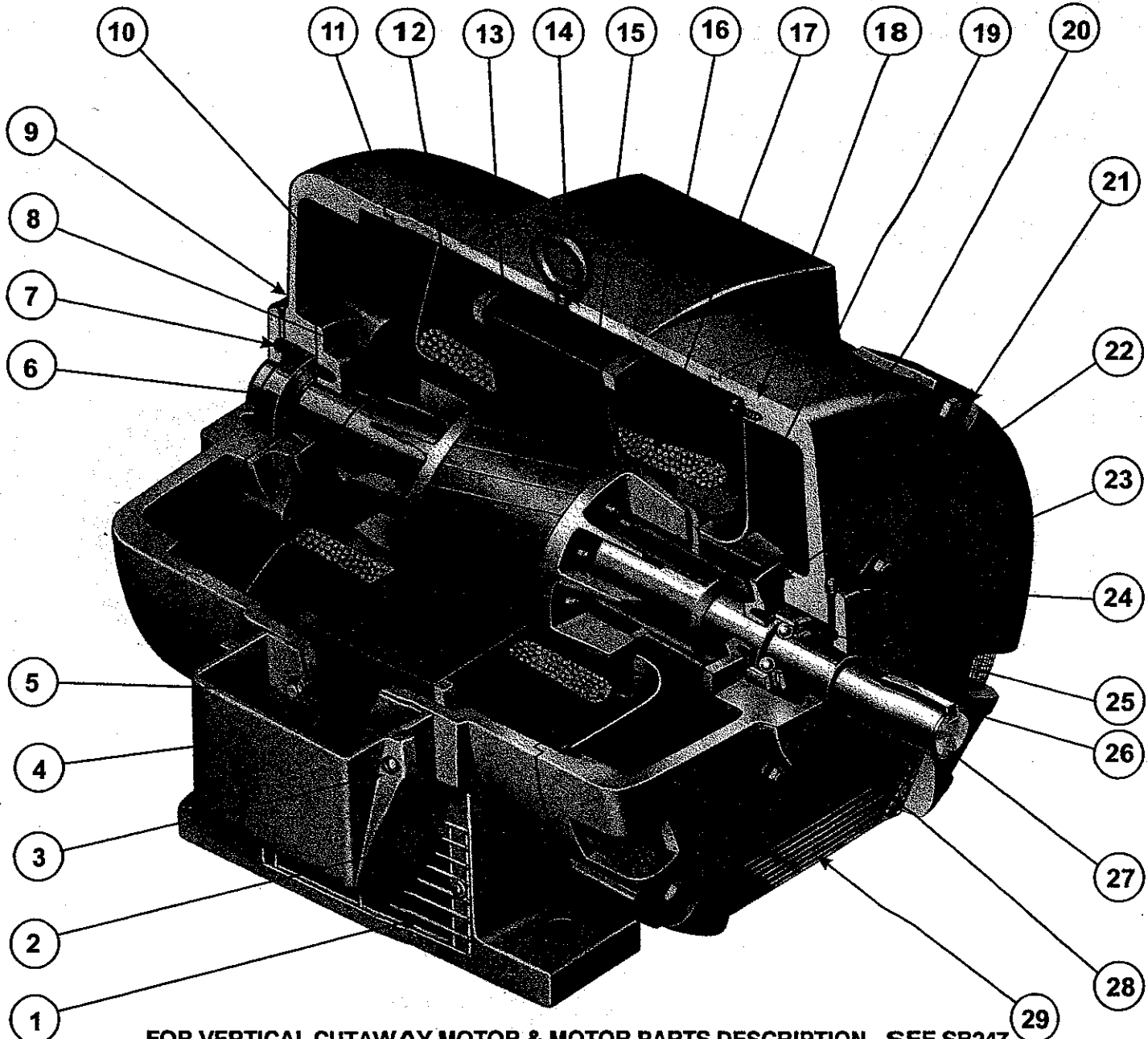


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**Installation, Operation,  
& Maintenance Instructions**

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**TYPICAL CUTAWAY VIEW  
OF A MARATHON DESIGNED, DRIPPROOF, HORIZONTAL  
INTEGRAL HORSEPOWER MOTOR & PARTS DESCRIPTION  
364 THRU 445 FRAME SIZE**



**FOR VERTICAL CUTAWAY MOTOR & MOTOR PARTS DESCRIPTION - SEE SB247**

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1.	Frame Vent Screen	11.	Bracket O.P.E.	21.	Bracket Holding Bolt
2.	Conduit Box Bottom	12.	Baffle Plate O.P.E.	22.	Inner Bearing Cap P.E.
3.	Conduit Box Top-Holding Screw	13.	Rotor Core	23.	Inner Bearing Cap Bolt
4.	Conduit Box Top	14.	Lifting Eye Bolt	24.	Grease Plug
5.	Conduit Box Bottom-Holding Bolt	15.	Stator Core	25.	*Ball Bearing P.E.
6.	*Ball Bearing O.P.E.	16.	Frame	26.	Shaft Extension Key
7.	Pre-loading Spring	17.	Stator Winding	27.	Shaft
8.	Inner Bearing Cap O.P.E.	18.	Baffle Plate Holding Screw	28.	Drain Plug (grease)
9.	Grease Plug	19.	Baffle Plate P.E.	29.	** Bracket Screen
10.	Inner Bearing Cap Bolt	20.	Bracket P.E.		

P.E. = Pulley End

O.P.E. = Opposite Pulley End

\* = Bearing Numbers are shown on motor nameplate when requesting information or parts always give complete motor description, model and serial numbers.

\*\* - Bracket and frame screens are optional.

### WARNING

These instructions must be followed to ensure safe and proper installation, operation and maintenance of the motor. They should be brought to the attention of all persons who install, operate or maintain this equipment.

## GENERAL INFORMATION

Marathon Electric motors are all fully factory tested and inspected before shipping. Damage during shipment and storage can occur. Motors not correctly matched to the power supply and/or the load will not operate properly. These instructions are intended as a guide to identify and eliminate these problems before they are overlooked or cause further damage.

### ACCEPTANCE

Check carefully for any damage that may have occurred in transit. If any damage or shortage is discovered, do not accept until an appropriate notation on the freight bill is made. Any damage discovered after receipt of equipment should be immediately reported to the carrier.

### STORAGE

- A. Keep motors clean
  - 1. Store indoors
  - 2. Keep covered to eliminate airborne dust and dirt.
  - 3. Cover openings for ventilation, conduit connections, etc. to prevent entry of rodents, snakes, birds, and insects, etc.
- B. Keep motors dry
  - 1. Store in a dry area indoors
  - 2. Temperature swings should be minimal to prevent condensation.
  - 3. Space heaters are recommended to prevent condensation.
  - 4. Treat unpainted flanges, shafts, and fittings with a rust inhibitor.
  - 5. Check insulation resistance before putting motor into service. (Consult manufacturer for guidelines).
- C. Keep Bearings Lubricated
  - 1. Once per month, rotate shaft several turns to distribute grease in bearings.
  - 2. If unit has been stored more than one year, add grease before start-up. (Refer to lubrication procedure).

## INSTALLATION

### UNCRATING AND INSPECTION

After uncrating, check for any damage which may have been incurred in handling. The motor shaft should turn freely by hand. Repair or replace any loose or broken parts before attempting to use the motor.

Check to be sure that motor has not been exposed to dirt, grit, or excessive moisture in shipment or storage before installation.

Measure insulation resistance (see operation). Clean and dry the windings as required.

Never start a motor which has been wet without having it thoroughly dried.

## SAFETY

Motors should be installed, protected and fused in accordance with latest issue of National Electrical Code, NEMA Standard Publication No. MG 2 and local codes.

Eyebolts or lifting lugs are intended for lifting the motor only. These lifting provisions should never be used when lifting or handling the motor with other equipment (i.e. pumps, gear boxes, fans or other driven equipment) as a single unit. Be sure the eyebolt is fully threaded and tight in its mounting hole.

Eyebolt lifting capacity ratings is based on a lifting alignment coincident with the eyebolt centerline. Eyebolt capacity reduces as deviation from this alignment increases. See NEMA MG 2.

Frames and accessories of motors should be grounded in accordance with National Electrical Code (NEC) Article 430. For general information of grounding refer to NEC Article 250.

Rotating parts such as pulleys, couplings, external fans, and shaft extensions should be permanently guarded.

### LOCATION

In selecting a location for the motor, consideration should be given to environment and ventilation. A motor with the proper enclosure for the expected operating condition should be selected.

The ambient temperature of the air surrounding the motor should not exceed 40°C (104°F) unless the motor has been especially designed for high ambient temperature applications. The free flow of air around the motor should not be obstructed.

The motor should never be placed in a room with a hazardous process, or where flammable gases or combustible material may be present, unless it is specifically designed for this type of service.

- 1. Dripproof (open) motors are intended for use indoors where atmosphere is relatively clean, dry and non-corrosive.
- 2. Dripproof (open) fire pump motors are to be installed in a Type 2 dripproof environment as defined in NEMA 250.
- 3. Totally enclosed motors may be installed where dirt, moisture and corrosion are present, or in outdoor locations.
- 4. Explosion proof motors are built for use in hazardous locations as indicated by Underwriters' label on motor. Consult UL, NEC, and local codes for guidance.

Refer to Marathon Electric for application assistance.

### FLOOR MOUNTING

Motors should be provided with a firm, rigid foundation, with the plane of four mounting pads flat within .010" for 56 to 210 frame; .015" from 250 through 500 frame. This may be accomplished by shims under the motor feet. For special isolation mounting, contact Marathon Electric for assistance.

### V-BELT DRIVE

- 1. Select proper type and number of belts and sheaves. Excessive belt load will damage bearings. Sheaves should be in accordance to NEMA Spec. MG-1 or as approved by the manufacturer for a specific application.
- 2. Align sheaves carefully to avoid axial thrust on motor bearing. The drive sheave on the motor should be positioned toward the motor so it is as close as possible to the bearing.

- When adjusting belt tension, make sure the motor is secured by all mounting bolts before tightening belts.
- Adjust belt tension to belt manufacturers recommendations. Excessive tension will decrease bearing life.

## DIRECT CONNECTED DRIVE

Flexible or solid shaft couplings must be properly aligned for satisfactory operation. On flexible couplings, the clearance between the ends of the shafts should be in accordance with the coupling manufacturer's recommendations or NEMA standards for end play and limited travel in coupling.

MISALIGNMENT and RUN-OUT between direct connected shafts will cause increased bearing loads and vibration even when the connection is made by means of a flexible coupling. Excessive misalignment will decrease bearing life. Proper alignment, per the specifications of the coupling being used, is critical.

Some large motors are furnished with roller bearings. Roller bearings should **not** be used for direct drive.

## ELECTRICAL CONNECTIONS

### CAUTION

Install and ground per local and national codes. Consult qualified personnel with questions or if repairs are required.

### WARNING

- Disconnect power before working on motor or driven equipment.
- Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.
- Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.
- Discharge all capacitors before servicing motor.
- Always keep hands and clothing away from moving parts.
- Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector, or thermocouple.
- Electrical repairs should be performed by trained and qualified personnel only.
- Failure to follow instructions and safe electrical procedures could result in serious injury or death.
- If safety guards are required, be sure the guards are in use.

of full load amps as shown on the nameplate for all other motors. Do not use protection with larger capacities than recommended. Three phase motors must have all three phases protected.

## THERMAL PROTECTOR INFORMATION

The nameplate will indicate one of the following:

- Motor is thermally protected
- Motor is not thermally protected
- Motor is provided with overheat protective device

For examples, refer to paragraphs below:

- Motors equipped with built-in thermal protection have "THERMALLY PROTECTED" stamped on the nameplate. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded. The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, press the red button to reset.
- Motors without thermal protection have nothing stamped on nameplate about thermal protection.
- Motors that are provided with overheat protective device that does not open the motor circuit directly will indicate "WITH OVERHEAT PROTECTIVE DEVICE".
  - Motors with this type of "Overheat Protective Device" have protector leads brought out in the motor conduit box marked "P1" and "P2". These leads are intended for connection in series with the stop button of the 3-wire pilot circuit for the magnetic starter which controls the motor. See Figure 1.
  - The circuit controlled by the above "Overheat Protective Device" must be limited to a maximum of 600 volts and 360 volt-amps.

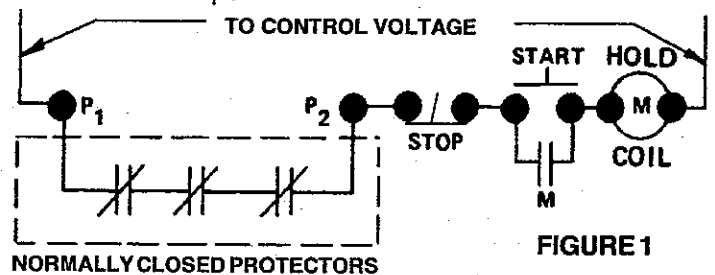
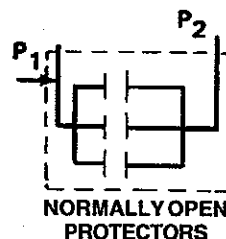


FIGURE 1



Normally Open (N/O) Motor Thermostats may be used in conjunction with controls installed by Original Equipment Manufacturers.

FIGURE 1A

## CHANGING ROTATION

- Keep hands and clothing away from rotating parts.
- Before the motor is coupled to the load, determine proper rotation.
- Check rotation by jogging or bumping. Apply power to the motor leads for a short period of time, enough to just get motor shaft to rotate a slight amount to observe shaft rotating direction.
- Three phase - interchange any two (2) of the three (3) line leads. Single phase - reconnect per the connection diagram on the motor.

- All wiring, fusing, and grounding must comply with National Electrical Codes and local codes.
- To determine proper wiring, rotation and voltage connections, refer to the information and diagram on the nameplate, separate connection plate or decal. If the plate or decal has been removed, contact Marathon Electric for assistance.
- Use the proper size of line current protection and motor controls as required by the National Electrical Code and local codes. Recommended use is 125% of full load amps as shown on the nameplate for motors with 40°C ambient and a service factor over 1.0. Recommended use is 115%



## REDUCED VOLTAGE STARTING

Motors used on reduced voltage starting, should be carefully selected based upon power supply limitations and driven load requirements. The motors starting torque will be reduced when using reduced voltage starting. The elapsed time on the start step should be kept as short as possible and should not exceed 5 seconds. It is recommended that this time be limited to 2 seconds. Refer to Marathon Electric for application assistance.

## OPERATION

### WARNING

Disconnect and lock out before working on motor or driven equipment.

### BEFORE INITIAL STARTING

1. If a motor has become damp in shipment or in storage, measure the insulation resistance of the stator winding.

$$\text{Minimum Insulation Resistance} = 1 + \frac{\text{Rated Voltage}}{1000}$$

In Megohms

Do not attempt to run the motor if the insulation resistance is below this value.

2. If insulation resistance is low, dry out the moisture in one of the following ways:
  - a. Bake in oven at temperature not more than 90°C (194°F).
  - b. Enclose motor with canvas or similar covering, leaving a hole at the top for moisture to escape, and insert heating units or lamps.
  - c. Pass a current at low voltage (rotor locked) through the stator winding. Increase the current gradually until the winding temperature, measured with a thermometer, reaches 90°C (194°F). Do not exceed this temperature.
3. See that voltage and frequency stamped on motor and control nameplates correspond with that of the power line.
4. Check all connections to the motor and control with the wiring diagram.
5. Be sure rotor turns freely when disconnected from the load. Any foreign matter in the air gap should be removed.
6. Leave the motor disconnected from the load for the initial start (see following caution). Check for proper rotation. Check for correct voltage (within  $\pm 10\%$  of nameplate value) and that it is balanced within 1% at the motor terminals. After the machine is coupled to the load, check that the nameplate amps are not exceeded. Recheck the voltage level and balance under load per the above guidelines.

Shut down the motor if the above parameters are not met or if any other noise or vibration disturbances are present. Consult NEMA guidelines or the equipment manufacturer if any questions exist before operating equipment.

### CAUTION

For motors nameplated as "belted duty only", do not run motor without belts properly installed.

## COLLECTOR RINGS (Wound Rotor Motors Only)

The collector rings are sometimes treated at the factory to protect them while in stock and during shipment. The brushes have been fastened in a raised position. Before putting the motor into service, the collector rings should be cleaned to remove this treatment. Use a cleaning fluid that is made for degreasing electrical equipment. All of the brushes must be released and lowered to the collector surface. Keep the rings clean and maintain their polished surfaces. Ordinarily, the rings will require only occasional wiping with a piece of canvas or non-linting cloth. Do not let dust or dirt accumulate between the collector rings.

## BRUSHES (Wound Rotor Motors Only)

See that the brushes move freely in the holders and at the same time make firm, even contact with the collector rings. The pressure should be between 2 and 3 pounds per square inch of brush surface.

When installing new brushes, fit them carefully to the collector rings. Be sure that the copper pigtail conductors are securely fastened to, and make good contact with, the brushholders.

## ALLOWABLE VOLTAGE AND FREQUENCY RANGE

If voltage and frequency are within the following range, motors will operate, but with somewhat different characteristics than obtained with correct nameplate values.

1. Voltage: Within 10% above or below the value stamped on the nameplate. On three phase systems the voltage should be balanced within 1%. A small voltage unbalance will cause a significant current unbalance.
2. Frequency: Within 5% above or below the value stamped on the nameplate.
3. Voltage and Frequency together: Within 10% (providing frequency above is less than 5%) above or below values stamped on the nameplate.

## CLEANLINESS

Keep both the interior and exterior of the motor free from dirt, water, oil and grease. Motors operating in dirty places should be periodically disassembled and thoroughly cleaned.

## CONDENSATION DRAIN PLUGS

All explosion proof and some totally enclosed motors are equipped with automatic drain plugs, they should be free of oil, grease, paint, grit and dirt so they don't clog up. The drain system is designed for normal floor (feet down) mounting. For other mounting positions, modification of the drain system may be required, consult Marathon Electric.

## SERVICE

### WARNING

Disconnect power before working on motor or driven equipment. Motors with automatic thermal protectors will automatically restart when the protector cools. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.

### CAUTION

Overgreasing bearings can cause premature bearing and/or motor failure. The amount of grease added should be carefully controlled.

### NOTE

If lubrication instructions are shown on the motor nameplate, they will supersede this general instruction.

Marathon Electric motors are pregreased with a polyurea mineral oil NGLI grade 2 type grease unless stated otherwise on the motor nameplate. Some compatible brands of polyurea mineral base type grease are: Chevron SRI #2, Rykon Premium #2, Shell Oil Dolium R or Texaco Polystar RB.

Motors are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the motor has been in storage for a period of 12 months or longer (refer to lubrication procedure that follows).

## LUBRICATION PROCEDURES

1. Stop motor. Disconnect and lock out of service.
2. Remove contaminants from grease inlet area.
3. Remove filler and drain plugs.
4. Check filler and drain holes for blockage and clean as necessary.
5. Add proper type and amount of grease. See the Relubrication Time Intervals table for service schedule and Relubrication Amounts table for volume of grease required.
6. Wipe off excess grease and replace filler and drain plugs (see following warning).
7. Motor is ready for operation.

### WARNING

If motor is nameplated for hazardous locations, do not run motor without all of the grease or drain plugs installed.

## RELUBRICATION TIME INTERVAL

(For motors with regreasing provisions).

Service Condition	NEMA FRAME SIZE					
	140-180		210-360		400-510	
	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM	1800 RPM and less	Over 1800 RPM
Standard	3 yrs.	6 months	2 yrs.	6 months	1 yr.	3 months
Severe	1 yr.	3 months	1 yr.	3 months	6 months	1 month
Seasonal	See Note 2.					

### NOTE

1. For motors nameplated as "belted duty only" divide the above intervals by 3.
2. Lubricate at the beginning of the season. Then follow service schedule above.

**SEASONAL SERVICE:** The motor remains idle for a period of 6 months or more.

**STANDARD SERVICE:** Up to 16 hours of operation per day, indoors, 100°F maximum ambient.

**SEVERE SERVICE:** Greater than 16 hours of operation per day. Continuous operation under high ambient temperatures (100° to 150°F) and/or any of the following: dirty, moist locations, high vibration (above NEMA standards), heavy shock loading, or where shaft extension end is hot.

## RELUBRICATION AMOUNTS

(For motors with regreasing provisions).

NEMA FRAME SIZE	VOLUME cu. in. (fluid oz.)
140	25 (.14)
180	.50 (.28)
210	.75 (.42)
250	1.00 (.55)
280	1.25 (.69)
320	1.50 (.83)
360	1.75 (.97)
400	2.25 (1.2)
440	2.75 (1.5)
500	3.00 (1.7)

## TROUBLESHOOTING

### WARNING

1. Disconnect power before working on motor or driven equipment.
2. Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.
3. Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.
4. Discharge all capacitors before servicing motor.
5. Always keep hands and clothing away from moving parts.
6. Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector, or thermocouple.
7. Electrical repairs should be performed by trained and qualified personnel only.
8. Failure to follow instructions and safe electrical procedures could result in serious injury or death.
9. If safety guards are required, be sure the guards are in use.

If trouble is experienced in the operation of the motor, make sure that:

1. The bearings are in good condition and operating properly.
2. There is no mechanical obstruction to prevent rotation in the motor or in the driven load.
3. The air gap is uniform. (Consult manufacturer for specifications).
4. All bolts and nuts are tightened securely.
5. Proper connection to drive machine or load has been made. In checking for electrical troubles, be sure that:
  1. The line voltage and frequency correspond to the voltage and frequency stamped on the nameplate of the motor.
  2. The voltage is actually available at motor terminals.
  3. The fuses and other protective devices are in proper condition.
4. All connections and contacts are properly made in the circuits between the control apparatus and motor.

These instructions do not cover all details or variations in equipment nor provide for every possible condition to be met in connection with installation, operation or maintenance. Should additional information be desired for the purchaser's purposes, the matter should be referred to the nearest Marathon Electric Manufacturing Corp. sales office listed on the back page.

### MOTOR TROUBLE SHOOTING CHART

Your motor service and any trouble shooting must be handled by qualified persons who have proper tools and equipment.

TROUBLE	CAUSE	WHAT TO DO
Motor fails to start	Blown fuses	Replace fuses with proper type and rating
	Overload trips	Check and reset overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor nameplate and load factor.
	Improper line connections	Check connections with diagram supplied with motor.
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed. Check for loose wiring connections. Also see that all control contacts are closing.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearings and lubrication.
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor defective	Look for broken bars or end rings.
Motor may be overloaded	Reduce load.	
Motor stalls	One phase may be open	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload	Reduce load.
	Low voltage	See that nameplate voltage is maintained. Check connection.
	Open circuit	Fuses blown, check overload relay, stator and pushbuttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Starting load too high	Check load motor is supposed to carry at start.
	Broken rotor bars or loose rotor	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor takes too long to accelerate and/or draws high amp	Excessive load	Reduce load.
	Low voltage during start	Check for high resistance. Adequate wire size.
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running under load	Overload	Reduce load.
	Frame or bracket vents may be clogged with dirt and prevent proper ventilation of motor.	Open vent holes and check for a continuous stream of air from the motor.
	Motor may have one phase open	Check to make sure that all leads are well connected.
	Grounded coil	Locate and repair.
	Unbalanced terminal voltage	Check for faulty leads, connections and transformers.
Motor vibrates	Motor misaligned	Realign.
	Weak support	Strengthen base
	Coupling out of balance	Balance coupling.
	Driven equipment unbalanced	Rebalance driven equipment.
	Defective bearings	Replace bearing.
	Bearings not in line	Line up properly.
	Balancing weights shifted	Rebalance motor.
	Polyphase motor running single phase	Check for open circuit.
Excessive end play	Adjust bearing or add shim.	
Unbalanced line current on polyphase motors during normal operation	Unequal terminal volts	Check leads and connections.
	Single phase operation	Check for open contacts.
	Unbalanced voltage	Correct unbalanced power supply.
Scraping noise	Fan rubbing air shield	Remove interference.
	Fan striking insulation	Clear fan.
	Loose on bedplate	Tighten holding bolts.
Noisy operation	Airgap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
Hot bearings general	Bent or sprung shaft	Straighten or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small.	Use larger pulleys.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease	Maintain proper quantity of grease in bearing.
	Deterioration of grease or lubricant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant	Reduce quantity of grease, bearing should not be more than 1/2 filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing, first clean housing thoroughly.

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P.O. Box 8003  
100 E. Randolph Street  
Wausau, WI 54402-8003  
Phone: (715) 675-3311  
FAX: (715) 675-6361



PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3				RECIPROCATING PUMP		SHEET 1 OF 1	
				REV	BY	DATE	REVISION DESCRIPTION
CUSTOMER : XXXXXX				0	RDD	03/15/05	ISSUED FOR PURCHASE
PLANT : REFRIGERATION PLANT 8B							
SERVICE : GLYCOL INJECTION PUMPS							
JOB NO. : 054468 TAG NO: P-655A/B							
MFR. : NATIONAL OILWELL MODEL NO: 2S-1M							
1	SIZE & TYPE	34.9 mm	NO. REQUIRED				2
2	MOTOR DRIVE	Yes	TURBINE DRIVE				No
3	OPERATING CONDITIONS						
4	FLUID HANDLED	E. Glycol	SUCTION PRESS ON LIQ. SURFACE	(kpa)	ATM		
5			VAPOR PRESS OF LIQ AT PUMP TEMP	(kpa)	34.68		
6	CORROSION CONDITION	Mild	SUCTION LIQ LEVEL ABOVE PUMP INLET	MAX (m)			
7				MIN (m)	0.335		
8	FLUID PUMP TEMPERATURE	° C 93	CALCULATED PRESS DIFF IN SUCT LINE	(kpa)	3.45		
9	PRESSURE	(kpa) ATM	NPSH AVAILABLE / NPSH REQUIRED	(m)	5.425/2.44		
10	VISCOSITY AT PUMPING TEMP	(cP) 1.35	SUCTION PRESSURE	(m)			
11	SPECIFIC GRAVITY	1.044	DISCHARGE PRESSURE	(kpag)	8274		
12	CAPACITY AT PUMP TEMP DESIGN	(l/s) 0.095	DIFFERENTIAL PRESSURE	(kpag)	8274		
13	NORMAL	(l/s)	DIFFERENTIAL HEAD	(m)			
14	SPECIFICATION						
15	MANUFACTURER	National Oilwell	PUMP EFFICIENCY	NORMAL (%)	97 V.E.		
16	TYPE (HORIZONTAL/ VERTICAL)		DESIGN	(%)			
17	TYPE (SIMPLEX/ DUPLEX/ TRIPLEX)	Simplex	BHP	NORMAL (kW)	70 %M.E.		
18	SIZE		DESIGN	(kW)			
19	ROTATION DIRECTION LOOKING ON PUMP COUPLING FM MOTOR		MOTOR RECOMMENDED	(kW)	1.49 (2HP)		
20	END (CLOCKWISE/ COUNTERCLOCKWISE)		MOTOR MAKE & FRAME SIZE		184T		
21	PUMP SPEED	(RPM) 222	MOTOR SUPPLIER		WESTINGHOUSE		
22	SUCTION FLANGE BORE	(mm) 50.8	MOTOR DRAWING & REF. NO				
23	RATING	(ANSI) NPT	MOTOR TYPE		1.15S.F.		
24	DISCHARGE FLANGE BORE	(mm) 25.4	INSULATION		Class F		
25	RATING	(ANSI) NPT	ENCLOSURE		XP		
26	PLUNGER SIZE	(mm) 34.9	TEMP RISE	° C	44		
27	PUMP DESIGN PRESSURE	(kpa) 9425	VOLT/ PHASE/ CYCLES		460V/3PH/60HZ		
28			BEARING		Ball		
29			LUBE		Grease		
30	SUCTION VALVE AREA		TYPE OF DRIVER (DIRECT/ V-BELT)		V-Belt		
31	VELOCITY THROUGH VALVE NORMAL	(m/s)	COUPLING/ BELT SUPPLIER		STD		
32	DESIGN	(m/s)	STARTING TORQUE		TBA		
33	DISCHARGE VALVE AREA		% FULL LOAD TORQUE		TBA		
34	PUMP MFR SUPPLIED COMBINATION BEDPLATE	YES	PISTON SPEED	NORMAL (m/s)			
35	COUPLING	NO	DESIGN	(m/s)			
36	BELT & PULLEYS	YES	DOUBLE PISTON	NORMAL (stroke/s)	N/A		
37	MOTOR SENT TO PUMP MFR. FOR ASSEMBLY	YES	DESIGN	(stroke/s)			
38	ALL ROTATING PARTS MUST BE GUARDED	YES	VARIABLE STROKE	(Y/N)	NO		
39			GEARBOX	(Y/N)	NO		
40	MATERIALS						
41	CASE	CAST STAINLESS STEEL	SPRINGS				
42	LINER		BEARINGS				
43	PISTON & PISTON ROD		LUBRICATION		NO		
44	PLUNGER	TNGSTEN CARBIDE	STUFFING BOX		NO		
45	VALVES	SS DISC	PACKING		50/50 KEVLAR		
46	VALVES SEAT	316SS	AIR VESSEL		NO		
47	SPRINGS	INCONEL					
48	GENERAL INFORMATION						
49	COOLING WATER TEMP	° C N/A	HYDRAULIC TEST	YES (kpa)	21206		
50	PRESS	(kpa) N/A	WITNESSED PERFORMANCE	(Y/N)	No		
51	COOLING WATER TO BEARINGS	(l/s) N/A	ARRANGEMENT DRAWING NO.				
52	GLAND COOLING MEDIUM	(l/s) N/A	REFERENCE NO.				
53	COOLING PIPING SUPPLY	N/A	NET WEIGHT PUMP AND BEDPLATE	(kg)	207		
54	FOUNDATION BOLT SUPPLY	N/A					
55	NOTE:						
56							

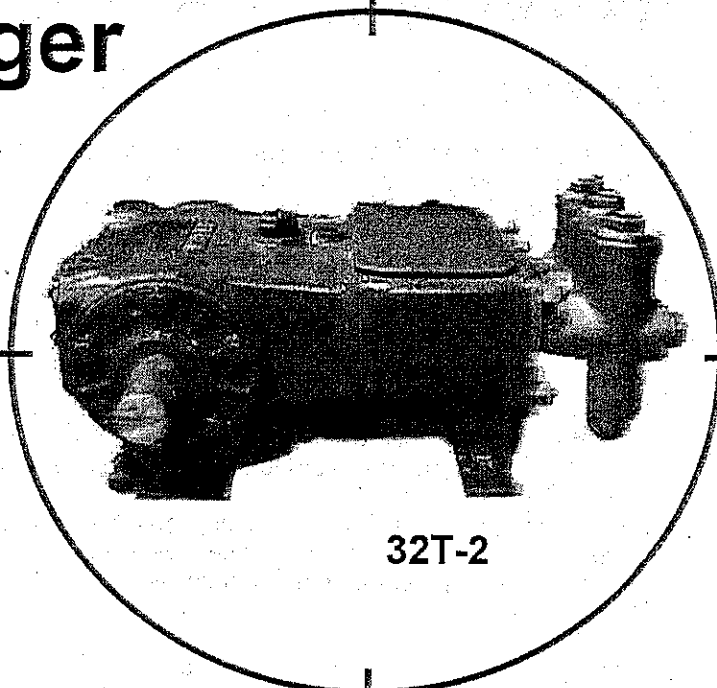


**NATIONAL OILWELL**

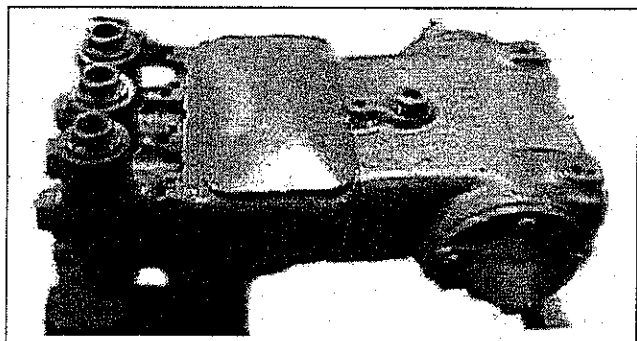
**P-655 A/B**

# Multiplex Plunger Pumps

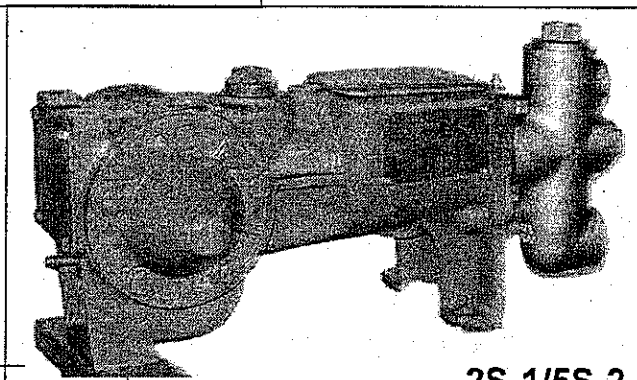
## Installation, Care and Operation Manual



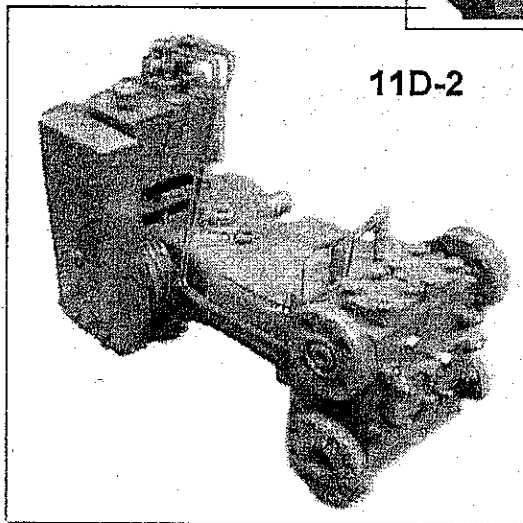
**32T-2**



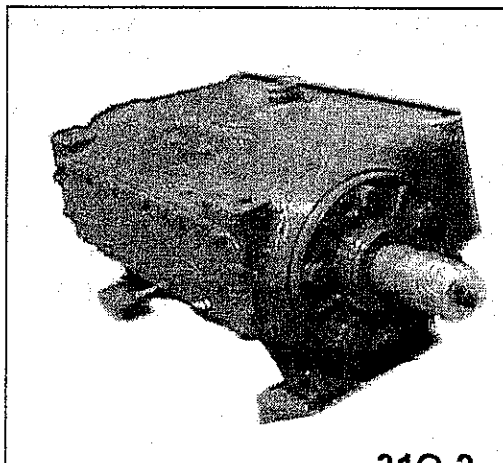
**22T-2**



**2S-1/5S-2**



**11D-2**



**31Q-2**

Covering the  
following pumps:

**2S-1**  
**5S-2**  
**11D-2**  
**22T-2**  
**32T-2**  
**31Q-2**

### Sales / Technical Information

USA Tollfree: 1-800-800-4110  
Phone: 1 (713) 462-4110  
Fax: 1 (713) 462-3152  
Internet: <http://www.natoil.com>



## Foreword...

This manual is published as a guide for the normal operation of your **NATIONAL-OILWELL** equipment. Because of the many factors, which contribute to the function or malfunction of this machinery, and not having complete knowledge of each factor or combination of factors, we cannot detail all facets of this subject. We must therefore confine the scope of this presentation and when situations encountered are not fully encompassed by complete, understandable instructions, these situations must be referred to the manufacturer.

When other than routine servicing is necessary, it can be most efficiently performed if the unit is removed to an area of adequate space where an over-head crane, hydraulic lift, bearing pullers, impact tools, etc., are accessible.

The dimensions and tolerances specified in this publication are those desirable for the most efficient operations of the equipment. When components become worn or when new parts are introduced into a worn unit, it may not be possible or economically feasible to reestablish such strict alignment and correct all dimensional deviations.

Improvements in design, engineering, materials, production methods, etc., may necessitate changes in these products and result in inconsistencies between the content of this publication and the physical equipment. We reserve the right to make these changes without incurring any liability or obligation beyond that which is stipulated in the purchase contract.

*The pictures, photographs, charts, diagrams, drawings, verbal contents and specifications are not to be construed as giving rise to any warranty on the part of NATIONAL-OILWELL. National-Oilwell makes no warranty, either expressed or implied beyond that which is stipulated in the purchase contract.*

**NATIONAL-OILWELL** pumps are manufactured by National-Oilwell at the Tulsa, Oklahoma plant. The serial number, assigned each pump, is stamped on the power end. Please refer to this serial number when ordering parts for the pump.

The right and left sides of the pump are determined by viewing the pump from the back of the power end, looking toward the fluid end. This position is also used to identify the plungers and their related parts as being number one, two and three, beginning at the left side of the pump.

## **! CAUTION! CAUTION! CAUTION!**

EXERCISE SAFETY IN ALL PERFORMANCES: DO NOT IGNORE ANY WARNINGS; USE ONLY APPROVED METHODS, MATERIALS AND TOOLS. DO NOT PERMIT ANY FUNCTION OF QUESTIONABLE SAFETY; ACCIDENTS ARE CAUSED BY UNSAFE ACTS AND UNSAFE CONDITIONS. SAFETY IS YOUR BUSINESS AND YOU ARE INVOLVED.

## **! WARNING! WARNING! WARNING!**

BEFORE PERFORMING ANY SERVICE FUNCTION, BE CERTAIN THAT THE UNIT IS SEPARATED FROM ITS POWER SOURCE OR THAT THE POWER SOURCE IS LOCKED-OUT TO PREVENT ANY FORM OF ENERGY FROM ENTERING THE EQUIPMENT. THIS WOULD INCLUDE ELECTRICAL OR MECHANICAL ENERGY INTO OR FROM THE PRIME MOVER(S), PNEUMATIC ENERGY FROM THE COMPRESSOR/AIR SYSTEM, ETC.





**⚠! WARNING ! WARNING ! WARNING ! ⚠**

FAILURE TO OBSERVE THE WARNINGS AND NOTES OF CAUTION IN THIS PUBLICATION CAN RESULT IN PROPERTY DAMAGE, SERIOUS BODILY INJURY, OR DEATH.

**⚠! ATTENTION - NOTICE - IMPORTANT ! ⚠**

THESE TERMS ARE USED TO DRAW ATTENTION TO ACTION THAT WILL CAUSE DAMAGE TO THE PUMP, COMPONENTS OR ATTACHMENTS.

**⚠! ATTENTION ! ⚠**

**PUMP NOMENCLATURE:**

ALL PUMP SIZES WITHIN THIS MANUAL WILL BE DESCRIBED WITH THE NEW OR CURRENT NOMENCLATURE. THE OLD PUMP NOMENCLATURES DESCRIBED ON THE FRONT COVER, BUT NOT INCLUDED IN THIS MANUAL EXCEPT AS NEEDED, ARE TO BE UNDERSTOOD AS BEING INCLUDED WITH THE NEW NOMENCLATURES.

**⚠! WARNING ! WARNING ! WARNING ! ⚠**

**BEFORE SERVICING PUMPS:**

1. SHUT DOWN OR DISENGAGE THE PUMP POWER SOURCE.
2. SHUT DOWN ALL PUMP ACCESSORY EQUIPMENT.
3. RELIEVE OR "BLEED OFF" ALL PRESSURE FROM THE PUMP FLUID CYLINDER(S).

FAILURE TO SHUT DOWN POWER AND RELIEVE PRESSURE FROM THE PUMP BEFORE SERVICING CAN RESULT IN SERIOUS PERSONAL INJURY AND PROPERTY DAMAGE.







**Plunger Pump Nomenclature Example....**

**22 T-2 M F**

RATED INPUT  
HORSEPOWER

T = TRIPLEX  
Q = QUINTUPLEX

F = FLANGED, T = THREADED

L = LOW PRESSURE  
M = MEDIUM, H = HIGH

STROKE LENGTH (IN.)





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## Installation...

### I. GENERAL

Careful planning of the plant layout will save considerable time and expense, both initially when the installation is made and later during the operation of the plant. In selecting the location for the pump, consideration should be given to the fact that a positive suction head at the pump inlet contributes toward the pump efficiency. However, the layouts of the piping, the arrangement of the fittings, and restrictions in the suction and discharge lines have even more effect. For this reason, all fittings and valves should be full opening; all bends should be of long radius or should be eliminated where possible. Long radius 45° ells should be used, particularly if installed near the fluid cylinder. The following points outline the basic requirements for an installation that will contribute greatly toward good pump operation.

#### A. SUCTION LINE

1. The suction line must not be smaller than the suction intake of the fluid cylinder and may be larger. The length of the suction line should be held to a minimum and should run straight from the supply tank to the pump.
2. When bends are required, they should be made with long radius 45° ells. Do not use a bend directly adjacent to the fluid cylinder. Avoid using any 90° bends if at all possible.
3. Provide a full opening gate valve in the suction line adjacent to the supply tank to permit the line to be drained when necessary. Do not use any type of restricting valve.
4. Do not use meters or other restrictions in the suction line. Eliminate any rise or summit in the suction line where air or vapor can collect.
5. Pulsation dampening devices are strongly recommended.
6. When necessary to manifold a number of pumps to a common suction, the diameter of the manifold and suction pipe leading from the supply tank must be such that it has a cross-sectional area equal to, or greater, than the area of the combined individual suction pipes.
7. When a charging or booster pump is used in the suction line, it must have a capacity equal to twice that of the pump output. This is necessary to provide a charging pump with an output great enough to meet the peak volume requirements of the plunger pump during the suction stroke and not act as a restriction in the line.
8. All piping, both suction and discharge must be solidly and independently supported. The first support must be as close to the pump as practical. This is necessary to prevent placing the pump in a strain and to keep any vibration in the system from acting directly on the pump.

#### B. DISCHARGE LINE

1. Use a pulsation dampener or a desurger in the discharge line. It should be placed in the line as near the fluid cylinder as possible and ahead of any bend in the line.
2. Do not reduce the size of the discharge line below that of the pump outlet until the line has passed through the desurger, and is away from the pump approximately 20 feet (6m).
3. Any bend in the discharge line should be made with a long radius 45° ell. Do not use a bend directly adjacent to the fluid cylinder, particularly a 90° bend.





## Installation...

### I. GENERAL

#### B. DISCHARGE LINE (Continued...)

4. A pressure relief valve should be installed in the discharge line. The relief valve should be set to operate at a pressure no greater than 25% above the maximum rated pressure for the plunger size being used. It should be installed in the line ahead of any valve and be piped so that any flow is returned to the supply tank rather than the suction line. This will prevent possible damage to the suction line and suction dampener.
5. A by-pass line should be installed to permit the pump to be started without load. This allows oil to circulate and reach all parts in the power end before they are loaded.

#### C. POWER END

1. The pump must be mounted level and should be grouted in and free of strain. This applies to a skid-mounted pump or a pump mounted directly on a concrete base.
2. The sheave of a belt driven pump must be correctly aligned with the prime mover sheave. Care must be used to prevent over-tightening as this will shorten belt life, place the pump in a strain, and cause undue additional loads on the crankshaft and bearings. Sheave sizes should not be smaller than the minimum approved diameter.
3. When connecting a direct-driven pump, the shafts must be correctly aligned. Couplings should not be expected to compensate for avoidable misalignment. With Thomas Flexible Couplings, angular misalignment should not exceed one-half degree. Offset misalignment of the centerlines of the two shafts should not exceed .015" (.381 mm). Actually, misalignment should be as small as practical.
4. Provision should be made to stop the pump automatically in the event of supply fluid failure. A pump should not be run dry, as this causes wear on the packing.
5. Adequate plunger chamber drains have been provided in the pump and should not be plugged. Drain lines should never be reduced in size from the connection provided.
6. The pump has been drained of oil after testing at the factory and **MUST** be filled with the proper oil (see page 11) before starting. The rust inhibiting oil coating inside the power end need not be removed before filling; however, it is recommended that the power end be checked to make sure dirt or contamination has not entered during shipment.

#### D. FLUID END

1. The fluid cylinder is shipped assembled to the pump complete with valves and cover plates. The stuffing boxes, plungers, and related items have also been assembled and tested with the pump (unless otherwise specified) and require no further assembly. Before the pump is started, these parts should be checked for tightness as well as for possible damage during shipment.
2. Thoroughly clean the suction line piping before starting the pump. Weld spatter, slag, mill scale, etc., will damage a pump in a short time.





## Installation...

### I. GENERAL (Continued)...

### E. PLUNGER PACKING

The recommended style of packing has been installed and run at the plant. It does, however, require further "setting up" as the pump is started and brought up to pressure. Refer to pages 29 through 34 for correct procedure for packing used.

### F. PLUNGER PACKING LUBRICATION

1. Automatic packing lubricators are beneficial on all installations and are required on pumps operating at high pressure (1200 psi [85kg/cm<sup>2</sup>] and up) to obtain good packing life.
2. When an automatic lubricator is used in water and power oil service, use Rock Drill (Air Drill) oil of proper viscosity. For butane-propane service, use NATURAL castor oil. Set lubricator to feed five to seven drops per minute.

### G. SUCTION PULSATION DAMPENERS

#### 1. Low Pressure - Plastic Body

- a. Some National-Oilwell plunger pumps are equipped with suction pulsation dampeners. These dampeners do an excellent job when properly charged and should be kept filled during operation.

## **! ATTENTION !**

At suction pressures over 10 psi (.7kg/cm<sup>2</sup>), the dampener should be deflated prior to bleeding off the suction pressure to prevent damage to the diaphragm.

- b. The plastic dampener body has an instruction decal attached, which lists the following installation and charging procedures:

## **! ATTENTION !**

**HANDLE WITH CARE.**

This is a plastic part and can be broken.

- c. Tighten capscrews with 10 to 12ft.-lbs. of torque.

## **! ATTENTION !**

Use thread-sealing compound on check valve and tighten until snug.  
**OVERTIGHTENING WILL DAMAGE BODY.**

- d. With pump operating - Charge dampener until bottom of diaphragm is visible through sight glass. Proper charge is when bottom of diaphragm is between center and top of sight glass.





## Installation...

### I. GENERAL

#### G. SUCTION PULSATION DAMPENERS (Continued)...

##### 2. High Pressure - Aluminum Body

- a. In pressures in excess of 20 psi (1.406 kg/cm<sup>2</sup>) and up to 70 psi (10.545 kg/cm<sup>2</sup>), it is necessary to use the National-Oilwell high-pressure suction dampener.
- b. The high-pressure dampener is charged in a similar manner to the low-pressure plastic dampener, using air or nitrogen to charge the diaphragm and maintain its position in relation to the sight glass.
- c. The following procedures should be used to service this dampener:
  - (1) The dampener is fitted to an adapter that may be either welded into an existing line or be a part of a separate dampener housing. Place a gasket on each side of the diaphragm retaining plate and place on the adapter.
  - (2) The dampener spacer is then placed on top of the retainer plate with the grooved side up and the flat side against the retainer gasket.
  - (3) The diaphragm fits into the groove on the spacer with the curved portion of the diaphragm above the spacer.
  - (4) Apply a continuous 1/8" diameter bead of silicone rubber on the outer edge of the diaphragm after it has been positioned into the spacer. This silicone rubber (GE Silicone Rubber or Dow-Corning Silastic) is readily available at most hardware stores. Assemble the body cover within 10 minutes after applying the silicone rubber.
  - (5) Fit the dampener cover over the diaphragm and assemble the capscrews. Tighten these capscrews evenly to approximately 80 ft-lbs. of torque.
  - (6) Install the sight glasses, one in each side of the cover. Be sure to seat the sight glass packing carefully into the groove on the cover, as this must be an airtight connection.
  - (7) The air check valve has a pipe thread and must be made up into the cover airtight. Use a good pipe thread sealant to promote sealing.





## Lubrication...

### I. GENERAL

NATIONAL-OILWELL Plunger Pumps are "splash" lubricated. The main bearings and crankshaft bearings are fed by splash. Crossheads and crosshead pin bushings are fed through holes in the crossheads and crosshead reservoir. Intermediate rods are lubricated from the splash they receive from the crosshead.

### A. OIL

Use "extreme pressure" gear oil. The chart below shows the recommended grades for various temperatures surrounding the pump.

U.S. UNITS OF MEASURE	
Temperature	AGMA Industrial EP Gear Oil
+50°F to +155°F	AGMA No. 6 EP or ASTM/ISO Grade No. 320 (viscosity 1335 to 1632 SSU 100°F)
+20°F to +100°F	AGMA No. 5 EP or ASTM/ISO Grade No. 220 (viscosity 918 to 1122 SSU 100°F)
-20°F to +60°F	AGMA No. 2 EP or ASTM/ISO Grade No. 68 (viscosity 284 to 347 SSU 100°F)

Crankcase Capacity - Quarts:	2S-1 - 2	5S-2 - 2	11D-2 - 3-1/2
	22T-2 - 5	32T-2 - 5	31Q-2 - 8

METRIC UNITS OF MEASURE	
Temperature	AGMA Industrial Gear Oil
+10°C to +68°C	AGMA No. 6 EP or ASTM/ISO Grade No. 320 (Viscosity 228-352 cSt at 37.8°C)
-7°C to +38°C	AGMA No. 5 EP or ASTM/ISO Grade No. 220 (Viscosity 198-242 cSt at 37.8°C)
-29°C to +16°C	AGMA No. 2 EP or ASTM/ISO Grade No. 68 (Viscosity 61-75 cSt at 37.8°C)

Crankcase Capacity - Liters:	2S-1 - 1.9	5S-2 - 1.9	11D-2 - 3.3
	22T-2 - 4.7	32T-2 - 4.7	31Q-2 - 7.6

Oil must pour freely at minimum operating temperature. Change oil every six months or as frequently as operating conditions require to maintain a clean, sludge-free oil of proper viscosity.







## Operation...

### I. GENERAL



**! ATTENTION !**

THE FOLLOWING POINTS SHOULD BE CHECKED FOR THE PREVENTION OF TROUBLE OR TO CORRECT TROUBLE THAT MAY ARISE.

#### A. OPERATION CHECKLIST

1. Pump must be at a set level for proper lubrication.
2. Make sure pump is filled with clean oil of the proper viscosity (see previous).
3. Do **not** over-speed the pump.
4. Do **not** use a smaller diameter sheave than is recommended for the pump.
5. Make sure all safety shutdown switches are operating properly.
6. Keep all suction and discharge line valves fully open.
7. If a bypass is used to regulate output, make sure it is set properly.
8. Make sure the pressure relief valve is set properly.
9. Do **not** exceed the pressure rating of the pump for the particular plunger size.
10. Make sure the suction line is tight, as air entering the suction line will cause severe hammering and knocking of the pump.
11. Make sure plunger and intermediate rod connections are tight and locked.
12. Check the plunger packing for correct adjustment (see pages 29 to 34).
13. Check the suction and discharge dampeners for proper charge, as this is very important for long life and good pump operation.
14. Make sure the hex nuts holding the cylinder in place are tight.





## Maintenance...

### I. GENERAL

The following points are intended as a guide to be used in setting up a maintenance program. Good preventive maintenance will pay big dividends in the form of reliable service with a minimum of trouble.

### A. DAILY MAINTENANCE

1. Check power end oil level daily. Do not attempt to check the oil with the pump running. Inspect the oil for dirt or contamination and change if necessary. An increase in oil level indicates fluid end leakage into power end. Change oil immediately and check intermediate rod wipers and surface smoothness of rod. Check for plunger packing leakage.
2. Lubricate plunger packing frequently. Packing life can be greatly increased by greasing every four (4) hours with a small amount of grease. Grease is not recommended at pressures above 1200 psi. Use an alternate packing lubricator to drip the proper oil of the plunger for lubrication. (See page 9 for further details).
3. Check lubricator for proper level and operation.
4. Check plunger packing for excessive leakage. Replace packing as required.
5. Check stuffing box adjusting nuts for tightness.
6. Drain plunger leakage sump tanks if required.
7. Flush plunger chamber drain lines with kerosene on power oil pumps and fresh water on salt pumps. This may be done weekly unless salt and paraffin accumulation is severe.
8. Make sure suction and discharge line valves are fully open.
9. Check for leakage between the fluid cylinder and frame or stuffing box to fluid cylinder packing if required.
10. Check all seals for leakage.
11. Check belts or clutch for slippage. If either condition exists, correct immediately.

### B. MONTHLY MAINTENANCE

1. Drain and refill crankcase every six (6) months or as often as required to maintain a clean, sludge-free oil of the proper viscosity.
2. Clean crankcase air breather with a non-explosive solvent.
3. Check all studs, nuts and capscrews for tightness. Inspect gaskets for leaks; tighten or replace as required.
4. Clean pump. Good housekeeping is a prerequisite to good maintenance.





## Maintenance...

### I. GENERAL (Continued)...

#### C. STORAGE

If the pump is to be idle for longer than one (1) week, it should be prepared for storage as follows:

1. Drain and clean crankcase thoroughly. Leave drain open and install 90° elbow, pointing downward, to permit air circulation and prevent condensation build-up.
2. Coat all bearings, finished surfaces, and entire inside surface of crankcase with a rust inhibiting oil.
3. Remove plungers and packing, clean and coat with rust inhibiting oil.
4. Remove fluid cylinder valves allowing cylinder to be thoroughly cleaned and drained.
5. Coat entire cylinder, valves and parts, with a rust inhibiting oil.
6. Thoroughly inspect pump and rotate crankcase once each month. Re-coat with rust inhibiting oil where necessary.

#### D. START-UP AFTER STORAGE

Any pump that has been in storage, either after field use or as shipped from the plant, will need a thorough inspection to make sure it has not been damaged in any way and that all parts are properly in place.



FAILURE TO OBSERVE THE FOLLOWING POINTS CAN RESULT IN SERIOUS DAMAGE.

1. Remove all covers on both power end and fluid end; thoroughly clean and inspect all parts and finished surfaces.
2. Check all bearings to make sure they are clean and in good condition.
3. Make sure valves, plungers and packing are properly installed and in good condition.
4. Carefully tighten all bolts, nuts, studs and working connections.
5. Fill power end to the proper level with clean oil of the proper viscosity. Make sure oil is poured into the crosshead reservoir and is worked into all bearings.
6. Fill packing lubricator and pump lines full. Check by breaking connection at stuffing box, working lubricator plunger until oil appears.





Maintenance (Continued)...

II. TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTION
KNOCKING OR POUNDING IN FLUID END AND PIPING	SUCTION LINE RESTRICTED BY: (1, 2, 3, 4)	
	1. TRASH, SCALE BUILD-UP, ETC.	LOCATE AND REMOVE
	2. PARTIALLY CLOSED VALVE IN SUCTION LINE	LOCATE AND CORRECT
	3. METERS, FILTERS, CHECK VALVES, NON-FULL-OPENING, CUT-OFF VALVE OR OTHER RESTRICTIONS	RE-WORK SUCTION LINE TO ELIMINATE
	4. SHARP 90° BENDS OR 90° BLIND TEES.	RE-WORK SUCTION LINE TO ELIMINATE.
	AIR ENTERING SUCTION LINE THROUGH CUT-OFF VALVE	TIGHTEN OR REPACK VALVE STEM PACKING
	AIR ENTERING SUCTION LINE THROUGH LOOSE CONNECTION OR FAULTY PIPE	LOCATE AND CORRECT
	AIR OR VAPOR TRAPPED IN SUCTION LINE	LOCATE, RISE OR TRAP AND CORRECT BY STRAIGHTENING LINE, PROVIDING ENOUGH SLOPE TO PERMIT ESCAPE AND PREVENT BUILD-UP
	LOW FLUID LEVEL	INCREASE SUPPLY AND INSTALL AUTOMATIC LOW LEVEL SHUT-DOWN SWITCH
	SUCTION DAMPENER NOT OPERATING	INSPECT AND REPAIR AS REQUIRED
	WORN VALVES	INSPECT AND REPAIR AS REQUIRED
	ENTRAINED GAS IN FLUID	PROVIDE GAS BOOT OR SCRUBBER FOR FLUID
	POOR INLET AND OUTLET ARRANGEMENT AT SUPPLY TANK	INLET TO BE AT TOP OF TANK AND BAFFLED TO BREAKOUT GAS AND PREVENT CHANNELING. OUTLET TO BE 12" FROM BOTTOM OF TANK AND AS FAR FROM INLET AS POSSIBLE, NEVER CLOSER THAN 90°
	LOOSE PACKING ADJUSTING NUT	TIGHTEN AND/OR REPLACE PACKING
	INADEQUATE SIZED SUCTION LINE	REPLACE WITH INDIVIDUAL SUCTION LINE OF NEXT SIZE LARGER THAN INLET PUMP
LEAKAGE PRESSURE RELIEF VALVE THAT HAS BEEN PIPED BACK INTO SUCTION LINE	REPAIR VALVE AND RE-WORK PIPING TO RETURN TO SUPPLY TANK - NOT SUCTION LINE	
BY-PASS PIPED BACK TO SUCTION	REWORK TO RETURN BY-PASSED FLUID BACK TO SUPPLY TANK - NOT SUPPLY LINE	
BROKEN PLUNGER	INSPECT WHEN ROTATING PUMP BY HAND AND REPLACE AS REQUIRED	
KNOCK IN POWER END	VALVE WEAR OR DAMAGE	CHECK FLUID END FOR BAD VALVES
	WORN MAIN BEARINGS	REPLACE AS REQUIRED
	LOOSE PLUNGER - INTERMEDIATE ROD CROSSHEAD CONNECTION	INSPECT FOR DAMAGE - REPLACE AS REQUIRED AND TIGHTEN
	WORN CROSSHEAD PIN, OR CONNECTING ROD	LOCATE AND REPLACE AS REQUIRED





**Maintenance...**

**II. TROUBLE SHOOTING GUIDE (Continued)...**

PROBLEM	POSSIBLE CAUSE	CORRECTION
<b>RAPID VALVE WEAR OR FAILURE</b>	CORROSION	TREAT FLUID AS REQUIRED
	ABRASIVES IN FLUID	FILTER AS REQUIRED
	IMPROPER INSTALLATION	INSPECT AND INSTALL PER INSTRUCTION SHEET IN PACKING BOX
	IMPROPER LUBRICATION (EITHER INSUFFICIENT OR EXCESSIVE OR INCORRECT TYPE)	CHECK INSTRUCTIONS IN MANUAL AND CORRECT AS REQUIRED
	LUBRICATOR NOT OPERATING	INSPECT AND CORRECT AS REQUIRED
	ADJUSTING NUT LOOSE	INSPECT AND REPACK PER INSTRUCTIONS
	SCALE OR BUILD UP ON PLUNGER	TREAT FLUID AS REQUIRED
<b>SHORT PACKING LIFE</b>	WORN OR PITTED PLUNGERS AND/OR STUFFING BOX	REPLACE AS REQUIRED
	ABRASIVES IN FLUID	FILTER AS REQUIRED
	PUMP OPERATED WITHOUT FLUID	CHECK SYSTEM FOR FAULTY LOW-LEVEL SHUTDOWN CONTROLS OR CLOSED VALVES AND CORRECT AS REQUIRED
	ABNORMALLY HIGH FLUID TEMPERATURES	CHECK WITH MANUFACTURER FOR RECOMMENDATIONS ON TYPE OF PACKING
	WRONG TYPE OF PACKING FOR PARTICULAR FLUID BEING HANDLED	CHECK WITH MANUFACTURER FOR RECOMMENDATIONS ON TYPE OF PACKING
	CAVITATION (KNOCKING AND POUNDING IN FLUID CYLINDER AND PIPING)	REFER TO CORRECTION OF "KNOCK IN POWER END" ABOVE
<b>BROKEN OR PITTED FROM IMPLOSIONS CAUSED BY IN EXCESSIVE GAS OR AIR ENTRAINED FLUID</b>	PLUNGER CRACKED AT INSTALLATION	INSTALL NEW PLUNGER USING CARE TO AVOID ANY SHARP BLOW OR FORCE ON PLUNGER.
	PLUNGER CRACKED FROM THERMAL SHOCK	CHECK SYSTEM TO ELIMINATE ANY SHARP OR SUDDEN TEMPERATURE DIFFERENCES. TEMPERATURE EXTREMES ON THE PLUNGER CAN OCCUR FROM PACKING AS DISCUSSED UNDER "SHORT PACKING LIFE" PROBLEM OR FROM TEMPERATURE CHANGES IN THE FLUID ITSELF
	PLUNGER PITTED FROM IMPLOSIONS CAUSED BY EXCESSIVE GAS OR AIR ENTRAINED IN FLUID.	CHANGE SUCTION SYSTEM TO ELIMINATE OR CHECK WITH MANUFACTURING REGARDING USE OF SPECIAL PACKING ARRANGEMENT
<b>RAPID WEAR OF HARD COATED PLUNGER</b>	PACKING FAILURE	CHECK AND CORRECT PER RECOMMENDATIONS UNDER "SHORT PACKING LIFE" PROBLEM
	PLUNGER NOT SUITABLE FOR PARTICULAR SERVICE	CHECK WITH MANUFACTURING FOR RECOMMENDATION
<b>OIL SEAL LEAKS</b>	PLUNGER NOT SUITABLE FOR PARTICULAR SERVICE	CHECK AND CORRECT AS REQUIRED
	PUMP NOT LEVEL	CHECK AND CORRECT AS REQUIRED
	WORN, CORRODED, PITTED, OR OTHERWISE DAMAGED SEALING SURFACE	CHECK AND CORRECT AS REQUIRED
	WORN OR DAMAGED SEALS	CHECK AND CORRECT AS REQUIRED
	OIL LEVEL TOO HIGH	CHECK AND CORRECT AS REQUIRED





## Overhaul and Repair...

### I. GENERAL

The bearings and other working parts in the power end have been designed for continuous duty, and if properly lubricated, will provide years of trouble-free service. However, after the pump has been in service for a long period of time, the bearings and other working parts will gradually loosen, and if not corrected, will lead to more serious trouble. The time to overhaul the pump will vary, depending on the operating conditions, and is therefore a matter that must be left to the good judgment of the operator. Complete disassembly and assembly procedures are discussed in their respective sections.

### A. TOOLS REQUIRED

Most of the tools required to overhaul the pump will be found in an ordinary set of mechanics hand tools. The special tools and equipment required, and not furnished, with the pump include a torque wrench, bearing puller, and a valve servicing kit. Also, a hot oil bath capable of reaching a temperature of 300°F (149°C) will be needed.

### B. CHECK POINTS AND ADJUSTMENTS

#### 1. 2S-1 & 5S-2:

The crankshaft main bearings are single row, shim adjusted, tapered roller bearings. They have been assembled and adjusted at the factory with proper clearance and will give long trouble-free service. The proper clearance is found by adjusting the amount of shims until the crankshaft has .001" to .003" endplay and will rotate freely.

#### 2. 11D-2, 22T-2, & 32T-2:

The crankshaft main bearings are single row, shim adjusted, tapered roller bearings. They have been assembled and adjusted at the factory with proper clearance and will give long trouble-free service. The proper clearance is found by adjusting the amount of shims until the crankshaft has .002" to .004" endplay and will rotate freely.

#### 3. 31Q-2:

The 31Q-2 has two single rows, shim adjusted, tapered roller end bearings. They have been assembled and adjusted at the factory with proper clearance and will give long trouble-free service. The proper end clearance is found by adjusting the amount of shims until the crankshaft has .004" to .006" endplay and will rotate freely. The 31Q-2 also has two steel backed Babbitt center mains which are non adjustable. The center mains should have .010" to .018" (.254 mm to .457 mm) total diametrical clearance. This is non adjustable.

#### 4. 2S-1, 5S-2, 11D-2, 22T-2, 32T-2, & 31Q-2:

- a. The connecting rod shell bearings or inserts are precision made steel backed Babbitt lined and require no shims for adjustment. Tolerances are listed on the following page.
- b. The normal clearance between the crosshead and crosshead bore is .003" (.076 mm) to .009" (.229 mm). The maximum allowable clearance, including wear, is .012" (.305 mm).
- c. The wrist pin bushings must be pressed into the connecting rods and reamed to size. The allowable clearance between the pin and bushing is listed on the following page.





**Overhaul and Repair...**

**I. GENERAL**

**B. CHECK POINTS AND ADJUSTMENTS (Continued)...**

PUMP	CRANKSHAFT O.D.		MAXIMUM CLEARANCE		MINIMUM CLEARANCE	
	in	mm	in	mm	in	mm
2S-1	<u>2.125</u>	<u>53.975</u>	.004	.102	.002	.051
5S-2	2.124	53.950				
11D-2	<u>2.125</u>	<u>53.975</u>	.004	.102	.002	.051
	2.124	53.950				
22T-2	<u>2.125</u>	<u>53.975</u>	.004	.102	.002	.051
32T-2	2.124	53.950				
31Q-2	<u>2.125</u>	<u>53.975</u>	.004	.102	.002	.051
	2.124	53.950				

PUMP	CROSSHEAD PIN O.D.		MAXIMUM CLEARANCE		MINIMUM CLEARANCE	
	in	mm	in	mm	in	mm
2S-1	<u>.9380</u>	<u>23.825</u>	.002	.051	.001	.025
5S-2	.9375	23.813				
11D-2	<u>.9380</u>	<u>23.825</u>	.002	.051	.001	.025
	.9375	23.813				
22T-2	<u>2.5635</u>	<u>65.113</u>	.002	.051	.001	.025
32T-2	2.5300	65.100				
31Q-2	<u>3.0015</u>	<u>76.238</u>	.002	.051	.001	.025
	3.0010	76.225				





## Disassembly...

### I. POWER END

It is not necessary to remove the fluid end when disassembling the power end. However, the plungers should be removed through the fluid end cylinder heads. The plungers and intermediate rods are one piece on all class fluid ends, except the "H" models. The "H" models have separate intermediate rods.

## **! ATTENTION !**

POWER END DISASSEMBLY AND OVERHAUL IS BEST PERFORMED IN A WELL EQUIPPED SHOP ENVIRONMENT. IF THE PUMP IS DISASSEMBLED AT LOCATION INSURE THE PRESSURE HAS BEEN REMOVED FROM THE FLUID END AND THE PUMP BLOCKED OUT WITH APPROPRIATE BLOCK VALVES. INSURE THE FLUID END IS DRAINED AND ANY POWER SOURCE OR DRIVER IS LOCKED OUT BEFORE PROCEEDING!

### A. PLUNGER/INTERMEDIATE RODS AND OIL WIPER RETAINERS (ALL PUMPS)

1. Remove the fluid end cylinder head.
2. Loosen the packing gland nuts.
3. If the pump has intermediate rods a back-up wrench is required. The plunger and intermediate rod separate at the knurl area interface. Using the back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
4. Using a pipe wrench on the knurled area of the intermediate rod, remove it from the crosshead and power end.
5. If the pump does not have an intermediate rod, use a pipe wrench on the knurled area of the plunger and break it loose from the crosshead. Unscrew and remove through the fluid cylinder opening.
6. Remove the two nuts holding the wiper box gland and remove the gland.
7. Slide the wiper box and seal assembly out of the power end.







## Disassembly...

### I. POWER END (Continued)...

### B. CRANKSHAFT ASSEMBLY

#### 1. 2S-1, 5S-2, 11D-2, 22T-2, & 32T-2

- a. Remove the rear power end crankcase cover.
- b. Remove connecting rod bolts and cap.

**NOTE:** Connecting rods and caps are matched marked and must be kept together. Do not mix caps and rods.

- c. Connecting rod and crosshead must be moved all the way forward to clear crankshaft.
- d. Remove crankshaft bearing retainers, seals, and shims. These parts should be tied together and marked for reassembly at their original location. There are two tapped holes in each bearing housing that can be used to jack the housing out.



COVER KEYWAYS TO PROTECT OIL SEALS DURING REMOVAL.

- e. Carefully remove the crankshaft out either side of the power frame. If reusing the end bearings remember, the crankshaft end bearing cones and cups are matched sets. Do not mix cones and cups.

#### 2. 31Q-2

- a. Remove the rear power end crankcase cover.
- b. Remove connecting rod bolts and cap.

**NOTE:** Connecting rods and caps are matched marked and must be kept together. Do not mix caps and rods.

- c. Connecting rod and crosshead must be moved all the way forward to clear crankshaft.
- d. Remove crankshaft bearing retainers, seals, and shims. These parts should be tied together and marked for reassembly at their original location. There are two tapped holes in each bearing housing that can be used to jack the housing out.
- e. Carefully remove the crankshaft out either side of the power frame. If reusing the end bearings remember, the crankshaft end bearing cones and cups are matched sets. Do not mix cones and cups.

### C. CRANKSHAFT BEARINGS (ALL PUMPS)

The crankshaft main bearings may be inspected while on the crankshaft and should not be removed unless necessary. A puller is required when replacement is necessary.

**NOTE:** Keep the component parts of the bearings together if they are to be re-installed. They are match marked and must be correctly assembled as a unit.





## Disassembly (Continued)...

### II. FLUID END



**BEFORE WORKING ON THE FLUID END ENSURE THE PRESSURE HAS BEEN REMOVED FROM THE FLUID END AND THE PUMP BLOCKED OUT WITH APPROPRIATE BLOCK VALVES. ENSURE THE FLUID END IS DRAINED AND ANY POWER SOURCE OR DRIVER IS LOCKED OUT BEFORE PROCEEDING!**

#### A. FLUID CYLINDER REMOVAL (ALL PUMPS)

1. Disconnect piping.
2. Remove the plungers as described below.
3. Remove the hex nuts holding the fluid end to the power end and slide cylinder forward until free.

#### B. PLUNGER REMOVAL (ALL PUMPS)

1. Remove the fluid end cylinder head.
2. Loosen the packing gland nuts.
3. Rotate the crankshaft until the knurl area of the plunger/intermediate rod is accessible in the cradle area of the pump.
4. If the pump has intermediate rods a back-up wrench is required. The plunger and intermediate rod separate at the knurl area interface. Using the back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
5. If replacing the intermediate rod, use a pipe wrench on the knurled area of the intermediate rod and remove it from the crosshead and power end.
6. If the pump does not have an intermediate rod, use a pipe wrench on the knurled area of the plunger and break it loose from the crosshead. Unscrew and remove through the fluid cylinder opening.

#### C. STUFFING BOX REMOVAL (ALL PUMPS)

Most pumps in this series have integral stuffing boxes. A few models do have separate stuffing boxes. On these pumps the stuffing box is clamped between the fluid end body and the power frame. The fit on the fluid end side is a slip fit. The fit on the power end side is a slight press. To remove the stuffing boxes follow this procedure.

1. Remove the plungers and fluid end as previously described.
2. Remove any lube fittings, etc.
3. Support the box with a lifting strap
4. Use a heavy brass bar and drive the box out of the power frame opening.

#### D. FLUID END VALVE REMOVAL

Refer to valve section located in the middle of this manual.





## Assembly...

### I. POWER END

#### A. CONNECTING ROD AND CROSSHEAD ASSEMBLY (ALL PUMPS)

1. Press the crosshead pin bushing into the connecting rod.
2. Ream bushing to obtain the clearance listed on page 18. (If service bushings are used, reaming will not be necessary in most cases).
3. Assemble the connecting rod to the crosshead by pressing the crosshead pin into the crosshead. Or to facilitate assembly, the crosshead may be heated to no more than 300°F (149°C) in an electric oven or bath.

NOTE: Crossheads have an oil groove on the topside. Connecting rods and bearing caps are match marked as units. The rod also has a lube hole on the topside. Install connecting rod in crosshead so the lube hole on the rod and the oil groove on the crosshead correspond. The oil groove and lube hole go up when installing in the power frame. See figure 1.

4. Lubricate the crosshead bore and slide the connecting rod crosshead assembly into the power frame. Push the assemblies all the way forward.

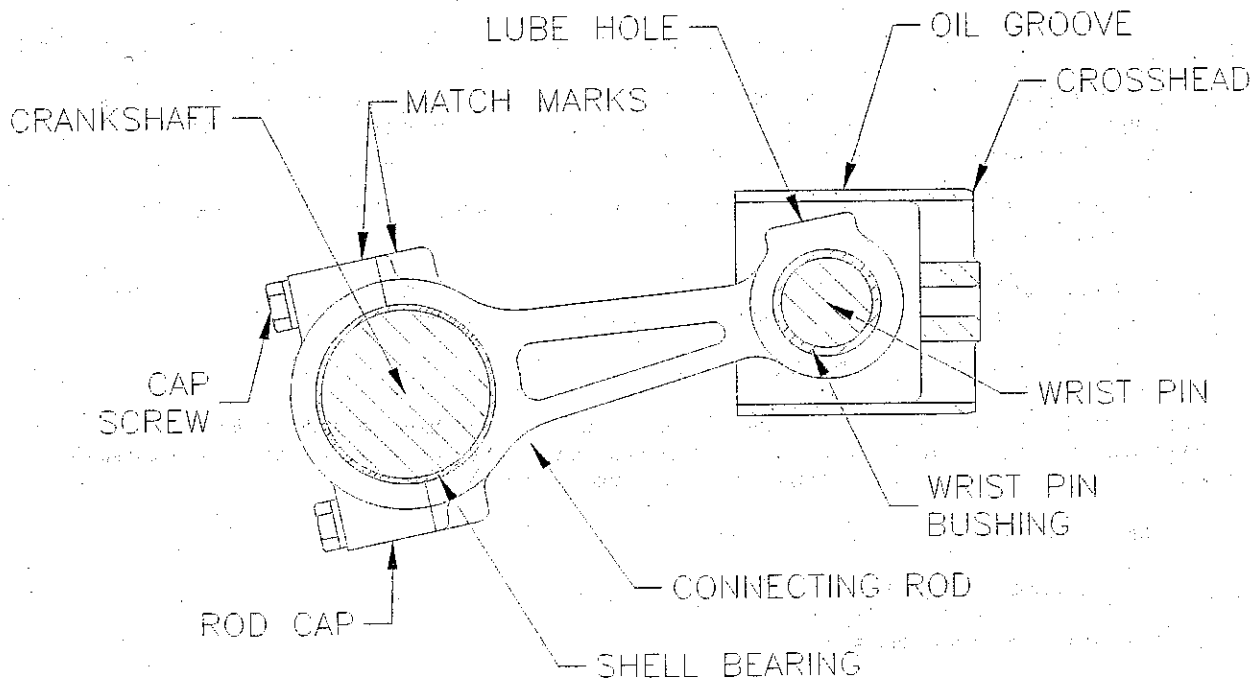


Figure 1





## Assembly...

### I. POWER END (Continued)...

### B. CRANKSHAFT AND MAIN BEARINGS

#### 1. 2S-1, 5S-2, 11D-2, 22T-2, & 32T-2

- a. Thoroughly clean and remove all burrs from the I.D. of the cone and roller assembly and from the bearing seating surfaces on the crankshaft.
- b. Heat the cone and roller assembly in an electric oven or oil bath to 300°F (149°C). It is recommended that a thermometer be used to prevent overheating.
- c. After the bearings have been brought up to temperature and with the crankshaft firmly supported, install the cone and roller assemblies on the crankshaft. *Make sure the cone and roller assemblies are firmly against the shoulders on the crankshaft.*
- d. Allow the crankshaft and bearing assembly to cool before installing in the power end.
- e. Make sure the main bearing openings in the frame are clean and free of burrs.

**NOTE:** The crossheads and connecting rods must be installed prior to replacing the crankshaft assembly.

- f. Install the crankshaft main bearing outer races or cups in the main bearing housing. These races can be carefully driven into the housing with a brass rod. An alternative and easier way is to chill the races in a freezer or with CO<sub>2</sub> and place them in their respective bearing housings. Ensure the races are completely seated.
- g. Place the crankcase main bearing shims, amounting to approximately .100" (2.54 mm) in thickness, on the crankshaft-bearing housing/retainers. *If the old bearings and retainers are being re-installed, use the same amount of shims as before.*
- h. Install the off-drive side bearing housing with shims in the power frame and tighten in place with the proper capscrews.
- i. With the cone and roller assemblies of the main bearings in place on the crankshaft, slide the crankshaft through the main bearing openings in the power end frame with No. 1 throw forward. Slide the off drive side bearing into its bearing housing and race.
- j. Assemble the drive side crankshaft-bearing housing/retainer and shims to the main frame and tighten in place with the proper capscrews.

**NOTE:** The following steps, k.1) and k.2) are necessary only if new bearings are being installed. When the same crankshaft main bearings are being reassembled, use the same amount of shims as were previously used and use the steps as a check for adjustment.





### Assembly...

#### I. POWER END

#### B. CRANKSHAFT AND MAIN BEARINGS

##### 1. 2S-1, 5S-2, 11D-2, 22T-2, & 32T-2 (Continued)...

- k. To determine the correct amount of shims when installing new bearings, the following steps are recommended.
- 1) When first installing shims, use only enough shims to produce a slight drag when the crankshaft is rotated. Tap shaft on each end sufficient to ensure that the bearing outer race is tightly against the retainer.
  - 2) Then, add enough shims to remove the slight drag or pre-load (approximately .005" [.127 mm] to .007" [.178 mm]), depending on the amount of pre-load). *The bearings are correctly adjusted when the endplay of the crankshaft is per the specifications and the crankshaft will rotate freely. Do not pre-load bearings.*

#### CRANKSHAFT END PLAY

PUMP	MAXIMUM END PLAY		MINIMUM END PLAY	
	in	mm	in	mm
2S-1 5S-2	.003	.076	.001	.025
11D-2	.004	.102	.002	.051
22T-2 32T-2	.004	.102	.002	.051
31Q-2	.006	.152	.004	.102

##### 2. 31Q-2

- a. Thoroughly clean and remove all burrs from the I.D. of the cone and roller assembly and from the bearing seating surfaces on the crankshaft.
- b. Heat the cone and roller assembly in an electric oven or oil bath to 300°F (149°C). It is recommended that a thermometer be used to prevent overheating.
- c. After the bearings have been brought up to temperature and with the crankshaft firmly supported, install the cone and roller assemblies on the crankshaft. *Make sure the cone and roller assemblies are firmly against the shoulders on the crankshaft.*
- d. Allow the crankshaft and bearing assembly to cool before installing in the power end.
- e. If installing new steel backed Babbitt lined center mains, install them at this time as described below.
  - 1) Chill the bearings in a freezer or with CO<sub>2</sub>.
  - 2) Carefully install the center mains.
  - 3) Allow the center mains to warm before proceeding.





## Assembly...

### I. POWER END

### B. CRANKSHAFT AND MAIN BEARINGS

#### 2. 31Q-2 (Continued)...

4) If you do not have a method to chill the bearings, they can be driven in place with a brass bar or pulled into place with a bearing installation tool. When using this method take care to not damage the bearing surface and remove any slight raised spots or burrs that occur from installation before proceeding.

f. Make sure the main bearing openings in the frame are clean and free of burrs.

**NOTE:** The crossheads and connecting rods must be installed prior to replacing the crankshaft assembly.

g. Install the crankshaft main bearing outer races or cups in the main bearing housing. These races can be carefully driven into the housing with a brass rod. An alternative and easier way is to chill the races in a freezer or with CO<sub>2</sub> and place them in their respective bearing housings. Ensure the races are completely seated.

h. Place the crankcase main bearing shims, amounting to approximately .100" (2.54 mm) in thickness, on the crankshaft-bearing housing/retainers. *If the old bearings and retainers are being re-installed, use the same amount of shims as before.*

i. Install the off-drive side bearing housing with shims in the power frame and tighten in place with the proper capscrews.

j. With the cone and roller assemblies of the main bearings in place on the crankshaft, carefully slide the crankshaft through the main bearing openings in the power end frame with No. 1 throw forward. Slide the off drive side bearing into its bearing housing and race.

k. Assemble the drive side crankshaft-bearing housing/retainer and shims to the main frame and tighten in place with the proper capscrews.

**NOTE:** The following steps, l.1) and l.2) are necessary only if new bearings are being installed. When the same crankshaft main bearings are being reassembled, use the same amount of shims as were previously used and use the steps as a check for adjustment.

l. To determine the correct amount of shims when installing new bearings, the following steps are recommended.

1) When first installing shims, use only enough shims to produce a slight drag when the crankshaft is rotated. Tap shaft on each end sufficient to ensure that the bearing outer race is tightly against the retainer.

2) Then, add enough shims to remove the slight drag or pre-load (approximately .005" [.127 mm] to .007" [.178 mm]), depending on the amount of pre-load. *The bearings are correctly adjusted when the endplay of the crankshaft is per the specifications and the crankshaft will rotate freely. Do not pre-load bearings.*

3) After installation the center mains should have .005" (.127 mm) to .009" (.229 mm) clearance per side or .010" (.254 mm) to .018" (.457 mm) clearance on the diameter.





### Assembly...

#### I. POWER END (Continued)...

#### C. CONNECTING ROD TO CRANKSHAFT ASSEMBLY (ALL PUMPS)

1. Thoroughly clean and remove all burrs and nicks from connecting rod and crankshaft journals.
2. Position the No. 1 crankshaft throw to the rear.
3. Take a shell bearing half and carefully locate it in the rod half of the connecting rod assembly. Note: the upsets on the bearings and the notches in the connecting rod must match.
4. Lubricate the connecting rod pin and rod bearing.
5. Slide the connecting rod back over the crankshaft throw using caution so the outer surface of the insert is not damaged. Note: the match numbers of the cap and rod to be certain the rod is assembled correctly.
7. Install the two (2) capscrews and torque as shown in chart.

PUMP	TORQUE: FT-LBS			
	2S-1 5S-2	11D-2	22T-2 32T-2	31Q-2
Cast Iron rods	18-24	18-24	18-24	18-24
Aluminum rods	12-16	12-16	12-16	12-16

*The connecting rod bearings are precision fitting inserts requiring no adjustment. When re-installing the same inserts, assemble them in pairs at their original location. Make sure the match marks on the connecting rod and cap are the same on the corresponding sides.*

#### D. INTERMEDIATE RODS AND OIL SEAL RETAINERS (ALL PUMPS)

The power end wiper box is held in the power frame by two adjustment studs and the wiper box gland. The wiper box seals are a set of V-ring seals and should be installed with the lips turned toward the crosshead. To replace the seals follow the instructions below.

1. Clean the stuffing box and gland.
2. Take a new set of seals, lubricate the seals, and install with the lips facing the crosshead.
3. Place the stuffing box back in the power frame.
4. Install the follower and loosely install the gland. Do not tighten until the plunger or adapter rod is reassembled.





## Assembly (Continued)...

### II. FLUID END

#### A. STUFFING BOXES AND PLUNGERS (ALL PUMPS)

Plungers are available in ceramic or steel.



NATIONAL-OILWELL DOES **NOT** RECOMMEND THE USE OF CERAMIC PLUNGERS FOR PUMPING FLAMMABLE OR HAZARDOUS LIQUIDS.

1. If the pump has separate stuffing boxes, thoroughly clean and remove any nicks or burrs from all mating surfaces of the main frame, fluid cylinder and stuffing boxes.
2. Insert stuffing boxes into main frame.

**NOTE:** The stuffing box is a press fit in the main frame and will have to be driven into position. As an alternative you can chill the stuffing box in a freezer or with CO<sub>2</sub>.



PREVENT DAMAGE BY PLACING A BLOCK OF WOOD OVER THE STUFFING BOX FACE.

3. Insert seals (stuffing box to fluid cylinder) into grooves in the face of the stuffing boxes. Grease lightly to hold in place until fluid cylinder is installed.
4. Assemble packing in stuffing box bore as per instructions included with each set of packing, or as described on pages 29 to 34.
5. Torque adapter rods, if applicable, or plungers and torque to 30 ft.-lbs.

#### B. POWER END/FLUID END ADAPTERS (ALL PUMPS)

If the pump has integral stuffing boxes, a power end to fluid end adapter is used. The adapter is a press fit into the power frame. The adapter is used to locate the fluid end and contains the threads for the packing gland nut.

1. Thoroughly clean and remove any nicks or burrs from all mating surfaces of the main frame, fluid cylinder and adapters.
2. Insert adapters into main frame.

**NOTE:** The adapter is a press fit in the main frame and will have to be driven into position. As an alternative you can chill the adapter in a freezer or with CO<sub>2</sub>.







## Assembly...

### II. FLUID END

#### B. POWER END/FLUID END ADAPTERS (ALL PUMPS) (Continued)...



PREVENT DAMAGE BY PLACING A BLOCK OF WOOD OVER THE ADAPTER FACE.

3. Insert the O-Ring into the groove on the adapter face. Grease lightly to hold in place until fluid cylinder is installed.

#### C. FLUID CYLINDER (ALL PUMPS)

1. Carefully slide fluid end body into place. Ensure stuffing box or adapter seals are not pinched as cylinder is moved into place.
2. Tighten nuts alternately, pulling fluid cylinder up evenly; torque nuts to the following values:

THREADS	2S-1 5S-2	11D-2	22T-2 32T-2	31Q-2
Lubricated (ft-lbs)	95	150	150	95

#### D. FLUID VALVES - TAPERED SEAT TYPE (ALL PUMPS)

See Valve section of this manual.

#### E. PIPING INSTALLATION (ALL PUMPS)

1. Install flanges on fluid cylinder with special high carbon double heat-treated capscrews furnished with the pump.
2. Install suction and discharge lines to flanges.





## Assembly...

### II. FLUID END (Continued)...

#### F. PLUNGER PACKING INSTALLATION

##### 1. 838 PACKING

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear. 838 packing is assembled in units consisting of a pressure ring along with a top and bottom adapter. Each set will have two or three units. Pay attention to the arrangement of the old packing sets to ensure the new sets are installed correctly. Another check is the units are installed so the lantern ring is positioned under the lubrication port. If the lantern ring does not align with the lubrication port, the pump is not correctly packed.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one or two rounds.
- c. If the pump has intermediate rods a back-up wrench is required. The plunger and intermediate rod separate at the knurl area interface. Using the back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
- d. If the pump does not have an intermediate rod, use a pipe wrench on the knurled area of the plunger and break it loose from the crosshead. Unscrew and remove through the fluid cylinder opening.
- e. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- f. Rotate the pump to bring the next plunger forward.
- g. Repeat steps "b." through "f." until all the plungers and packing have been removed.
- h. Check the throat bushing, lantern ring, and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- i. Lightly lubricate the stuffing box bore and install the throat bushing.
- j. Lightly lubricate a packing unit and install each component separately insuring each component is fully seated at the bottom of the box before installing the next component. Repeat and install the second unit. **(DO NOT GREASE)**.
- k. Install the lantern ring. Check to ensure the lubrication port is aligned with the lantern ring. If not, too few or too many units have been installed ahead of the lantern ring.
- l. Install the last unit of packing.
- m. Install the follower ring and start the gland nut. Adjust the gland nut hand tight only.
- n. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.
- o. Torque plunger and, if used, intermediate rod to 30 ft.-lbs.





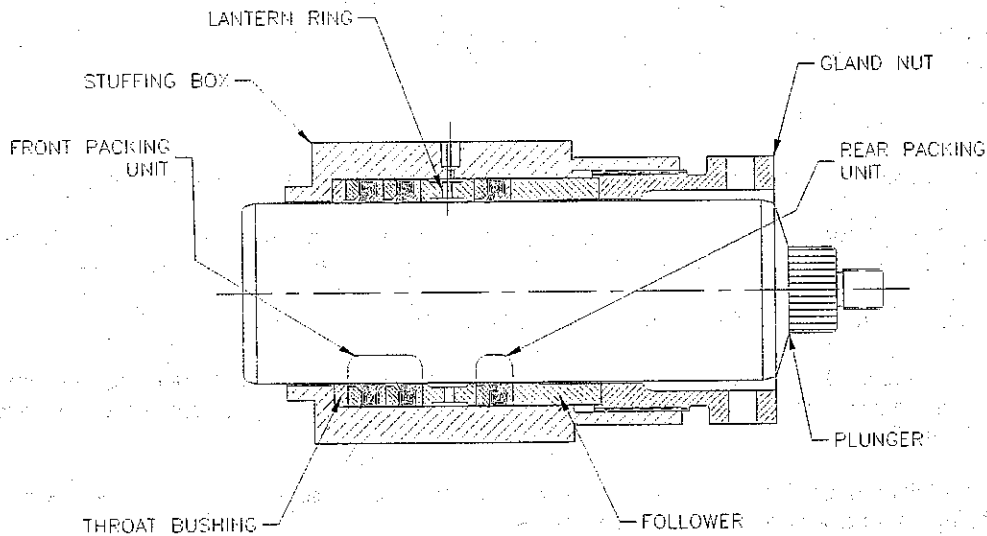
## Assembly...

### II. FLUID END

#### F. PLUNGER PACKING INSTALLATION

##### 1. 838 PACKING (Continued)...

- p. Repeat steps "h." through "o." until all cylinders have been repacked.
- q. Tighten gland nut with the wrench provided. Pull snug by hand, but **DO NOT USE A CHEATER.**
- r. Start the pump and operate at pressure for two to three hours while observing for excessive leakage. If leakage is excessive, stop the pump and readjust. After the two or three hours, stop the pump and readjust. Again, **DO NOT USE A CHEATER.**
- s. This style packing is considered non-adjustable and should be ready to go at this point. However, it may take as much as one or two days to fully seat. After a couple of days, stop the pump and check the packing again. After this adjustment the pump should be ready to run without further adjustment.



838 STYLE PACKING

FIGURE 2





## Assembly...

### II. FLUID END

#### F. PLUNGER PACKING INSTALLATION (Continued)...

##### 2. BRAIDED PACKING

It is important that the following procedure be observed when replacing old packing to prevent rapid packing wear. Braided packing sets consist of braided packing rings, spacer rings, and end rings. The composition and number of rings vary depending on the fluid compatibility and stuffing box depth.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one or two rounds.
- c. If the pump has intermediate rods a back-up wrench is required. The plunger and intermediate rod separate at the knurl area interface. Using the back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
- d. If the pump does not have an intermediate rod, use a pipe wrench on the knurled area of the plunger and break it loose from the crosshead. Unscrew and remove through the fluid cylinder opening.
- e. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- f. Rotate the pump to bring the next plunger forward.
- g. Repeat steps "b." through "f." until all the plungers and packing have been removed.
- h. Check the throat bushing and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- i. Ensure the stuffing box lube port is plugged or has not been drilled completely through. Braided packing does not use a lantern ring and the port must be plugged or the packing can extrude through the port.
- j. Lightly lubricate the stuffing box bore and install the throat bushing.
- k. Install the first end ring into the box. Ensure it is fully seated against the bottom of the box and not cocked.
- l. Install the first pressure ring into the box and ensure it is fully seated.
- m. Install the spacer and ensure it is fully seated.
- n. Repeat this procedure until all the packing is installed and fully seated. **ENSURE THE SPLITS ON EACH PACKING RING ARE STAGGERED FROM THE PREVIOUS RING. DO NOT ALIGN THE SPLITS.**
- o. Install the follower ring and loosely install the gland nut.
- p. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.
- q. Torque plunger and, if used, intermediate rod to 30 ft.-lbs.





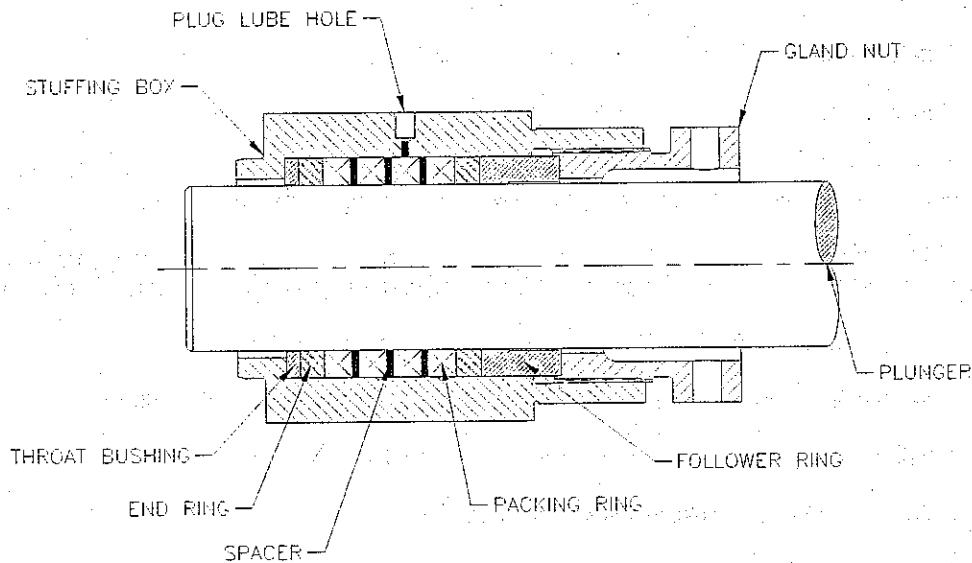
## Assembly...

### II. FLUID END

#### F. PLUNGER PACKING INSTALLATION

##### 2. BRAIDED PACKING (Continued)...

- r. Repeat steps "h." through "q." until all cylinders have been repacked.
- s. Tighten gland nuts finger tight. Some braided packing is very sensitive to gland tightening. Do not over tighten.
- t. Start the pump and bring up to pressure. Watch the packing carefully for signs of excessive heat. If the packing starts to smoke, back the gland off a little. Braided packing does normally drip a small amount. This is by design and helps keep the packing from over heating.
- u. Continue to slowly tighten the nut to reduce the leakage to an acceptable level. Remember this type of packing does leak a small amount and tightening the gland until all leakage has stopped will usually result in excessive heat and failed packing. This style packing is adjustable packing and will have to be inspected regularly to keep the nut tight and leakage to a minimum. If the pump is allowed to operate with too loose packing, the packing will prematurely fail and you run the risk of damaging the stuffing box.



BRAIDED PACKING

FIGURE 3





## Assembly...

### II. FLUID END

#### F. PLUNGER PACKING INSTALLATION (Continued)...

##### 3. 1068-4 PACKING

1068-4 packing is spring loaded, molded V-ring style packing. It is normally used in reverse osmosis services, but may be used in other selected applications. This is non-adjustable packing.

- a. Remove cradle cover and rotate pump to bring the first plunger to the forward position.
- b. Back off gland nut one or two rounds.
- c. If the pump has intermediate rods a back-up wrench is required. The plunger and intermediate rod separate at the knurl area interface. Using the back-up wrench break the plunger loose and unscrew from the intermediate rod. Remove the plunger through the fluid cylinder opening.
- d. If the pump does not have an intermediate rod, use a pipe wrench on the knurled area of the plunger and break it loose from the crosshead. Unscrew and remove through the fluid cylinder opening.
- e. Remove the gland nut, old packing, and packing adapters. Note the order of the packing and adapters. Clean the stuffing box and inspect for any damage.
- f. Rotate the pump to bring the next plunger forward.
- g. Repeat steps "b." through "f." until all the plungers and packing has been removed.
- h. Check the throat bushing and follower for excessive wear. These items can often be reused, but if they are worn, replace them. Reusing worn trim will cause premature packing failure.
- i. Ensure the stuffing box lube port is plugged or has not been drilled completely through. 1068-4 packing does not use a lantern ring and the port must be plugged or the packing can extrude through the port.
- j. Lightly lubricate the stuffing box bore and install the throat bushing, if used.
- k. Install the packing spring.
- l. Lubricate and install the packing set and adapters.
- m. Install the follower ring (if used) and gland nut. Do not fully tighten the gland nut at this time.
- n. Lightly oil the plunger and install it through the fluid cylinder. Do not use worn plungers on new packing, as this will shorten packing life.
- o. Torque plunger and, if used, intermediate rod to 30 ft.-lbs.
- p. Repeat steps "h." through "o." until all cylinders have been repacked.





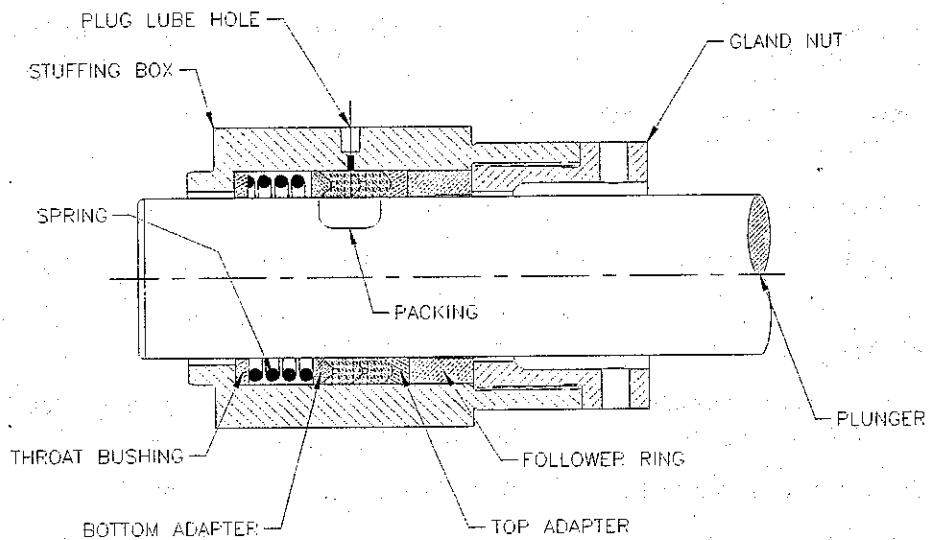
## Assembly...

### II. FLUID END

#### F. PLUNGER PACKING INSTALLATION

##### 3. 1068-4 PACKING (Continued)...

- q. Using the standard gland wrench tighten all glands completely. The glands will pull completely up. Again, this packing is spring-loaded and non-adjustable so once the glands are properly pulled up there is no more adjustment.
- r. Start the pump and bring up to pressure.



1068-4 PACKING

FIGURE 4





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**PLUNGER PUMP VALVES**

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## Plunger Pump Valves...

### I. OPERATIONAL MAINTENANCE

#### A. SUCTION AND DISCHARGE

As with any plunger pump, the necessity for having an adequate suction head and proper piping design of both suction and discharge cannot be over emphasized.

### **! ATTENTION !**

NOISY VALVES, DUE TO IMPROPER FILLING, CAN LEAD TO SHORT LIFE AND RAPID MECHANICAL WEAR OF THE POWER END PARTS.

#### B. VALVE COVERS

### **CAUTION**

THE VALVE COVERS, AS USED WITH THE NATIONAL-OILWELL PLUNGER PUMPS, **MUST** BE KEPT TIGHT AT ALL TIMES. DUE TO THE DISCHARGE PRESSURE APPLYING A CONSTANT LOAD TO THE COVERS, IT IS **NOT** POSSIBLE TO CHECK THEIR TIGHTNESS WITH THE PUMP RUNNING OR WITH PRESSURE IN THE CYLINDER.

Bleed off the discharge pressure and check the tightness of the covers as outlined under the assembly procedure for the type of cover used.

#### C. VALVE COVER SEALS

Tapered Seat Valves: The cover seals should be replaced as required.

#### D. VALVE SPRINGS

The springs used with the NATIONAL-OILWELL valves are made of inconel alloy or other stainless steel.

### **! ATTENTION !**

THESE SPRINGS SHOULD BE CHANGED APPROXIMATELY ONCE A YEAR IN ORDER TO ASSURE PROPER VALVE ACTION AND ELIMINATE THE POSSIBILITY OF A SPRING BREAK.

#### E. VALVE AND SEAT

Tapered Seat Valves: There are three basic valve & seat assemblies available, depending on the type of service. They are the severe duty (abrasion resistant) tapered seat valves, the disc tapered seat valves, and the spherical tapered seats.





## Plunger Pump Valves (Continued)...

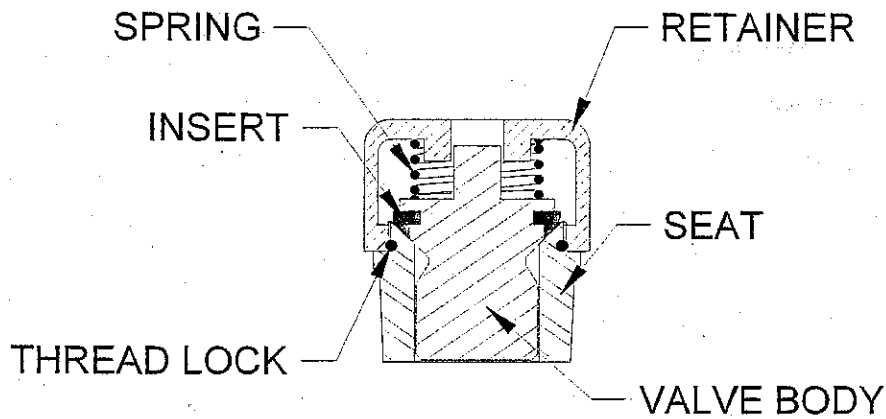
### II. TAPERED SEAT VALVES

#### A. SEVERE DUTY VALVE

This section will assist in servicing the severe duty (abrasion resistant) valve in your National Oilwell multiplex pump.

##### 1. NOMENCLATURE.

### NOMENCLATURE



### SEVERE DUTY VALVE ASSEMBLY

FIGURE 5

For part numbers and pullers see the following table.

Severe Duty Valve			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
2S-1H, 5S-2H, 11D-2H, 22T-2H, 32T-2H	998-016313-027	998-016313-028	002-010359-220
2S-1M&L, 5S-2M&L, 11D-2M&L, 22T-2M&L, 32T-2M&L, and 31Q-2M&L	100SD0304	100SD0304	998-016202-091





## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### A. SEVERE DUTY VALVE (Continued)...

##### 2. VALVE REMOVAL PROCEDURE

- Ensure pressure is removed from fluid end and pump is "LOCKED OUT".
- The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head. Remove both covers.
- Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- Starting with the discharge valve assembly use the cage wrench (see tools section of parts list for special tools and numbers) and remove the valve retainer by turning the wrench counter-clockwise.
- Remove the valve spring.
- Remove the valve body.
- Use the special valve puller and remove the valve seat. See Figure 6.
- Repeat steps "c." through "g." for the suction valve assembly.

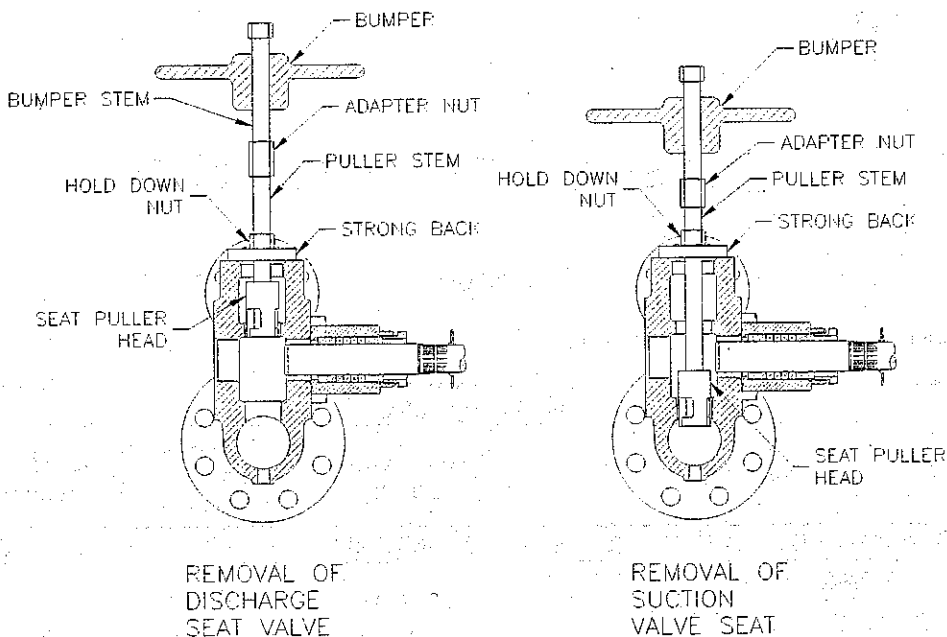


FIGURE 6





## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### A. SEVERE DUTY VALVE (Continued)...

##### 3. VALVE INSPECTION PROCEDURE (See Figure 5 for part reference)

###### a. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the spring and improper valve action.

###### b. SPRING

The spring is made from inconel or other stainless steel and will work in most corrosive environments. It should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

###### c. INSERT

The valve insert is made from polyurethane. A good insert is vital for good sealing in slurries or dirty fluids. Inspect the insert for tears, nibbling, and extrusion. If the insert is worn, replace it. Generally you can replace the insert a couple of times before having to replace the valve body.

###### d. THREAD LOCK

The thread lock is a nitrile rubber. It is used to lock the retainer and prevent it from backing off during pump operation. If the thread lock is torn or damaged, replace it.

###### e. VALVE BODY

The valve body is heat-treated 17-4 PH stainless. Inspect the body for excessive wear, cracks, or washing. The guides should also be inspected for proper fit in the seat and any cracks or excessive wear. Replace the valve body when these conditions are present. If replacing the valve body, a new insert should also be used.

###### f. SEAT

The seat is also a heat-treated 17-4 PH stainless steel. It should be inspected for excessive wear and/or wash on the seating surface. Also check the taper for signs of wash by or wear. If any of these conditions exist, the seat should be replaced. Do not use an old valve body with a new seat.

With the seat out of the pump also inspect the liquid end seating area for washing or excessive wear. The seats should fit in the liquid end with a small amount of stand off. If the liquid end seating area is washed or there is no stand off on the seats, the liquid end will have to be repaired. This type of repair will require the services of a machine shop.



## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### A. SEVERE DUTY VALVE (Continued)...

##### 4. VALVE INSTALLATION PROCEDURE

- a. Thoroughly clean the fluid cylinder seat area with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to "jump out" of the bore and could cause major damage to the pump.**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Insert the suction seat into the fluid cylinder suction bore.
- d. Using a metal plate or old worn valve body, drive the seat into place with several sharp blows from a hammer and bar. See Figure 7.

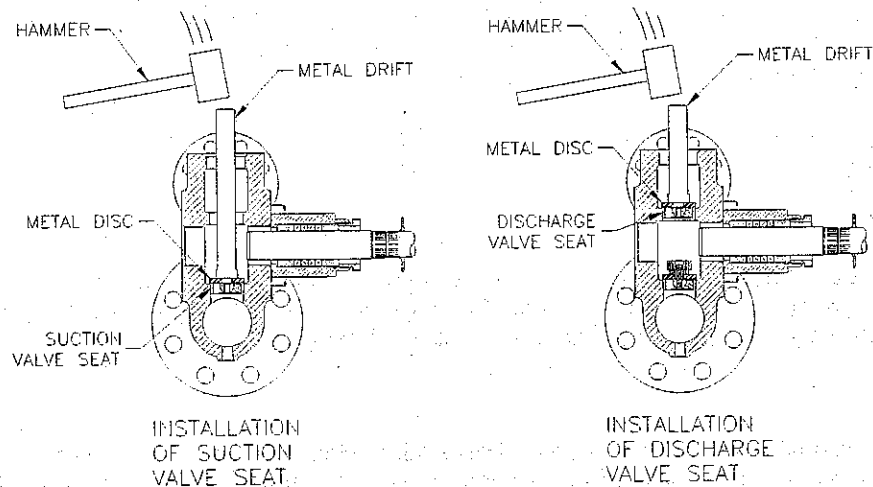


Figure 7

- e. Install the new valve body with insert.
- f. Install the spring.
- g. Using the cage wrench (see parts list for special tools) install the retainer cage.
- h. Repeat this procedure for the discharge valve.
- i. Repeat until all valve assemblies have been installed.



# Plunger Pump Valves...

## II. TAPERED SEAT VALVES (Continued)...

### B. DISC VALVE

#### 1. NOMENCLATURE

#### NOMENCLATURE

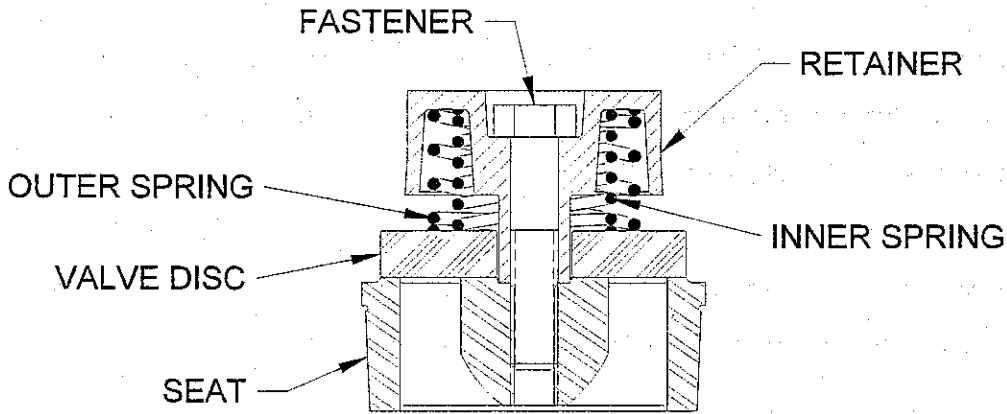


Figure 8

For part numbers and pullers see the following table.

Disc Style Valve			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
2S-1H, 5S-2H, 22T-2H, 32T-2H	Not Available	Not Available	Not Available
2S-1M&L, 5S-2M&L, 11D-2M&L, 22T-2M&L, 32T-2M&L, and 31Q-2M&L	(Delrin Disc) 001DP0304	(Delrin Disc) 001DP0304	998-016202-092
2S-1M&L, 5S-2M&L, 11D-2M&L, 22T-2M&L, 32T-2M&L, and 31Q-2M&L	(Titanium Disc) 001TP0304	(Titanium Disc) 001TP0304	998-016202-092





## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### B. DISC VALVE (Continued)...

##### 2. VALVE REMOVAL PROCEDURE

- a. Ensure pressure is removed from the fluid end and pump is "Locked out".
- b. The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head. Remove both covers.
- c. Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- d. Starting with the discharge valve assembly remove the socket head capscrew holding the retainer in place.
- e. Remove the retainer and valve springs.
- f. Remove the valve disc.
- g. Use the special valve puller and remove the seat. See Figure 9.
- h. Repeat steps "c." through "g." for the suction valve assembly.

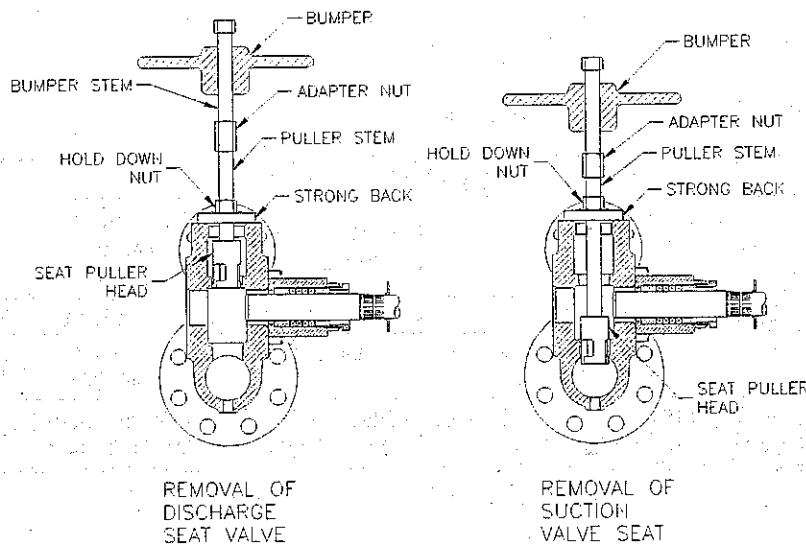


Figure 9





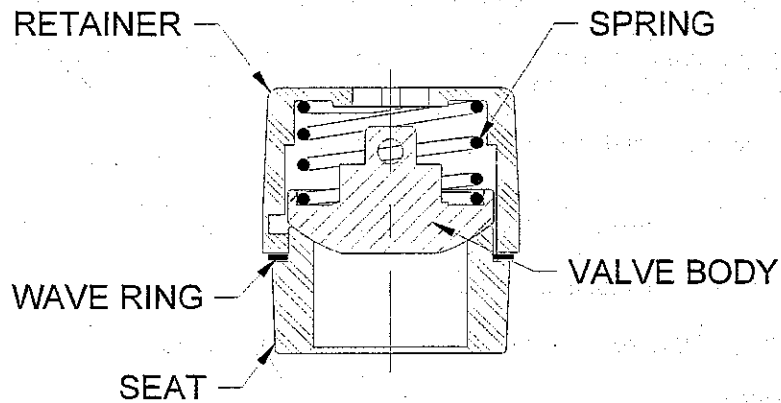
# Plunger Pump Valves...

## II. TAPERED SEAT VALVES (Continued)...

### C. SPHERICAL VALVE

#### 1. NOMENCLATURE

## NOMENCLATURE



## SPHERICAL VALVE ASSEMBLY

Figure 11

For part numbers and pullers see the following table.

Spherical Valve			
Pump Model	Suction Valve Assembly	Discharge Valve Assembly	Valve Puller Assembly
2S-1H, 5S-2H, 22T-2H, 32T-2H	Not Available	Not Available	Not Available
2S-1M&L, 5S-2M&L, 11D-2M&L, 22T-2M&L, 32T-2M&L, and 31Q-2M&L	179150025W	179150025W	181259201







## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### C. SPHERICAL VALVES AND SEATS (Continued)...

##### 2. VALVE REMOVAL PROCEDURE

- a. Ensure pressure is removed from fluid end and pump is "LOCKED OUT".
- b. The discharge valve is removed through the valve cover and the suction valve is removed through the cylinder head. Remove both covers.
- c. Rotate the pump so the plunger for the cylinder you are working on is all the way back.
- d. Remove the spring retainer by pressing downward on the puller head and turn counter clockwise about 1/8 of a turn or until retainer stops. Remove the retainer with the retriever. See Figure 13.
- e. Remove spring(s) and valve with the retriever. See Figure 15.
- f. Remove seat by placing the puller head through the seat opening and engage lugs to the underside of the seat. Pull seat or bump seat loose and remove. See Figure 15.
- g. Repeat steps "c." through "f." for the suction valve assembly.

##### 3. VALVE INSPECTION PROCEDURE (SEE FIGURE 11 FOR PART REFERENCE)

###### a. RETAINER

The retainer will not need to be replaced very often. It should be inspected for corrosion or to see if it has been warped or bent. If this is the case, replace the retainer because this can cause undue wear on the springs and improper valve action.

###### b. SPRINGS

The springs are made from inconel or other stainless steel and will work in most corrosive environments. It should be inspected for wear and/or nicks. If such evidence is apparent, the spring should be replaced.

###### c. VALVE BODY

The valve body is a stainless steel spherical disc. Inspect the valve for excessive wear, cracks, or washing. If any of these conditions exist, replace the valve.

###### d. SEAT

The seat is stainless steel and should be inspected for excessive wear and/or wash on the seating surface. Also check the lugs, which engage the retainer for any damage. Check the taper for any signs of wash. Replace if these conditions exist.

###### e. WAVE RING

The wave rings protect the valve integrity and is a safety device to prevent the cage from coming loose in the rare event a spring breaks. Check the wave ring for cracks or damage. Replace if necessary.





## Plunger Pump Valves...

### II. TAPERED SEAT VALVES

#### C. SPHERICAL VALVES AND SEATS (Continued)...

##### 4. VALVE INSTALLATION PROCEDURE

- a. Thoroughly clean the cylinder taper with a cleaner that will not leave an oily residue. **Do not oil the taper area of the seat or fluid cylinder seating area. This will cause the seat to "jump out".**
- b. Clean the taper on the suction seat using the same precautions as with the fluid cylinder bore. The two surfaces must be clean and dry before assembly.
- c. Inspect for corrosion or damaged areas. Repair or replace as required.
- d. Place seat in the suction bore making certain it is straight.
- e. With a bar and a driver tap seat in place with two or three strokes. **NOTE:** Seat does not have to be completely seated. Pump start-up pressure will drive seat home. See Figure 16.
- f. Install valve, spring(s), and spring retainer. See Figure 17.

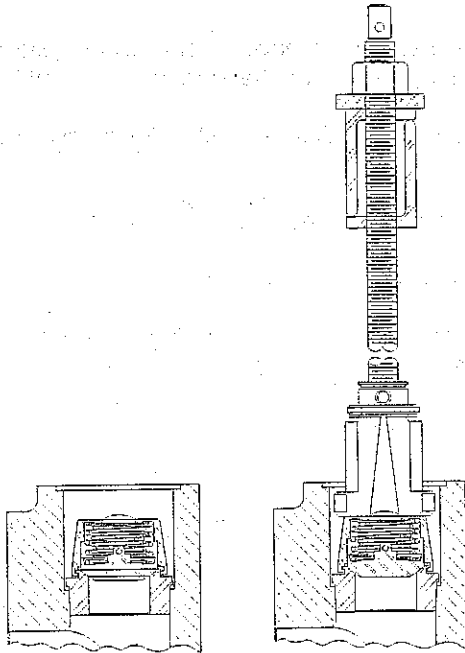




## Plunger Pump Valves...

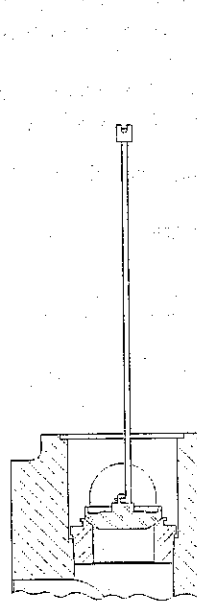
### II. TAPERED SEAT VALVES

#### C. SPHERICAL VALVES AND SEATS (Continued)...

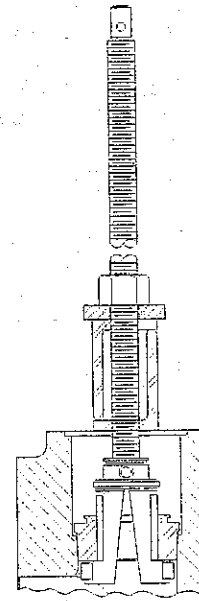


**Figure 12**

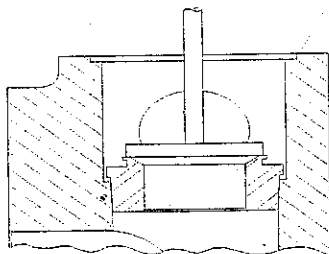
**Figure 13**



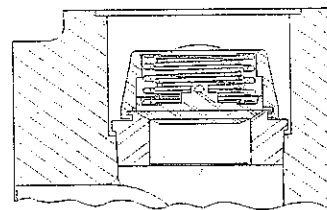
**Figure 14**



**Figure 15**



**Figure 16**



**Figure 17**





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**P-55U LUBRICATOR**

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4. Overfilling of Sight Glass.....	50
5. Reservoir Oil Level.....	50
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## P-55U Pump...

### A. OPERATING INSTRUCTIONS

#### 1. BOX SUCTION PUMPS (VACUUM FEED)

- Fill reservoir with oil.
- Loosen union nut on pump outlet.
- Remove the vent screw and fill the sight glass with oil. Prime by manually pumping flushing unit until air free oil is observed from the drip tube and oil level drops in the sight glass.
- Replace vent screw and tighten union nut.
- Maintain oil level in sight glass below the drip tube so drops can be observed.

#### 2. FLOW RATE ADJUSTMENT

- Loosen locknut on flushing unit.
- Turn flushing unit counter-clockwise to increase flow.
- Turn flushing unit clockwise to decrease flow.
- Tighten locknut when desired flow rate is achieved.

#### 3. SIGHT GLASS

In a vacuum type sight feed, it is not uncommon for oil level in the sight glass to drop during operation. Absence of a level indicates air is being taken in with the oil. Some oils, due to viscosity conditions, will release air faster than others. When the quality of air becomes excessive, it can eventually air lock the pump.

*For this reason it is recommended that an oil level in the sight glass be maintained.*

When level drops, remove the vent screw and fill sight glass to top; replace vent screw and operate flushing unit manually, observing that an oil in the sight glass is free from air. If air is not expelled, it may be necessary to loosen union nut (on pump outlet) and expel air at this point. It is desirable to maintain level below the drip tube so drops can be seen during operation.

#### 4. OVERFILLING OF SIGHT GLASS

In a vacuum type sight feed, it is not uncommon to see a reverse action whereas sight glass fills with oil and the drops cannot be observed. Overfilling is caused by oil absorbing air in the sight glass and normally does not affect the operation of the pump. Remove the vent screw from sight glass and allow level to drop below drip tube. Tighten vent screw and check to see that air free oil from drip tube can be observed in the sight glass. If overfilling continues, it may be caused by plunger wear and oil slippage is being drawn back to sight glass. If this is the problem, the feed setting in drops per stroke will then automatically be reduced by the amount of slippage.

#### 5. RESERVOIR OIL LEVEL (LOSS OF PRIME)

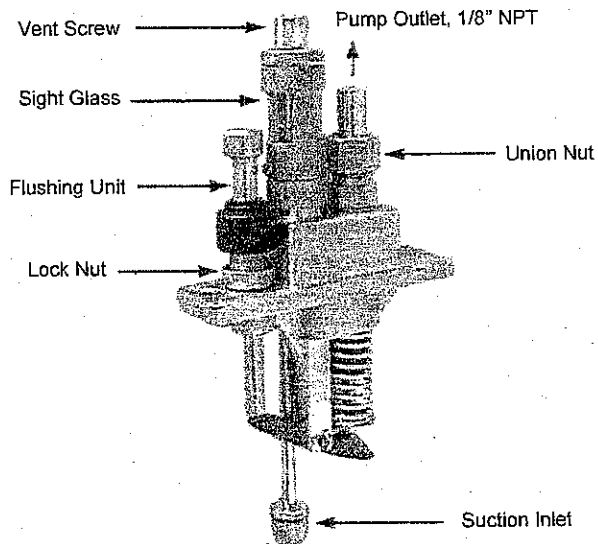
If reservoir runs low on oil (at a point below the suction inlet of the pump) it may be necessary to prime individual pumps after filling, using procedure listed above.

#### 6. PUMP DISPLACEMENT

Maximum output (per stroke):

1/4 Plunger = .018 Cubic Inches  
3/8 Plunger = .038 Cubic Inches

The cubic volume for a pint of oil is 28.9 cubic inches and average drop size is .002 cubic inches.



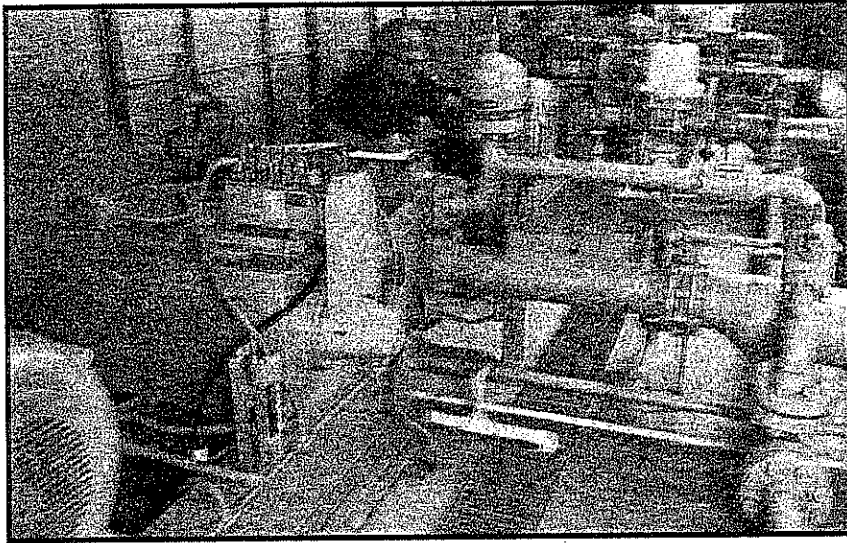


**Notes and Comments:**





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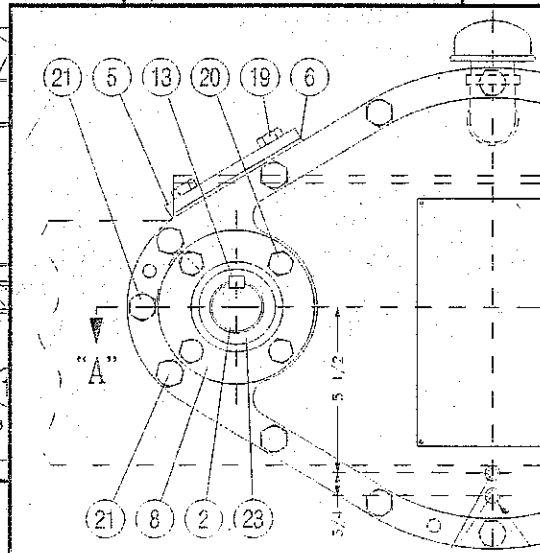
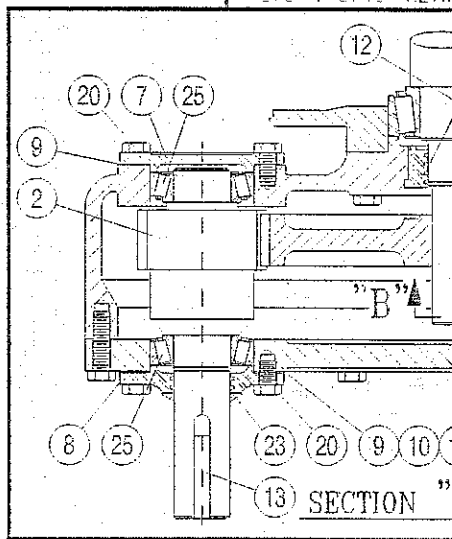
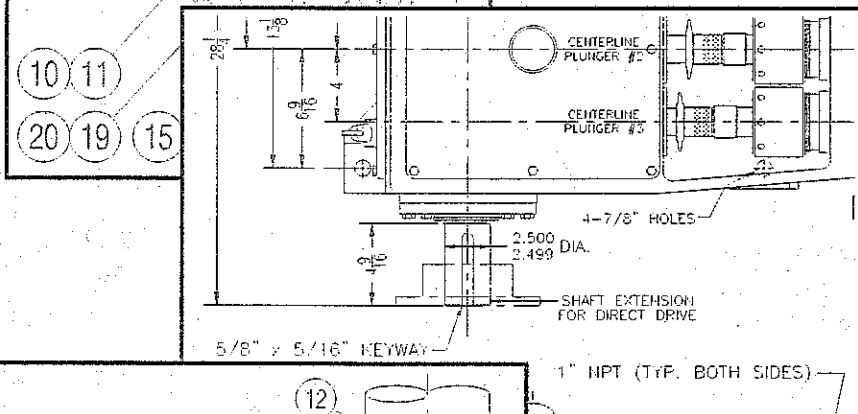
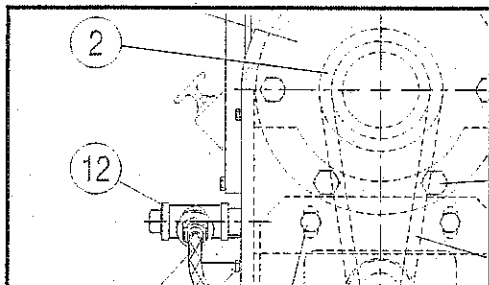
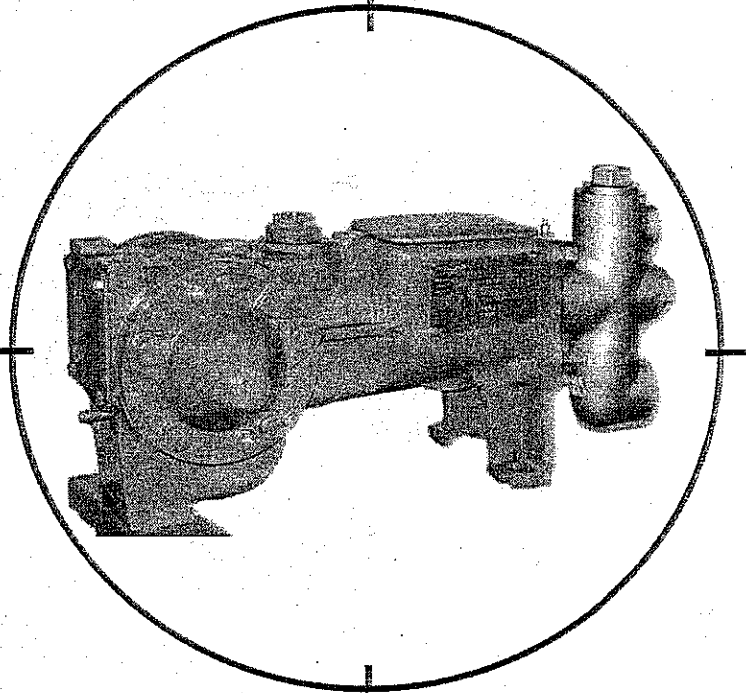
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# NATIONAL OILWELL

## 2S-1 and 5S-2 Multiplex Plunger Pumps Parts List



Types:  
2S-1  
5S-2

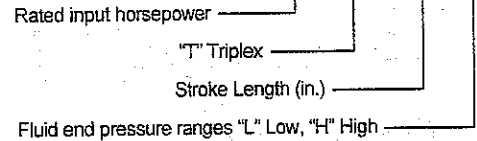
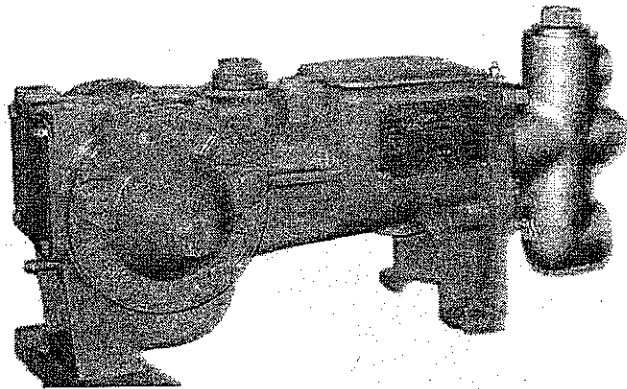
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Fax: 1 (713) 462-3152  
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NATIONAL OILWELL

# Parts List Multiplex Plunger Pump 2S-1



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3	117578	ASSY, CAST FLUID END, DUCTILE IRON	FIRST	8-27-04
4	117579	ASSY, BILLET FLUID END, STEEL & STAINLESS STEEL	FIRST	8-27-04
5	117580	ASSY, BILLET FLUID END, STEEL	FIRST	8-27-04
6	117581	ASSEMBLY, POWER END	FIRST	8-27-04
7	117582	ASSEMBLY, CRANKSHAFT POWER END	FIRST	8-27-04
8	117593	ASSEMBLY, DISC VALVE	FIRST	8-27-04
9	117594	ASSEMBLY, SPHERICAL VALVE	FIRST	8-27-04
10	117606	ASSEMBLY, VALVE	FIRST	8-27-04
11	117675	ASSEMBLY, SEVERE DUTY	FIRST	8-27-04
12	117568	TOOL KIT	FIRST	8-27-04
13	117607 P.1	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
14	117607 P.2	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
15	117607 P.3	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
16	117607 P.4	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
17	117607 P.5	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
18	117607 P.6	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" J-STYLE PACKING	FIRST	8-27-04
19	117608 P.1	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
20	117608 P.2	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
21	117608 P.3	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
22	117608 P.4	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
23	117608 P.5	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
24	117608 P.6	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" BRAID STYLE PACKING	FIRST	8-27-04
25	117609 P.1	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04
26	117609 P.2	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04



NATIONAL OILWELL

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PAGE	DWG. NUMBER	DESCRIPTION	SERIES OF ISSUE	DATE OF ISSUE
27	117609 P.3	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04
28	117609 P.4	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04
29	117609 P.5	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04
30	117609 P.6	ASSY, PLUNGER KIT 1-1/8 - 1-3/4" 1068-4 STYLE PACKING	FIRST	8-27-04
31	117610 P.1	ASSY, PLUNGER KIT 3/4 - 1" 805-4 STYLE PACKING	FIRST	8-27-04
32	117610 P.2	ASSY, PLUNGER KIT 3/4 - 1" 805-4 STYLE PACKING	FIRST	8-27-04
33	117610 P.3	ASSY, PLUNGER KIT 3/4 - 1" 805-4 STYLE PACKING	FIRST	8-27-04
34	117611	PLUNGERS, 1-1/8" THRU 1-3/4" HARD SURFACE	FIRST	8-27-04
35	117612	PLUNGERS, 1-1/8" THRU 1-3/4" CERAMIC	FIRST	8-27-04
36	117617	PLUNGERS, 3/4" TO 1" HARD SURFACE	FIRST	8-27-04
37	117591	ASSEMBLY, PACKING LUBRICATOR	FIRST	8-27-04
38	117603	ASSEMBLY, D.O.H. LUBRICATOR	FIRST	8-27-04
39	117589	GENERAL DIMENSION, RHD, CAST FLUID END	FIRST	8-27-04
40	117590	GENERAL DIMENSION, RHD, BILLET FLUID END	FIRST	8-27-04
41	117592	GENERAL DIMENSION, RHD, BILLET FLUID END	FIRST	8-27-04



117675  
117594  
117593

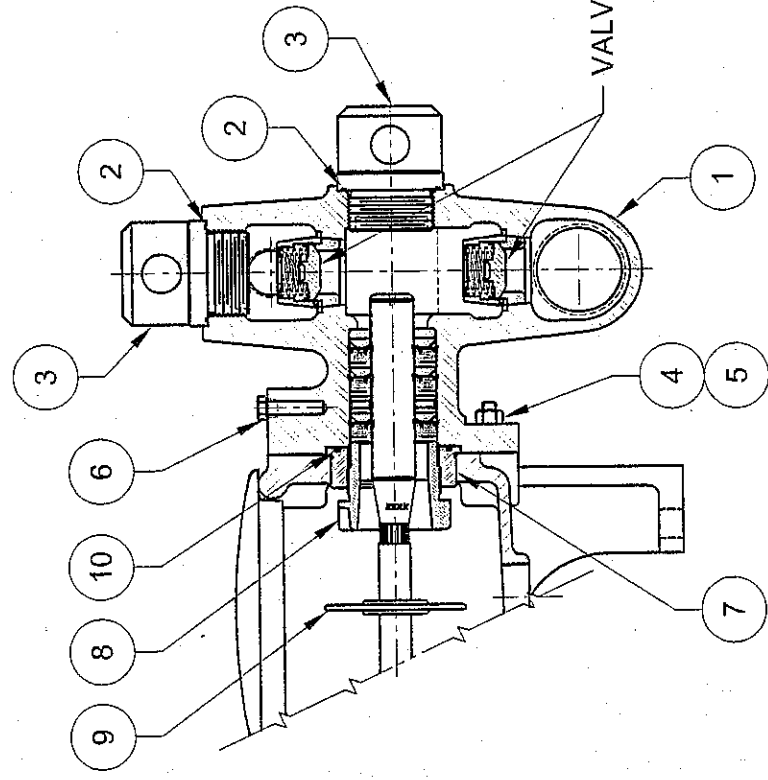
SEVERE DUTY VALVE  
SPHERICAL VALVE  
DISC VALVE  
VALVE ASSEMBLY:

DRAWING No:

1	110-000232-200	O-RING	10
1	001-008910-201	BAFFLE DISC	9
1	AAC-013800-E16	GLAND NUT 1-3/4"	
1	ABC-013800-E16	GLAND NUT 1-5/8"	
1	ACC-013800-E16	GLAND NUT 1-1/2"	
1	ADC-013800-E16	GLAND NUT 1-3/8"	
1	AEC-013800-E16	GLAND NUT 1-1/4"	
1	AFC-013800-E16	GLAND NUT 1-1/8"	8
1	001-003948-278	POWER END / FLUID END ADAPTER	7
1	170-018002-278	PIPE PLUG	6
4	133-058011-286	NUT	5
4	102-058214-286	STUD	4
2	AAC-117697-E16	CYLINDER HEAD / VALVE COVER	3
2	110-000036-200	SEAL	2
1	008-028742-261	FLUID END, STAINLESS STEEL CAST	1

REQ'D	Part No.	DESCRIPTION	ITEM
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BILL OF MATERIAL



VALVE ASSEMBLY



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, CAST FLUID END  
STAINLESS STEEL  
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117576	SCALE: NONE	REV: A	SHT.: 1
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SEVERE DUTY VALVE  
 SPHERICAL VALVE  
 DISC VALVE  
 VALVE ASSEMBLY:

1176.  
 117594  
 117593  
 DRAWING No:

1	110-000232-200	O-RING	10
1	001-008910-201	BAFFLE DISC	9
1	001-008909-304	GLAND NUT 1-3/4"	
1	001-011231-304	GLAND NUT 1-5/8"	
1	001-011230-304	GLAND NUT 1-1/2"	
1	001-011229-304	GLAND NUT 1-3/8"	
1	001-011228-304	GLAND NUT 1-1/4"	
1	001-011227-304	GLAND NUT 1-1/8"	8
1	001-003948-313	POWER END / FLUID END ADAPTER	7
1	180-165000-220	LUBRICATION FITTING	6
4	133-058011-286	NUT	5
4	102-058214-286	STUD	4
2	002-028954-316	CYLINDER HEAD / VALVE COVER	3
2	110-000036-201	SEAL	2
1	004-010190-316	FLUID END, BRONZE CAST	1

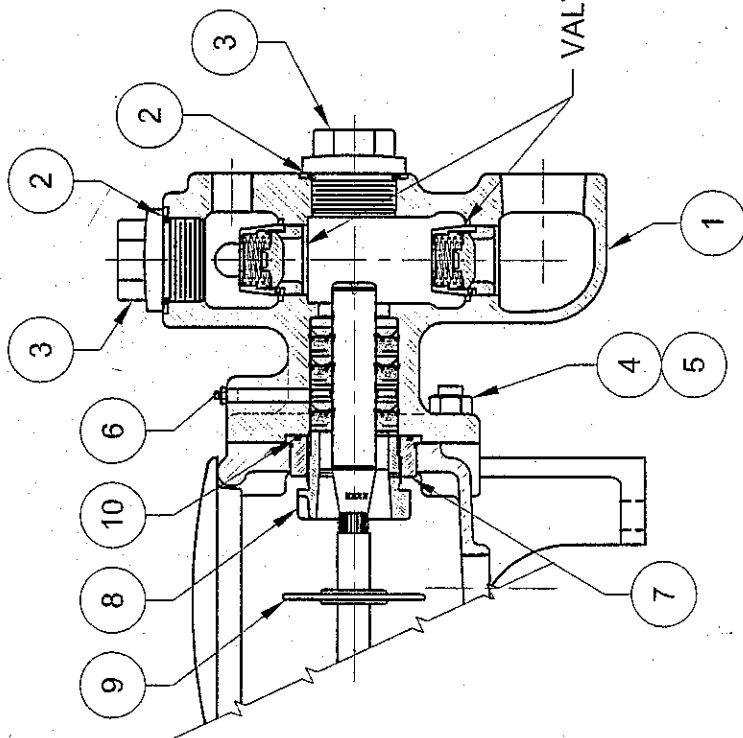
ITEM

DESCRIPTION

Part No.

REQ'D

BILL OF MATERIAL



VALVE ASSEMBLY



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, CAST FLUID END  
 BRONZE  
 2S-1M / 5S-2M ( P50A, P50B )

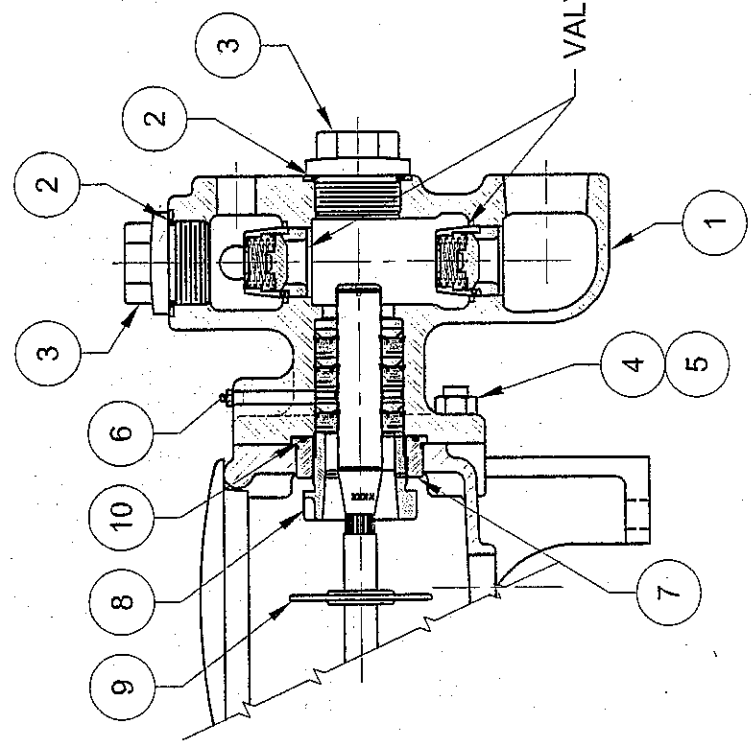
DWG No.: 117577 SCALE: NONE REV: A SHT: 1 OF 1

117675 SEVERE DUTY VALVE  
 117594 SPHERICAL VALVE  
 117593 DISC VALVE  
 DRAWING No: VALVE ASSEMBLY:

REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	10
1	001-008910-201	BAFFLE DISC	9
1	001-008909-304	GLAND NUT 1-3/4"	
1	001-011231-304	GLAND NUT 1-5/8"	
1	001-011230-304	GLAND NUT 1-1/2"	
1	001-011229-304	GLAND NUT 1-3/8"	
1	001-011228-304	GLAND NUT 1-1/4"	
1	001-011227-304	GLAND NUT 1-1/8"	8
1	001-003948-236	POWER END / FLUID END ADAPTER	7
1	180-165000-220	LUBRICATION FITTING	6
4	133-058011-286	NUT	5
4	102-058214-286	STUD	4
2	002-028954-351	CYLINDER HEAD / VALVE COVER	3
2	110-000036-201	SEAL	2
1	004-010190-351	FLUID END, DUCTILE IRON CAST	1

REQ'D Part No. DESCRIPTION ITEM

BILL OF MATERIAL



VALVE ASSEMBLY

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, CAST FLUID END  
 DUCTILE IRON  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117578 SCALE: NONE REV: A SHIT: 1

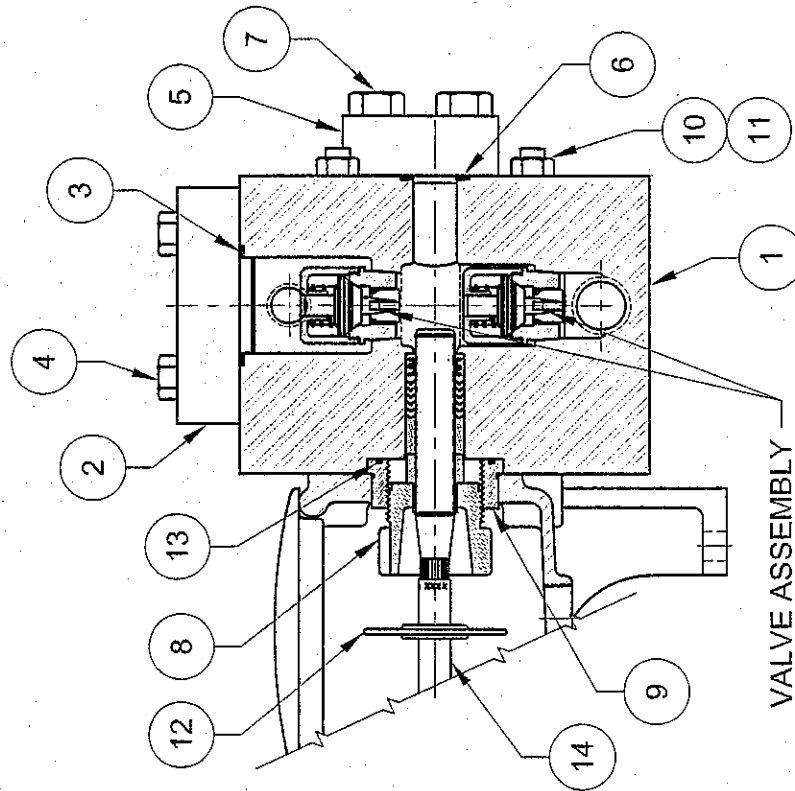
306

POLYURETHANE SEAL VALVE

VALVE ASSEMBLY:

REQ'D	Part No.	DESCRIPTION	ITEM
1	001-014266-402	PONY ROD	14
1	110-000232-200	O-RING	13
1	001-008910-201	BAFFLE DISC	12
4	133-058011-243	NUT	11
4	102-058934-286	STUD	10
1	001-019879-310	POWER END / FLUID END ADAPTER	9
	001-014278-351	GLAND NUT (DI)	
1	001-014278-304	GLAND NUT (BRZ)	8
3	100-100234-290	CAP SCREW	7
1	001-010354-200	GASKET (CYLINDER HEAD)	6
	001-010351-278	CYLINDER HEAD (SS)	
1	001-010351-231	CYLINDER HEAD (STL)	5
4	100-118300-290	CAP SCREW	4
1	001-010355-200	GASKET (VALVECOVER)	3
	AAC-010350-278	VALVE COVER (SS)	
1	001-010350-231	VALVE COVER (STL)	2
	004-019777-276	FLUID END (SS)	
1	004-019777-250	FLUID END (STL)	1

BILL OF MATERIAL



VALVE ASSEMBLY

**NATIONAL OILWELL**  
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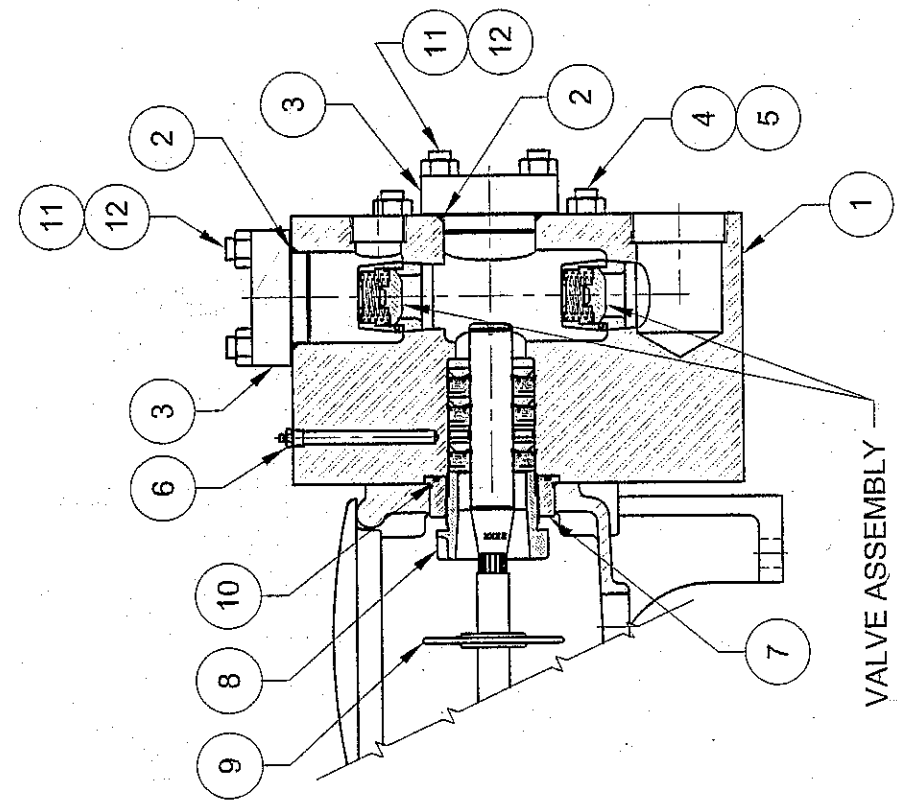
TITLE: ASSEMBLY, BILLET FLUID END  
 STEEL & ST. STEEL, 3/4", 7/8", 1" PLGR.  
 2S-1H / 5S-2H ( P50H )

DWG No.: 117579      SCALE: NONE      REV: A      SHEET: 1 OF 1

117675 SEVERE DUTY VALVE  
 117594 SPHERICAL VALVE  
 117593 DISC VALVE  
 DRAWING No: VALVE ASSEMBLY:

8	133-058011-286	NUT	12
8	102-058212-286	STUD	11
1	110-000232-200	O-RING	10
1	001-008910-201	BAFFLE DISC	9
1	001-008909-304	GLAND NUT 1-3/4"	
1	001-011231-304	GLAND NUT 1-5/8"	
1	001-011230-304	GLAND NUT 1-1/2"	
1	001-011229-304	GLAND NUT 1-3/8"	
1	001-011228-304	GLAND NUT 1-1/4"	
1	001-011227-304	GLAND NUT 1-1/8"	
1	001-003948-236	POWER END / FLUID END ADAPTER	8
1	180-165000-220	LUBRICATION FITTING	7
4	133-058011-286	NUT	6
4	102-058812-286	STUD	5
2	AAB-030923-231	CYLINDER HEAD / VALVE COVER	4
2	110-000229-201	SEAL	3
1	AAC-030924-C06	FLUID END	2

REQ'D	Part No.	DESCRIPTION	ITEM
		BILL OF MATERIAL	



VALVE ASSEMBLY

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

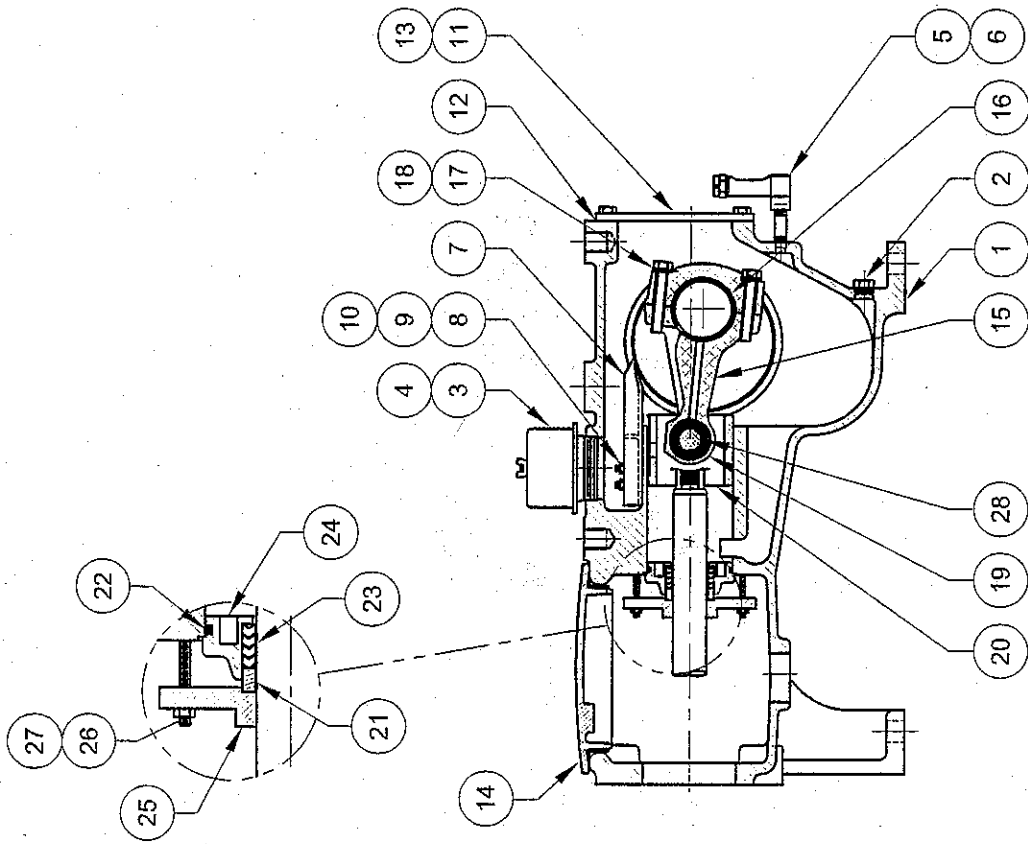
TITLE: ASSEMBLY, BILLET FLUID END  
 STEEL  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117580 SCALE: NONE REV: A SHEET: 1

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REQ'D	Part No.	DESCRIPTION	ITEM
1	001-008920-236	WRIST PIN	1
2	150-038016-306	NUT	2
2	102-038214-286	STUD	2
1	001-008906-283	GLAND	1
1	001-008916-302	FOLLOWER	1
1	001-011616-381	PACKING	1
1	110-000232-201	O-RING	1
1	002-008907-283	WIPER BOX	1
1	002-008905-350	CROSSHEAD	1
1	001-008921-302	BUSHING, WRIST PIN	1
2	100-038214-290	CAP SCREW	2
2	154-038068-220	LOCK WASHER	2
1	001-001699-999	SHELL BEARING	1
1	004-026366-350	CONN. ROD & CAP	1
1	004-003656-350	BARREL COVER	1
4	100-038012-290	CAP SCREW	4
1	001-003672-204	GASKET	1
1	001-003676-231	CRANKCASE COVER	1
2	152-014050-220	LOCK WASHER	2
2	155-014034-220	WASHER, FLAT	2
2	113-014038-220	MACHINE SCREW	2
1	004-006068-280	OIL TROUGH	1
1	157-018112-220	PIPE NIPPLE	1
1	001-011409-999	OIL GAUGE	1
1	AAA-030436-999	AIR BREATHER	1
1	161-200034-353	BUSHING	1
1	170-038005-353	DRAIN PLUG	1
1	004-022335-350	POWER FRAME	1

BILL OF MATERIAL



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
**ASSEMBLY, POWER END**  
**2S-1 / 5S-1 ( P50A, P50B )**

DWG No: 117581      SCALE: NONE      REV A      SHEET 1 OF 1

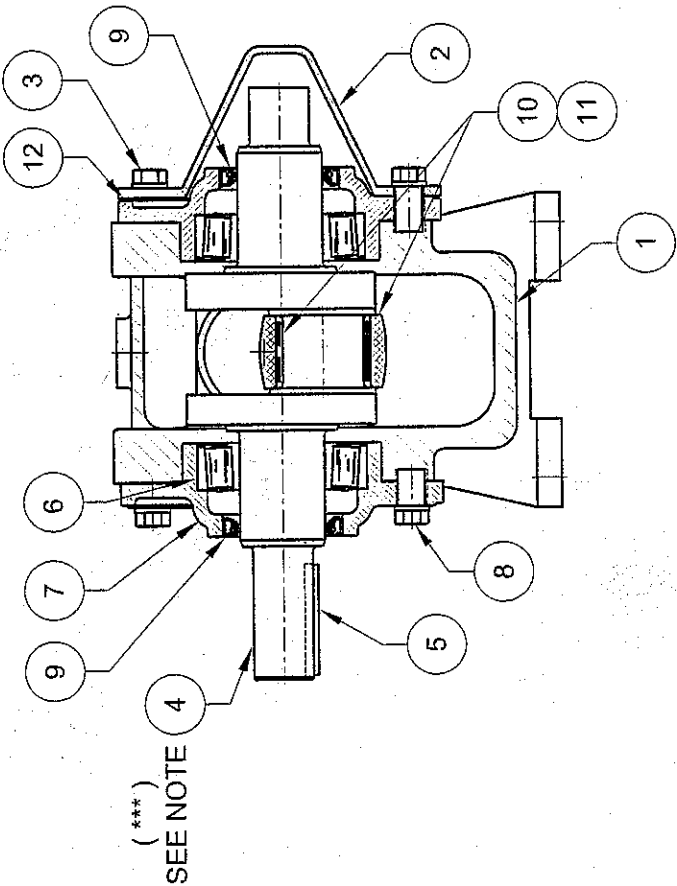
( SEE DWG. No: 117582 FOR OPTIONAL KITS & PARTS )



REQ'D	Part No.	DESCRIPTION	OPTION
1	998-016200-012	(INCLUDES WRIST PIN BUSHING) CONNECTING ROD KIT ( * )	CC
1	998-016200-013	WIPER BOX GLAND NUT KIT ( * )	BB
1	998-001650-012	POWER END GASKET KIT ( * )	AA
REQ'D	Part No.	DESCRIPTION	OPTION
1	998-016200-014	SHIM/GASKET KIT	12
1	001-01699-999	SHELL BEARING	11
1	004-026866-350	CONN. ROD & CAP	10
2	145-218300-999	OIL SEAL	9
8	100-058114-290	CAP SCREW	8
2	004-000065-571	BEARING HOUSING	7
2	120-218042-999	END BEARING	6
1	146-038200-236	KEY	5
1	004-012554-351	CRANKSHAFT, 2S-1 ( *** )	4
1	008-003677-351	CRANKSHAFT, 5S-2 ( *** )	3
2	100-058112-290	CAP SCREW ( ** )	2
1	001-001982-350	EXTENSION GUARD ( ** )	1
1	004-022535-350	POWER FRAME	
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL

\* NOT SHOWN ON PARTS DRAWING.  
 \*\* OMIT WHEN LUBRICATOR IS USED.  
 \*\*\* NOTE DIFFERENT PART NUMBERS FOR 2S-1 AND 5S-1 CRANKSHAFT.

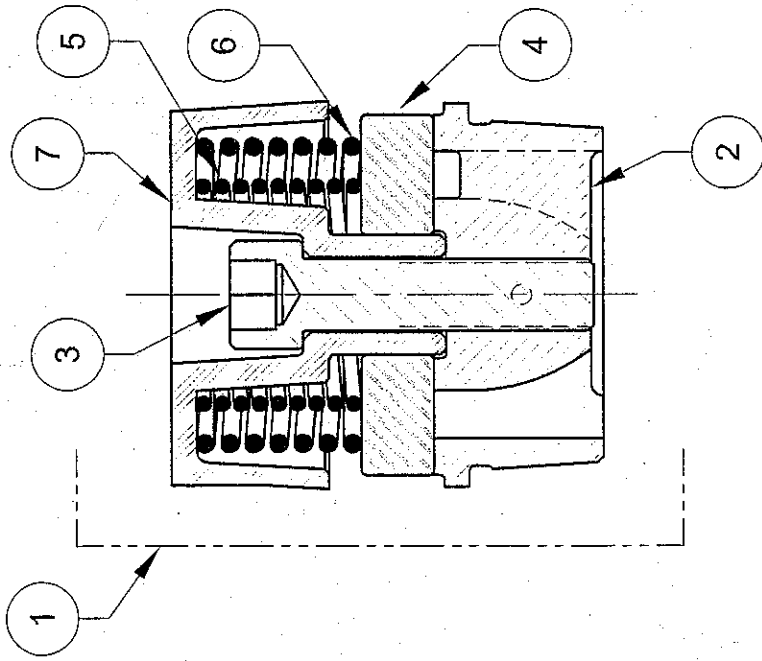


( \*\*\* )  
SEE NOTE

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE: ASSEMBLY, CRANKSHAFT  
 POWER END  
 2S-1 / 5S-2 ( P50A, P50B )

DWG No.: 117582      SCALE: NONE      REV: A      SHEET: 1



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REQ'D	Part No.	DESCRIPTION	ITEM
1	SR015	RETAINER	6
1	IS011	SPRING, OUTER	5
1	IS022	SPRING, INNER	4
1	TP03	DISC - TITANIUM	3
1	38178M	FASTENER	2
1	0010304	SEAT	1
1	001TP0304	ASSEMBLY, TITANIUM ) ASSEMBLY, T/CF8M DISC VALVE	1
REQ'D	Part No.	DESCRIPTION	ITEM
1	SR015	RETAINER	7
1	IS011	SPRING, OUTER	6
1	IS022	SPRING, INNER	5
1	DP03	DISC - DELRIN	4
1	38178M	FASTENER	3
1	0010304	SEAT	2
1	001DP0304	ASSEMBLY, DELRIN ) ASSEMBLY, DEL/CF8M DISC VALVE	1
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, DISC VALVE  
2S-1L & M / 5S-2L & M ( P50A, P50B )

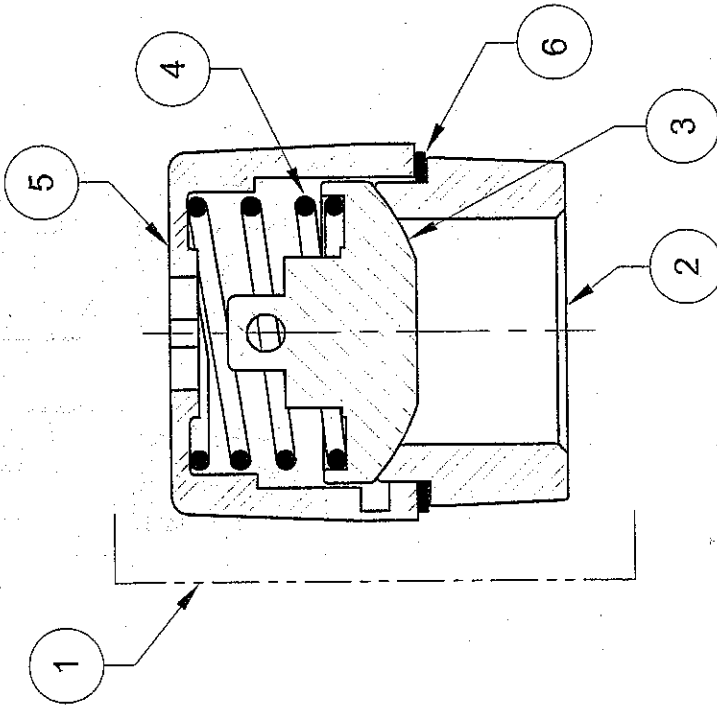
DWG No.: 117593

SCALE: NONE

REV: A

SHT.: 1

OF 1



9

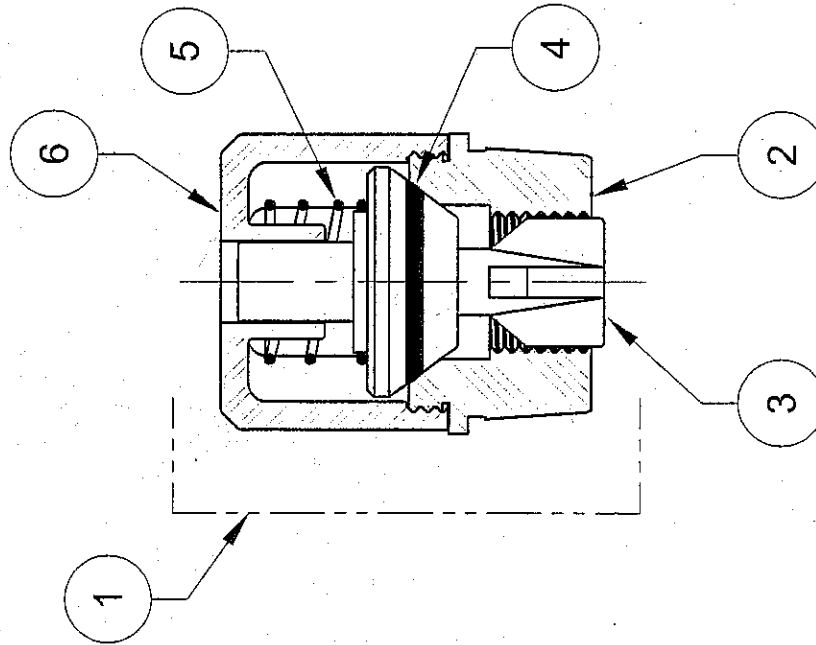
REQ'D	Part No.	DESCRIPTION	ITEM
1	9707074	WAVE RING	6
1	17915036W	RETAINER	5
1	1791504	SPRING	4
1	179150225	BODY (VALVE)	3
1	179150125	SEAT	2
1	179150025W	ASSEMBLY, SPHERICAL VALVE	1

BILL OF MATERIAL

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE: ASSEMBLY, SPHERICAL VALVE  
 2S-1L & M / 5S-2L & M ( P-50A, P50B )

DWG No.: 117594      SCALE: NONE      REV: A      SH1: 1



10

1	001-021273-402	RETAINER	5
1	001-006389-362	SPRING	4
1	110-000214-503	O-RING	3
1	002-021274-402	BODY	2
1	001-011747-402	SEAT	1
1	998-016313-028	ASSEMBLY, VALVE	

(DISCHARGE)

REQ'D	Part No.	DESCRIPTION	ITEM
1	001-021273-402	RETAINER	6
1	001-006389-362	SPRING	5
1	110-000214-503	O-RING	4
1	002-021274-402	BODY	3
1	001-011744-402	SEAT	2
1	998-016313-027	ASSEMBLY, VALVE	1

(SUCTION)

REQ'D	Part No.	DESCRIPTION	ITEM
BILL OF MATERIAL			



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A.

ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, VALVE  
( POLYURETHANE SEAL )  
2S-1H / 5S-2H ( P50H )

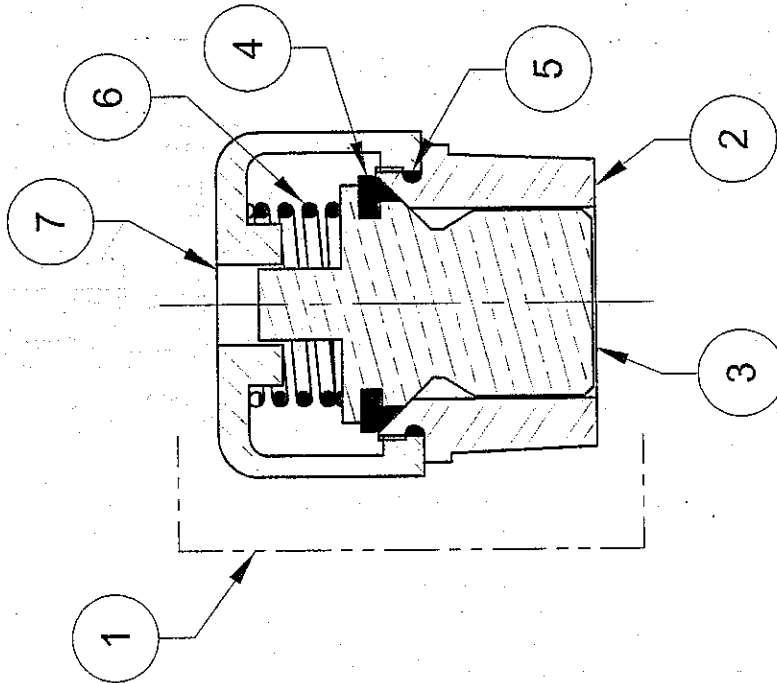
DWG No.: 117606

SCALE: NONE

REV A

SHT:

1 of 1



11

REQ'D	Part No.	DESCRIPTION	ITEM
1	SDR03	RETAINER	7
1	SDS031	SPRING	6
1	SDL03	THREAD LOCK	5
1	SDI03	INSERT	4
1	SD03	VALVE L/INSERT	3
1	1000304	SEAT	2
1	100SD0304	ASSEMBLY, SEVERE DUTY	1

**BILL OF MATERIAL**

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
**ASSEMBLY, SEVERE DUTY  
 2S-1L & M / 5S-2L & M ( P50A, P50B )**

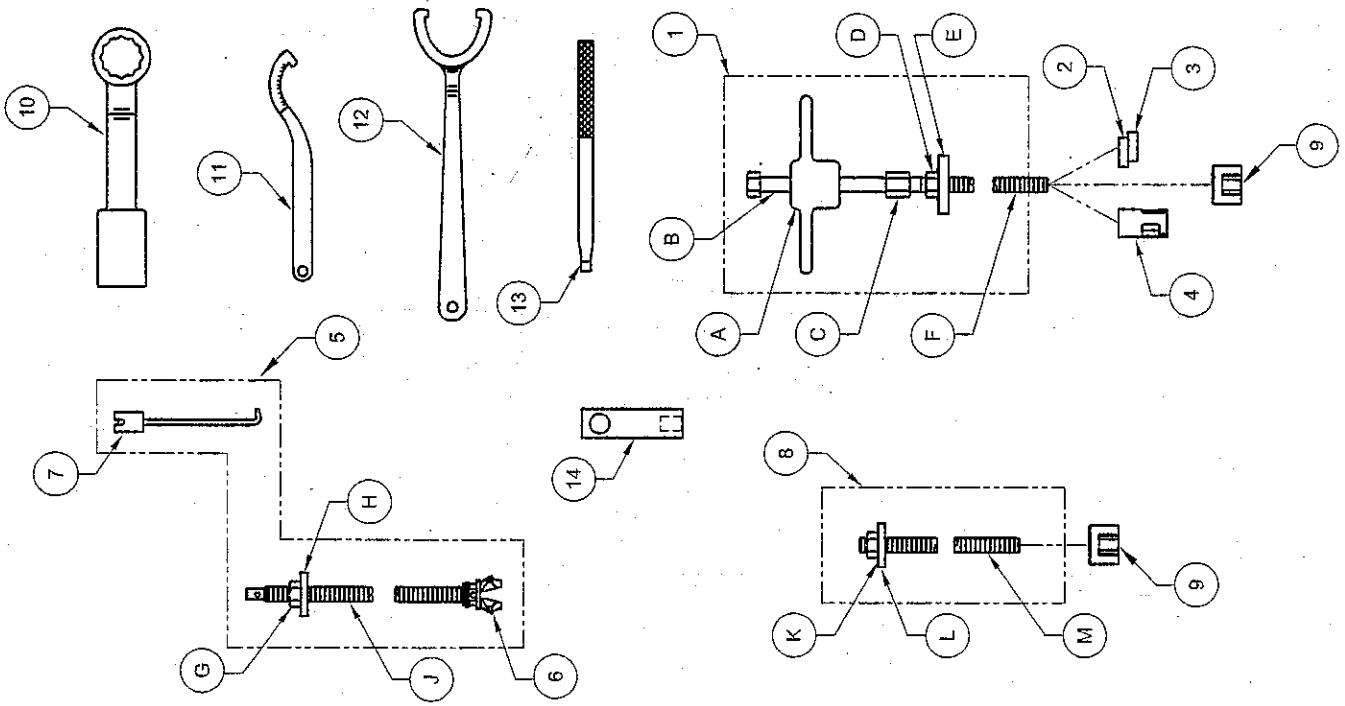
DWG No: 117675 SCALE: NONE REV A SHT: 1

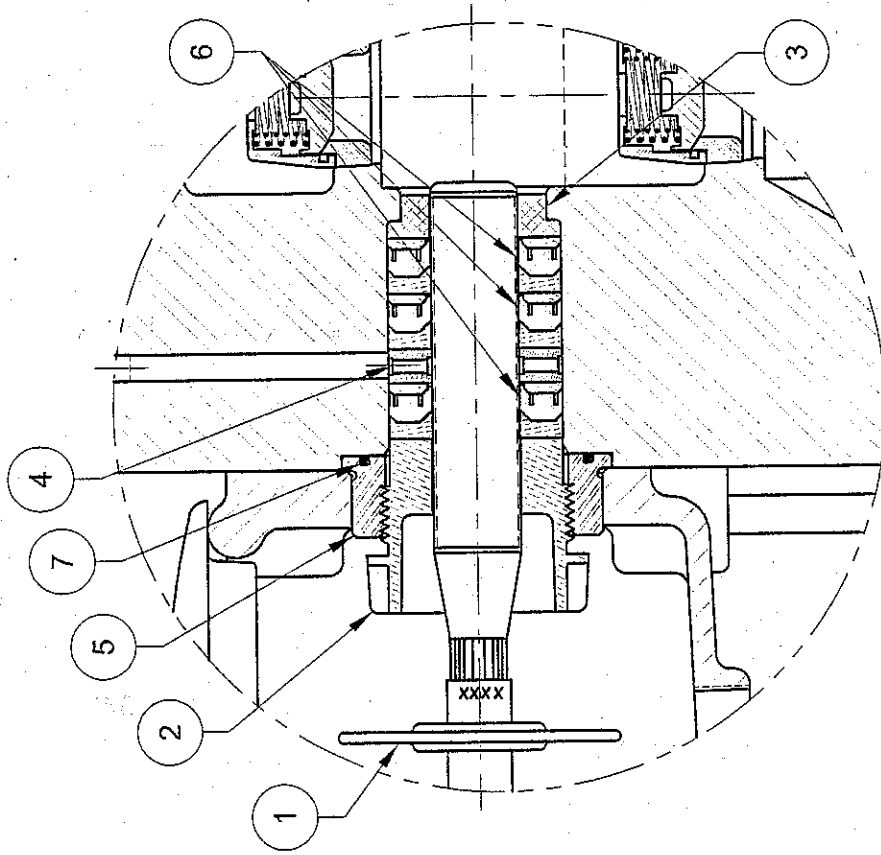
REQ'D	Part No.	DESCRIPTION	ITEM
1	002-01441	PLUNGER WRENCH - (2S-1H/5S-2H/P50H)	13
1	AAB-030420-274	WRENCH, GLAND NUT (STAINLESS STEEL)	12
1	002-009388-351	WRENCH, GLAND NUT (DUCTILE IRON NUT)	11
1	002-014098-352	WRENCH, GLAND NUT (BRONZE NUT)	10
1	001-027568-989	WRENCH, VALVE COVER (HAMMER WRENCH)	9
1	002-021268-400	CAGE WRENCH - (F/2S-1H/5S-2H/P50H)	9
1	008-028546-043	CAGE WRENCH - (F/SEVERDUTY)	OPTIONAL
1	001-022028-271	PULLER STEM	M
1	001-022029-231	STRONG BACK	L
1	133-100008-243	HOLD DOWN NUT	K
1	002-010359-220	ASSEMBLY, VALVE SEAT PULLER - (2S-1H/5S-2H/P-50 H)	8
1	1790034	RETRIEVER	7
1	181259200	PULLER HEAD	6
1	20-220-329	PULLER STEM	J
1	20-220-330	STRONG BACK	H
1	75510308	HOLD DOWN NUT	G
1	181259201	ASSEMBLY, VALVE SEAT PULLER - (SPHERICAL)	5
1	001-011954-274	PULLER HEAD	4
1	008-028546-004	PULLER STEM	F
1	008-028546-034	STRONG BACK	E
1	008-028546-012	HOLD DOWN NUT	D
1	008-028546-015	ADAPTER NUT	C
1	008-028546-002	BUMPER STEM	B
1	008-028546-001	BUMPER	A
1	998-016202-092	ASSEMBLY, VALVE SEAT PULLER - (DISC VALVE)	1
1	008-028546-028	PULLER GUIDE	3
1	008-028546-018	ECCENTRIC, PULLER	2
1	008-028546-003	PULLER STEM	F
1	008-028546-034	STRONG BACK	E
1	008-028546-011	HOLD DOWN NUT	D
1	008-028546-014	ADAPTER NUT	C
1	008-028546-002	BUMPER STEM	B
1	008-028546-001	BUMPER	A
1	998-016202-091	ASSEMBLY, VALVE SEAT PULLER - (SEVERDUTY)	1

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE: TOOL KIT  
 2S-1/5S-2  
 (P50A, P50B, P50H)

DWG No.: 117568 SCALE: NONE REV: A SH: 1 of 1





13

REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	7
	182-118214-477		858
	182-118214-374		845
1	182-118214-370	PACKING	6
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	5
	001-011211-278		(BRZ)
	001-011211-235		(SS)
1	001-011211-302	LANTERN RING	4
	001-010961-278		(STL)
	001-010961-235		(BRZ)
1	001-010961-302	THROAT BUSHING	3
	AFC-013800-E16		(ST)
	001-011227-351		(DI)
1	001-011227-304	GLAND NUT	2
	001-008910-201	BAFFLE DISC	(BRZ)
1		(1-1/8" PLUNGER)	1

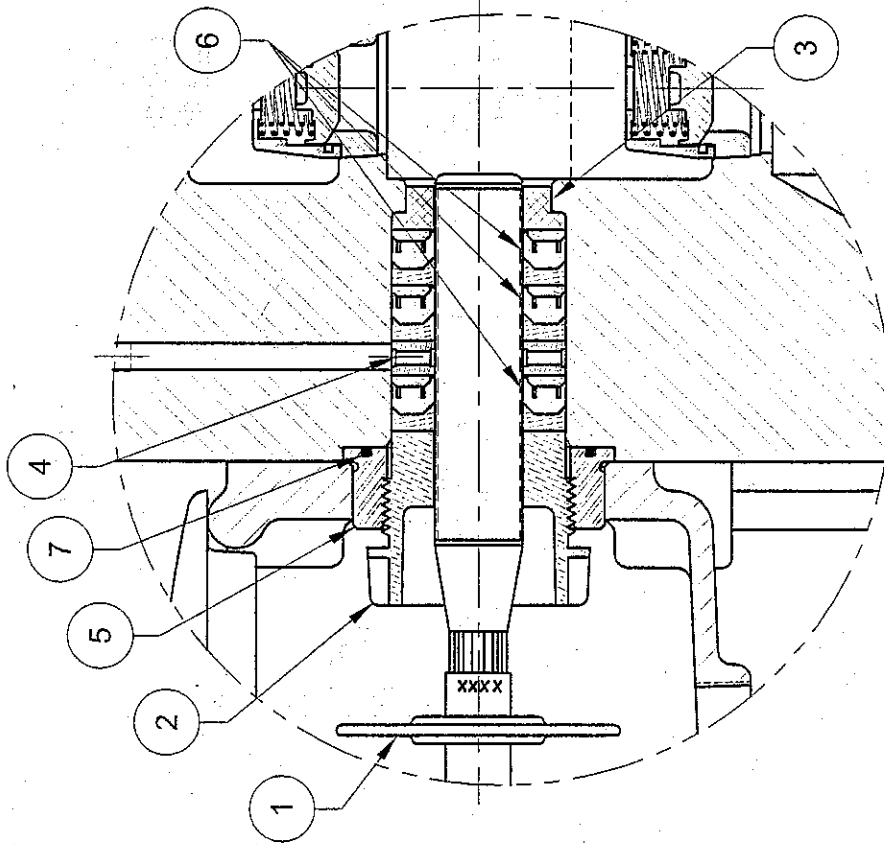
BILL OF MATERIAL

NOTE  
 1) FOR ALL " J " STYLE PACKING SEE DRAWING 117607,  
 SHEETS 1 THRU 6.

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 J-STYLE PKG, 1-1/8" THRU 1-3/4" PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117607 SCALE: NONE REV A SHT: 1 6



14

REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	
	182-114214-477		858
	182-114214-374		845
1	182-114214-370	PACKING	838
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	(BRZ)
	001-011212-278		(SS)
	001-011212-235		(STL)
1	001-011212-302	LANTERN RING	(BRZ)
	001-010950-278		(SS)
	001-010950-235		(STL)
1	001-010950-302	THROAT BUSHING	(BRZ)
	AEC-013800-E16		(SS)
	001-011228-351		(DI)
1	001-011228-304	GLAND NUT	(BRZ)
1	001-008910-201	BAFFLE DISC	
(1-1/4" PLUNGER)			

BILL OF MATERIAL

NOTE

1) FOR ALL "J" STYLE PACKING SEE DRAWING 117607, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

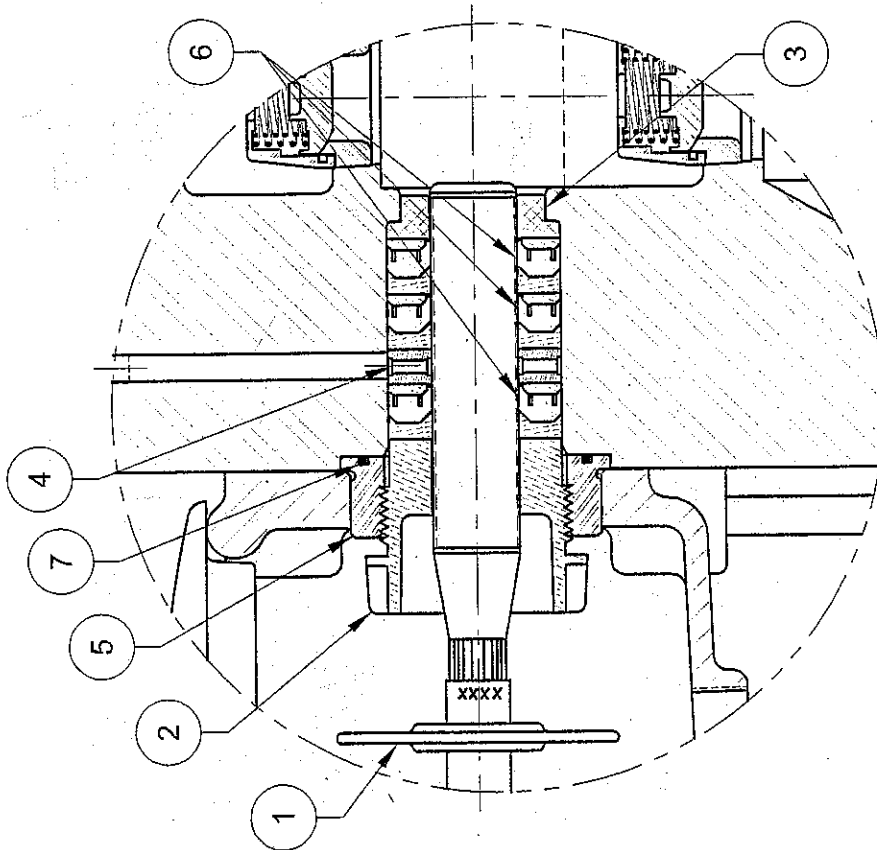
HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, PLUNGER KIT  
 J-STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B)

DWG No.: 117607	SCALE: NONE	REV: A	SHT.: 2 OF 6
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15

REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	7
	182-138214-477		858
	182-138214-374		845
1	182-138214-370	PACKING	6
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	5
	001-011221-278		(SS)
	001-011221-235		(STL)
1	001-011221-302	LANTERN RING	4
	001-008913-278		(BRZ)
	001-008913-235		(SS)
	001-008913-302		(STL)
1	001-008913-302	THROAT BUSHING	3
	ADC-013800-E16		(SS)
	001-011229-351		(DI)
1	001-011229-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1
(1-3/8" PLUNGER)			

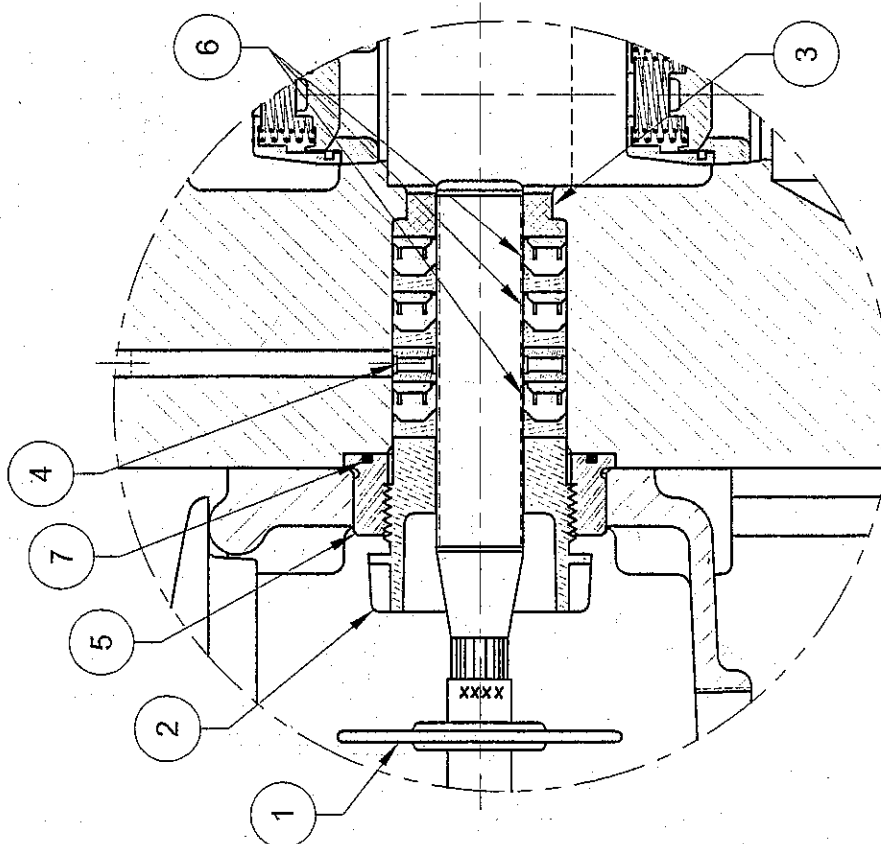
BILL OF MATERIAL

NOTE  
 1) FOR ALL " J " STYLE PACKING SEE DRAWING 117607,  
 SHEETS 1 THRU 6.

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 J-STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No: 117607      SCALE: NONE      REV: A      SIT.: 3      6



16


REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	858
	182-112214-477		845
	182-112214-374		838
1	182-112214-370	PACKING	(SS)
	001-003948-278		(STL)
	001-003948-236		(BRZ)
1	001-003948-316	ADAPTER	(SS)
	001-011218-278		(STL)
	001-011218235		(BRZ)
1	001-011218-302	LANTERN RING	(SS)
	001-010949-278		(STL)
	001-010949-235		(BRZ)
1	001-010949-302	THROAT BUSHING	(SS)
	ACC-013800-E16		(DI)
	001-011230-351		(BRZ)
1	001-011230-304	GLAND NUT	
1	001-008910-201	BAFFLE DISC	

(1-1/2" PLUNGER)

REQ'D	Part No.	DESCRIPTION	ITEM
		BILL OF MATERIAL	

NOTE

1) FOR ALL " J " STYLE PACKING SEE DRAWING 117607, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A.  
ENGINEERING, TULSA, OKLAHOMA

TITLE:

**ASSEMBLY, PLUNGER KIT**

J-STYLE PKG, 1-1/8 - 1-3/4 PLG

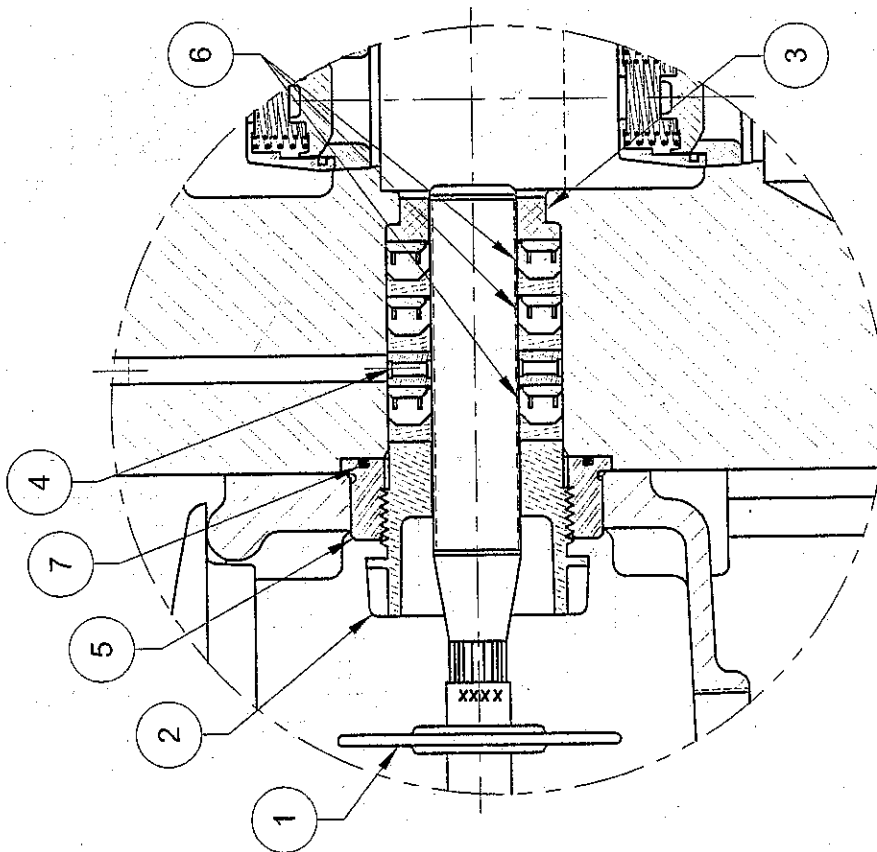
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117607

SCALE: NONE

REV: A

SHT.: 4 OF 6



17

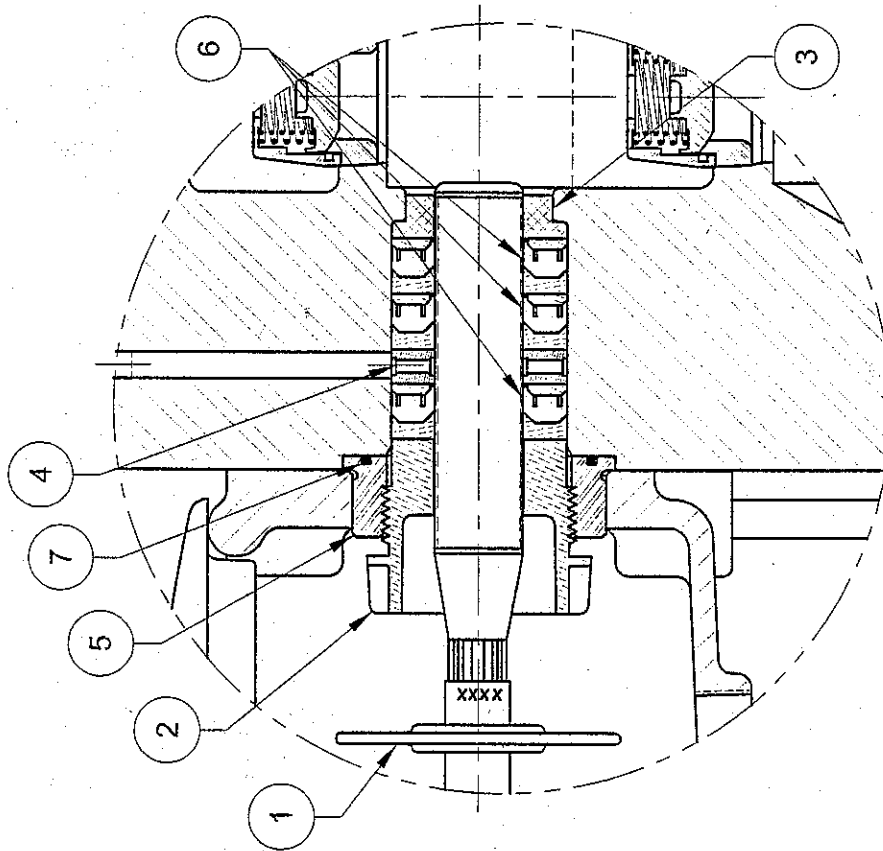
REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	7
	182-158214-477		858
	182-158214-374		845
1	182-158214-370	PACKING	6
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	5
	001-005305-278		(BRZ)
	001-005305-235		(SS)
	001-005305-235		(STL)
1	001-005305-302	LANTERN RING	4
	001-010962-278		(BRZ)
	001-010962-235		(SS)
1	001-010962-302	THROAT BUSHING	3
	ABC-013800-E16		(SS)
	001-011231-351		(DI)
1	001-011231-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1
(1-5/8" PLUNGER)			
REQ'D	Part No.	DESCRIPTION	ITEM
BILL OF MATERIAL			

NOTE  
 1) FOR ALL "J" STYLE PACKING SEE DRAWING 117607, SHEETS 1 THRU 6.

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 J-STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117607      SCALE: NONE      REV: A      SHEET: 5      6



REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	
	182-134178-477		858
	182-134178-374		845
1	182-134178-370	PACKING	838
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	(BRZ)
	001-011220-278		(SS)
	001-011220-235		(STL)
1	001-011220-302	LANTERN RING	(BRZ)
	001-010894-278		(SS)
	001-010894-235		(STL)
1	001-010894-302	THROAT BUSHING	(BRZ)
	AAC-013800-E16		(SS)
	001-008909-351		(DI)
1	001-008909-304	GLAND NUT	(BRZ)
1	001-008910-201	BAFFLE DISC	
(1-3/4" PLUNGER)			

BILL OF MATERIAL

NOTE

1) FOR ALL "J" STYLE PACKING SEE DRAWING 117607, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

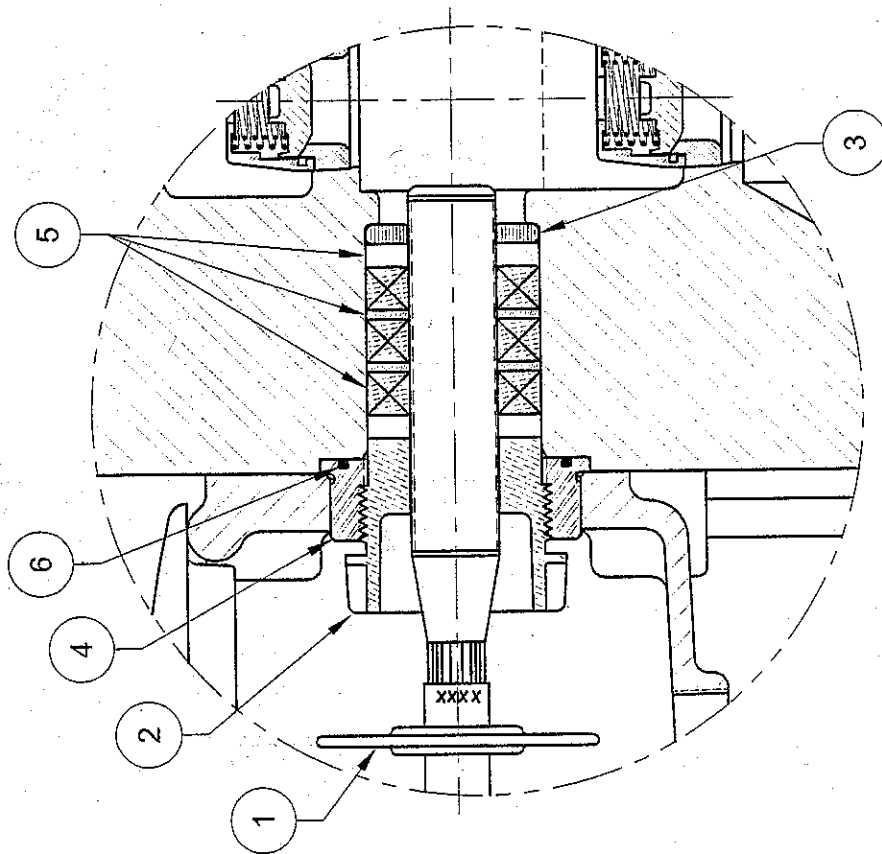
ASSEMBLY, PLUNGER KIT  
 J-STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117607

SCALE: NONE

REV A

SHT. 6 OF 6



REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
	287-118212-458		8921-k
	287-118212-339		249
	287-118212-337		241
1	287-118212-395	PACKING	5
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	4
	001-010961-278		(SS)
	001-010961-235		(STL)
1	001-010961-302	THROAT BUSHING	3
	AFC-013800-E16		(BRZ)
	001-011227-351		(SS)
			(DI)
1	001-011227-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1

REQ'D	Part No.	DESCRIPTION	ITEM
		(1-1/8" PLUNGER)	

BILL OF MATERIAL

NOTE

1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.

**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

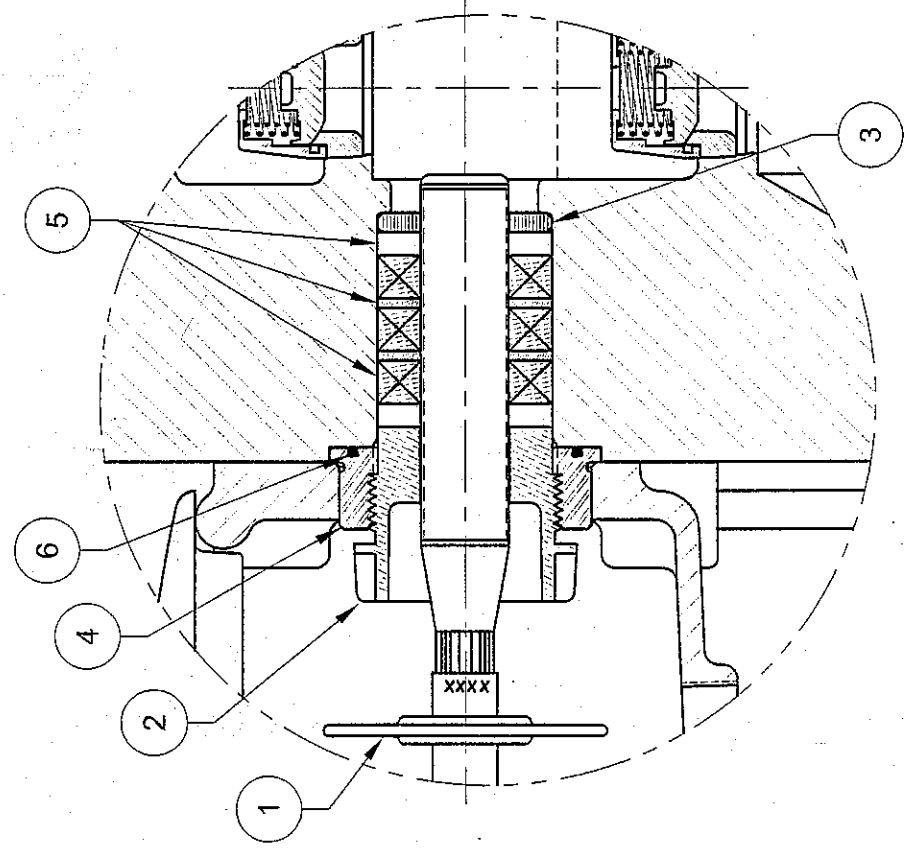
TITLE: ASSEMBLY, PLUNGER KIT  
 BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )


DWG No: 117608      SCALE: NONE      REV: A      SHT: 1      6

REQ'D	Part No.	DESCRIPTION	ITEM
	110-000232-200	O-RING	6
	287-114212-458		8921-K
	287-114212-339		249
	287-114212-337		241
1	287-114212-395	PACKING	238
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	(BRZ)
	001-010950-278		(SS)
	001-010950-235		(STL)
1	001-010950-302	THROAT BUSHING	(BRZ)
	AEC-013800-E16		(SS)
	001-011228-351		(DI)
1	001-011228-304	GLAND NUT	(BRZ)
1	001-008910-201	BAFFLE DISC	
( 1-1/4" PLUNGER )			

BILL OF MATERIAL

NOTE  
 1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.



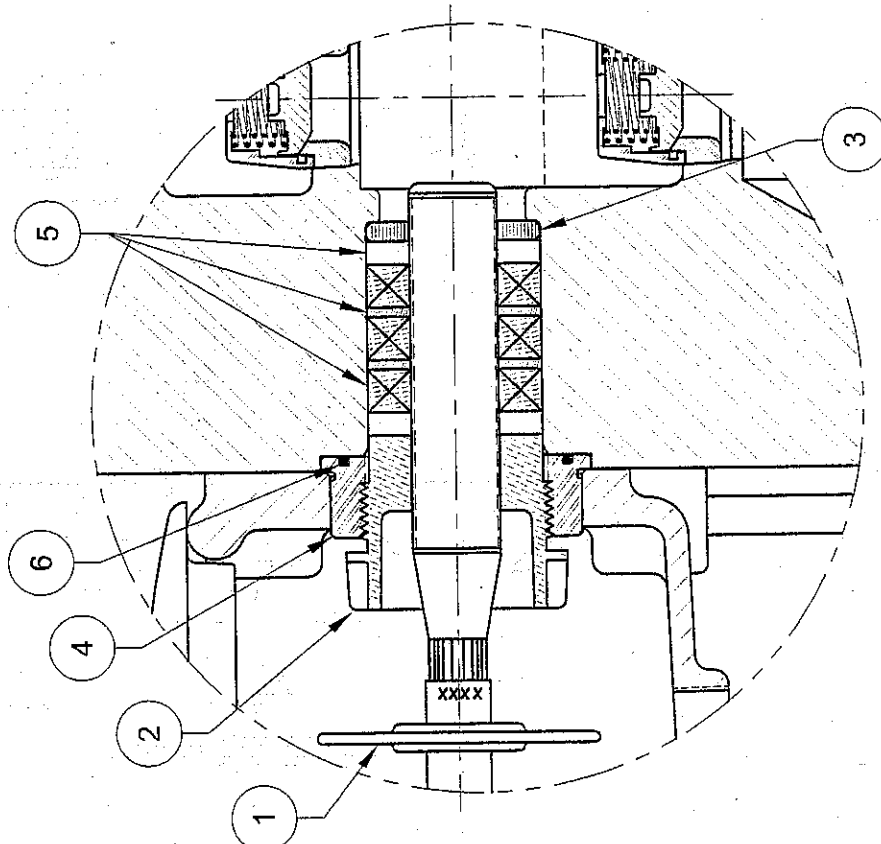


**NATIONAL OILWELL**  
 ENGINEERING, TULSA, OKLAHOMA

HOUSTON, TEXAS, U.S.A.

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117608    SCALE: NONE    REV: A    SHEET: 2 OF 6



REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
	287-138212-458		8921-K
	287-138212-339		249
	287-138212-337		241
1	287-138212-395	PACKING	5
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	4
	001-008913-278		(SS)
	001-008913-235		(STL)
1	001-008913-302	THROAT BUSHING	3
	ADC-013800-E16		(BRZ)
	001-011229-351		(SS)
1	001-011229-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1
(1-3/8" PLUNGER)			
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL

NOTE

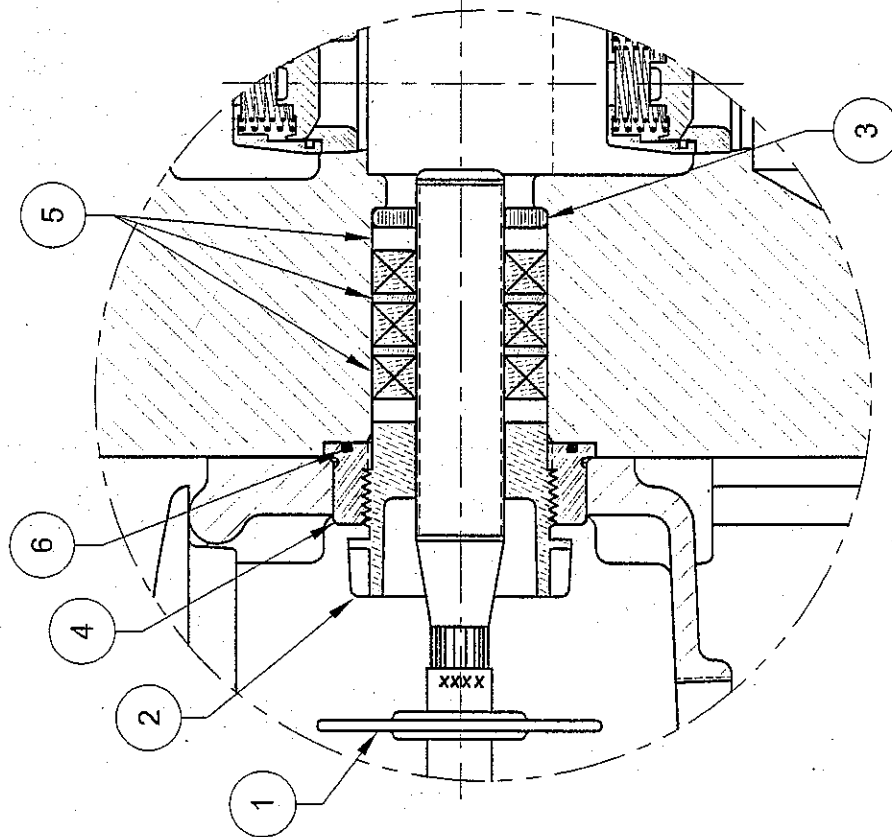
1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.

**NATIONAL OILWELL**  
ENGINEERING, TULSA, OKLAHOMA

HOUSTON, TEXAS, U.S.A.

TITLE:  
ASSEMBLY, PLUNGER KIT  
BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG  
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117608	SCALE: NONE	REV: A	SHT: 3
			6



22

REQ'D	Part No.	DESCRIPTION	ITEM
	110-000232-200	O-RING	8921-K
	287-112212-458		249
	287-112212-339		241
1	287-112212-395	PACKING	238
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	(BRZ)
	001-010949-278		(SS)
	001-010949-235		(STL)
1	001-010949-302	THROAT BUSHING	(BRZ)
	ACC-013800-E16		(SS)
	001-011230-351		(DI)
1	001-011230-304	GLAND NUT	(BRZ)
1	001-008910-201	BAFFLE DISC	
( 1-1/2" PLUNGER )			

BILL OF MATERIAL

NOTE

1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, PLUNGER KIT  
 BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117608

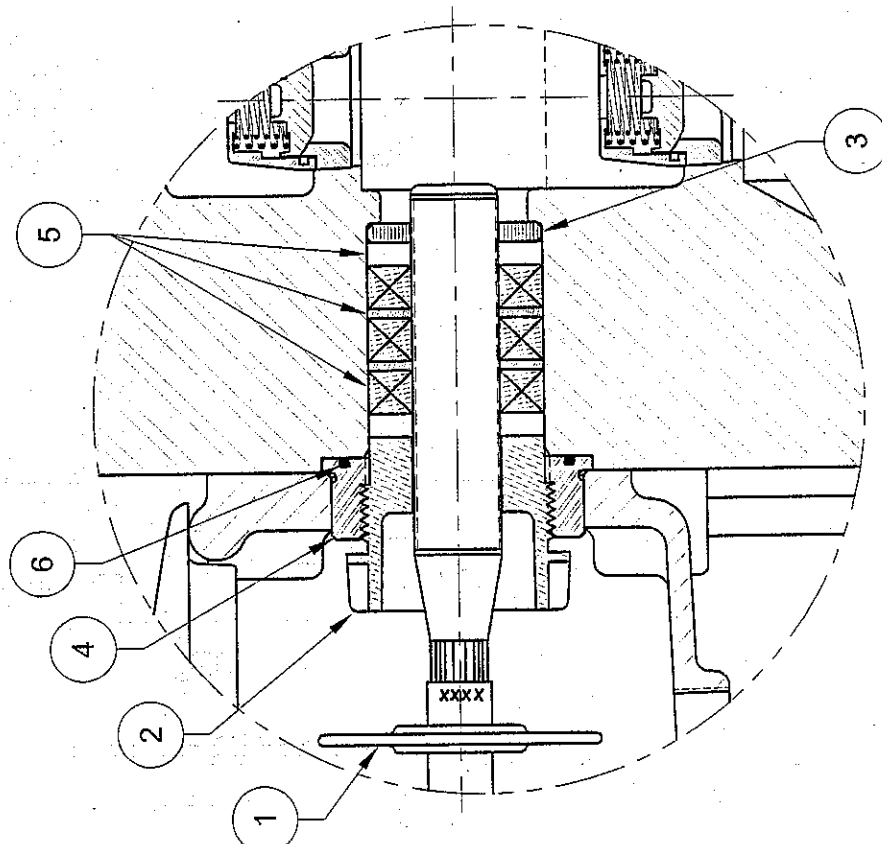
SCALE: NONE

REV A

SHT: 4

OF 6





REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
	287-158212-458		8921-K
	287-158212-339		249
	287-158212-337		241
1	287-158212-395	PACKING	5
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	4
	001-010962-278		(SS)
	001-010962-235		(STL)
1	001-010962-302	THROAT BUSHING	3
	ABC-013800-E16		(SS)
	001-011231-351		(DI)
1	001-011231-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1
(1-5/8" PLUNGER)			
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL

NOTE

1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

ASSEMBLY, PLUNGER KIT

BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG

2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117608

SCALE: NONE

REV: A

SHT.: 5

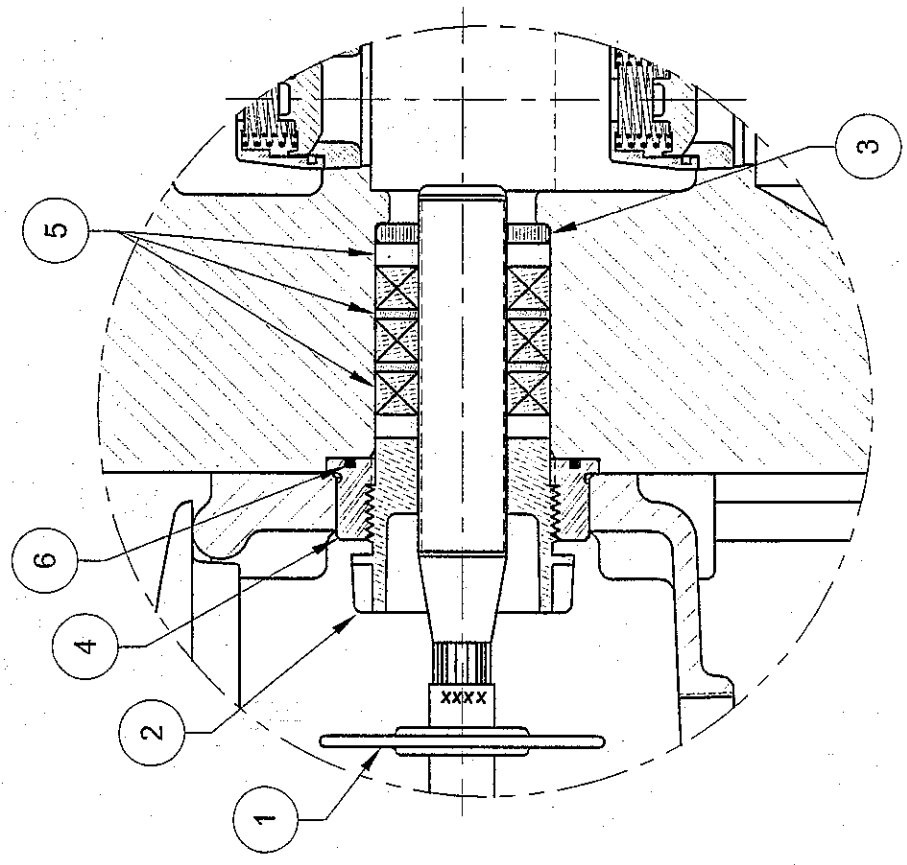
6

REQ'D	Part No.	DESCRIPTION	ITEM
	110-000232-200	O-RING	
	287-134212-458		8921-K
	287-134212-339		249
	287-134212-337		241
1	287-134212-395	PACKING	238
	001-003948-278		(SS)
	001-003948-236		(STL)
1	001-003948-316	ADAPTER	(BRZ) 4
	001-024096-278		(SS)
	001-024096-235		(STL)
1	001-024096-302	THROAT BUSHING	(BRZ) 3
	AAC-013800-E16		(SS)
	001-008909-351		(DI)
1	001-008909-304	GLAND NUT	(BRZ) 2
1	001-008910-201	BAFFLE DISC	1
	(1-3/4" PLUNGER )		
		DESCRIPTION	ITEM
		BILL OF MATERIAL	

24

NOTE

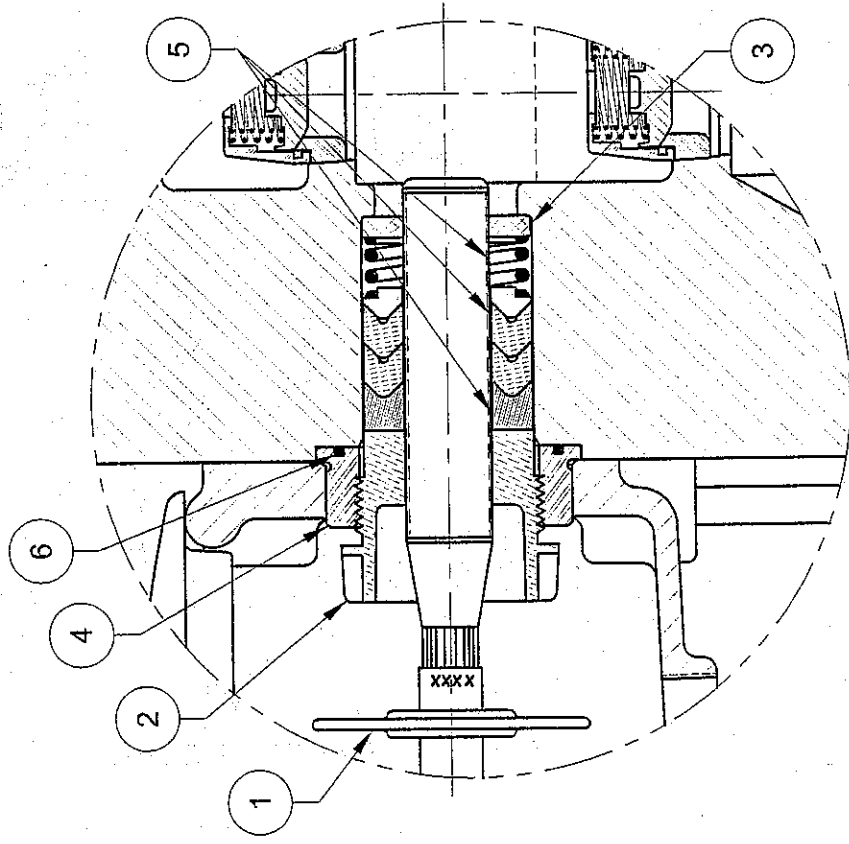
1) FOR ALL " BRAID STYLE " PACKING SEE DRAWING 117608, SHEETS 1 THRU 6.



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 BRAID STYLE PKG, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117608 SCALE: NONE REV: A SHT: 6 of 6



REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
1	432-118238-340	PACKING	5
	001-003948-278	(SS)	
	001-003948-236	(STL)	
1	001-003948-316	ADAPTER	4
	001-010961-278	(SS)	
	001-010961-235	(STL)	
1	001-010961-302	THROAT BUSHING	3
	AFC-013800-E16	(SS)	
	001-011227-351	(DI)	
1	001-011227-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1

(1-1/8" PLUNGER)

BILL OF MATERIAL

NOTE

1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.

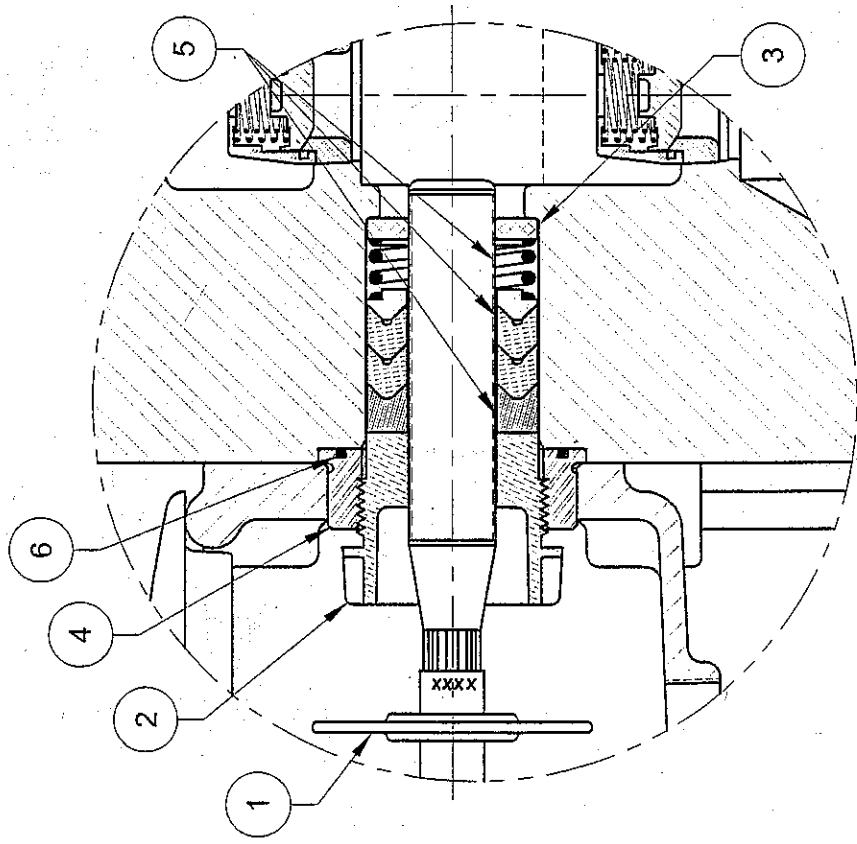
NATIONAL OILWELL ENGINEERING, TULSA, OKLAHOMA	
HOUSTON, TEXAS, U.S.A.	
TITLE: ASSEMBLY, PLUNGER KIT 1068-4 PACKING, 1-1/8 - 1-3/4 PLG 2S-1M / 5S-2M ( P50A, P50B )	
DWG No.:	117609
SCALE:	NONE
REV:	A
SHT.:	1
	6


REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	5
1	432-114238-340	PACKING	1068-4
	001-003948-278	(SS)	
	001-003948-236	(STL)	
1	001-003948-316	ADAPTER	4
	001-010950-278	(SS)	
	001-010950-235	(STL)	
1	001-010950-302	THROAT BUSHING	3
	AEC-013800-E16	(BRZ)	
	001-011228-351	(SS)	
1	001-011228-304	GLAND NUT	2
1	001-008910-201	BAFFLE DISC	1
(1-1/4" PLUNGER)			

BILL OF MATERIAL

NOTE

1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.





**NATIONAL OILWELL**  
HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

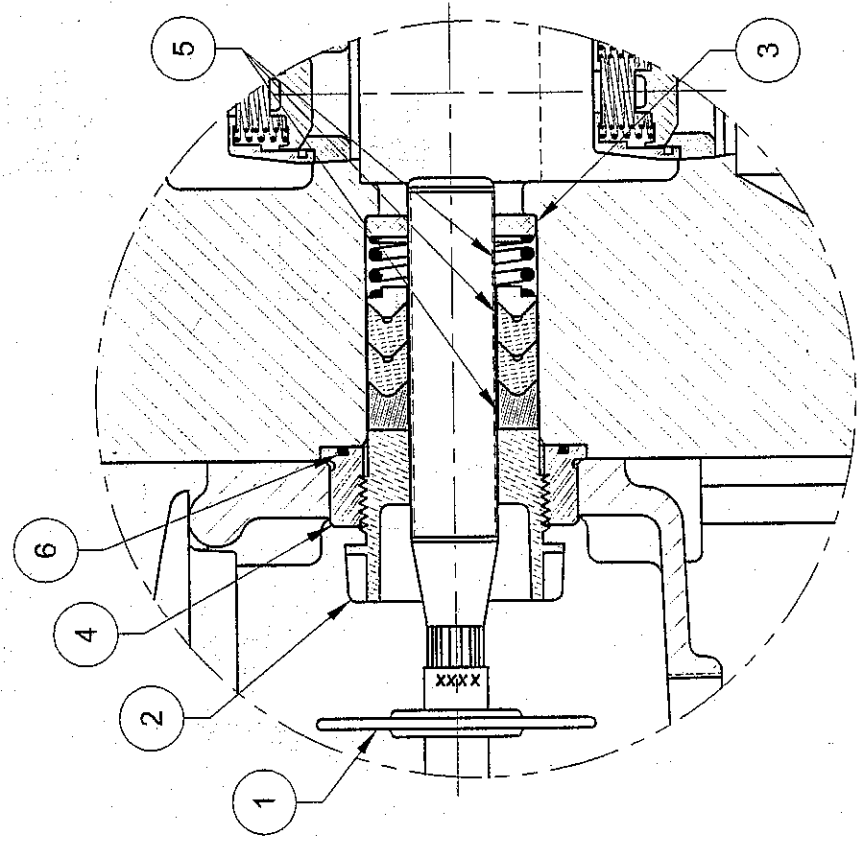
TITLE:  
ASSEMBLY, PLUNGER KIT  
1068-4 PACKING, 1-1/8 - 1-3/4 PLG  
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117609    SCALE: NONE    REV: A    SHT: 2 OF 6

REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
1	432-138238-340	PACKING	5
	001-003948-278	(SS)	
	001-003948-236	(STL)	
1	001-003948-316	ADAPTER	4
	001-008913-278	(SS)	
	001-008913-235	(STL)	
1	001-008913-302	THROAT BUSHING	3
	ADC-013800-E16	(BRZ)	
	001-011229-351	(SS)	
1	001-011229-304	GLAND NUT	2
	(DI)		
1	001-008910-201	BAFFLE DISC	1
(1-3/8" PLUNGER)			
BILL OF MATERIAL			

NOTE

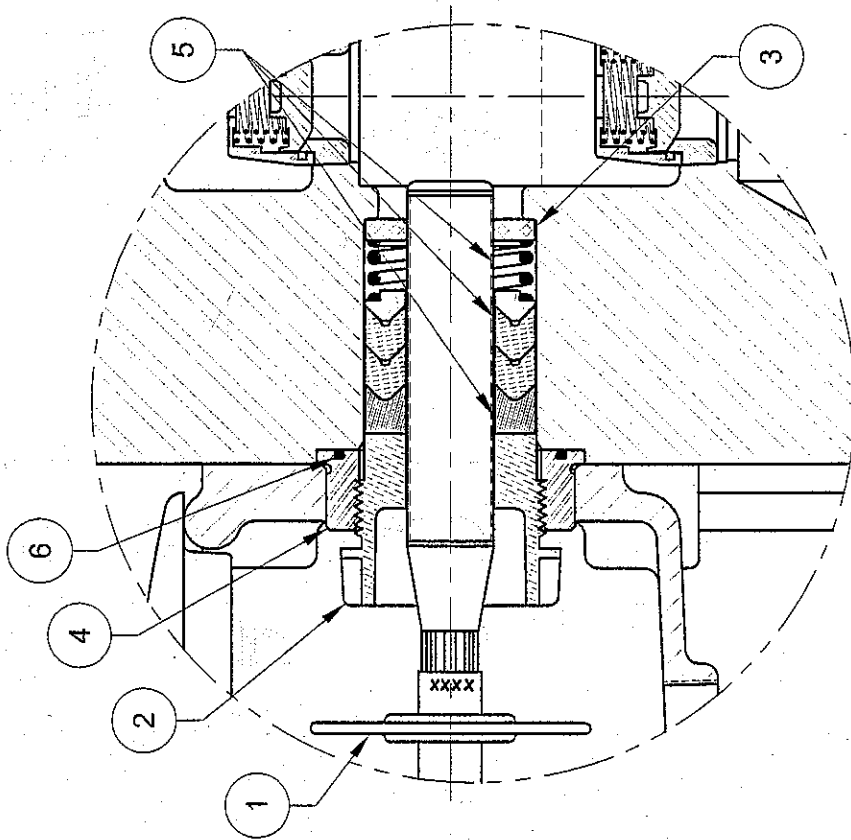
1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, PLUNGER KIT  
 1068-4 PACKING, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No: 117609      SCALE: NONE      REV: A      SHEET: 3      6



1	110-000232-200	O-RING	1068-4	5
1	432-112238-340	PACKING	(SS)	
	001-003948-278		(STL)	
	001-003948-236		(BRZ)	4
1	001-003948-316	ADAPTER	(SS)	
	001-010949-278		(STL)	
	001-010949-235		(BRZ)	3
1	001-010949-302	THROAT BUSHING	(SS)	
	ACC-013800-E16		(DI)	
	001-011230-351		(BRZ)	2
1	001-011230-304	GLAND NUT		
1	001-008910-201	BAFFLE DISC		1


(1-1/2" PLUNGER)

REQ'D	Part No.	DESCRIPTION	ITEM
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BILL OF MATERIAL

NOTE

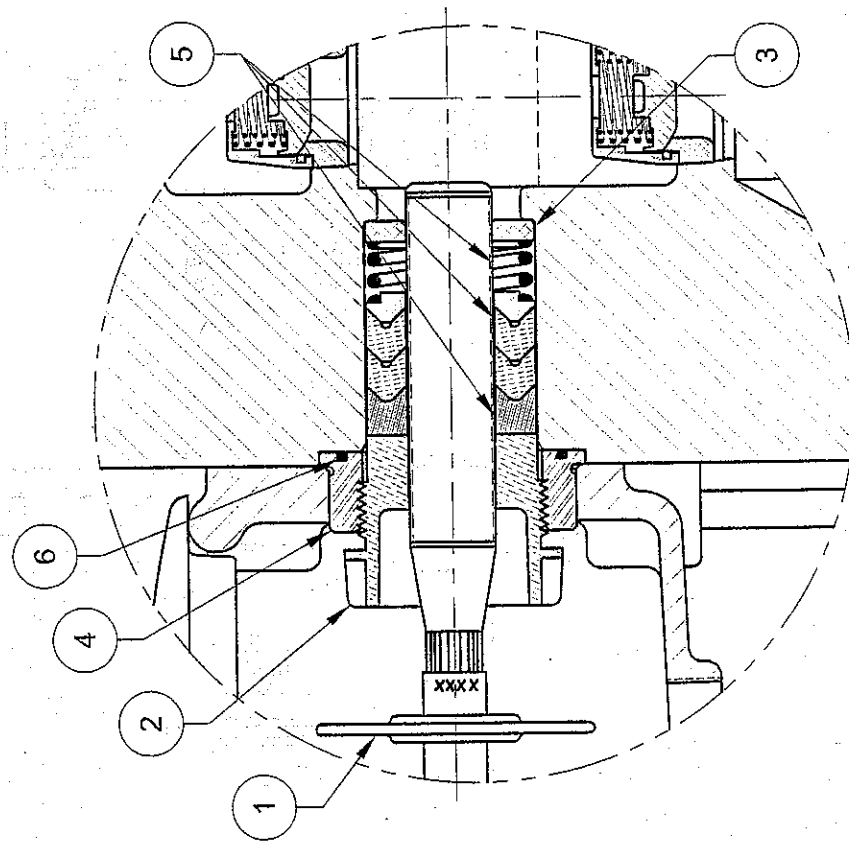
1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
**ASSEMBLY, PLUNGER KIT**  
**1068-4 PACKING, 1-1/8 - 1-3/4 PLG**  
**2S-1M / 5S-2M ( P50A, P50B )**

DWG No.: **117609**      SCALE: **NONE**      REV: **A**      SHT.: **4** OF **6**




REQ'D	Part No.	DESCRIPTION	ITEM
1	110-000232-200	O-RING	6
1	438-158238-340	PACKING	5
	001-003948-278	(SS)	
	001-003948-236	(STL)	
1	001-003948-316	ADAPTER	4
	001-010962-278	(SS)	
	001-010962-235	(STL)	
1	001-010962-302	THROAT BUSHING	3
	ABC-013800-E16	(BRZ)	
	001-011231-351	(SS)	
1	001-011231-304	GLAND NUT	2
	(DI)		
1	001-008910-201	BAFFLE DISC	1
	(BRZ)		

BILL OF MATERIAL

NOTE

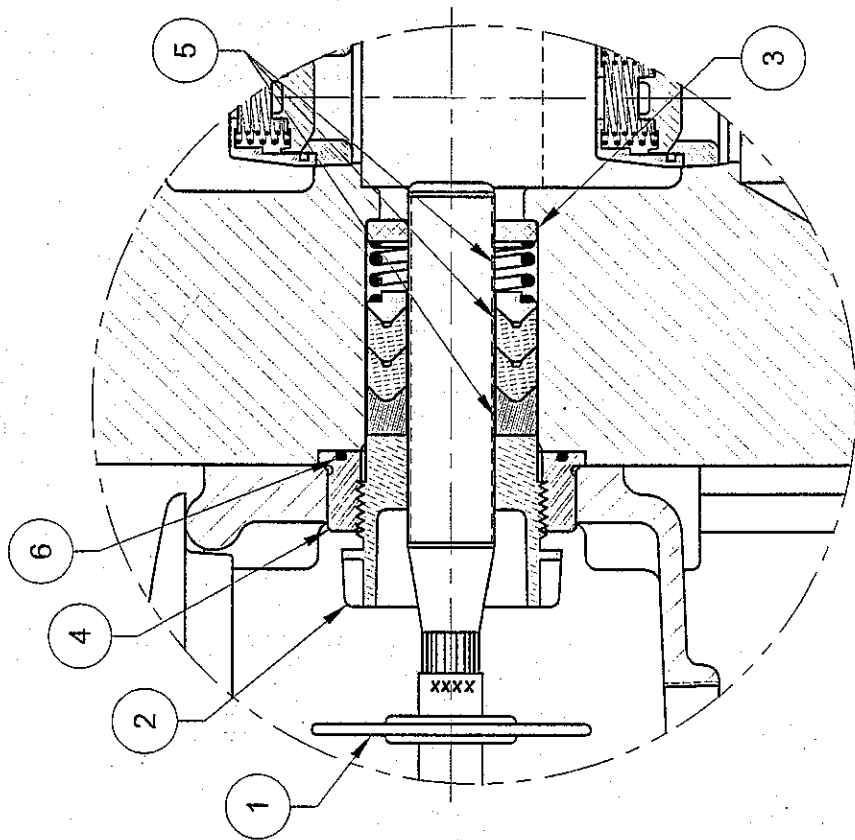
1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.



**NATIONAL OILWELL**  
HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE:  
**ASSEMBLY, PLUNGER KIT**  
1068-4 PACKING, 1-1/8 - 1-3/4 PLG  
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117609      SCALE: NONE      REV: A      SHT: 5      6




REQ'D	Part No.	DESCRIPTION	z e	ITEM
1	110-000232-200	O-RING	1068-4	5
1	432-134238-340	PACKING	(SS)	
	001-003948-278		(STL)	
	001-003948-236		(BRZ)	
1	001-003948-316	ADAPTER	(SS)	4
	001-024096-278		(STL)	
	001-024096-235		(BRZ)	
1	001-024096-302	THROAT BUSHING	(SS)	3
	AAC-013800-E16		(DI)	
	001-008909-351		(BRZ)	
1	001-008909-304	GLAND NUT		2
1	001-008910-201	BAFFLE DISC		1

(1-3/4" PLUNGER)

BILL OF MATERIAL

NOTE

1) FOR ALL " 1068-4 STYLE " PACKING SEE DRAWING 117609, SHEETS 1 THRU 6.

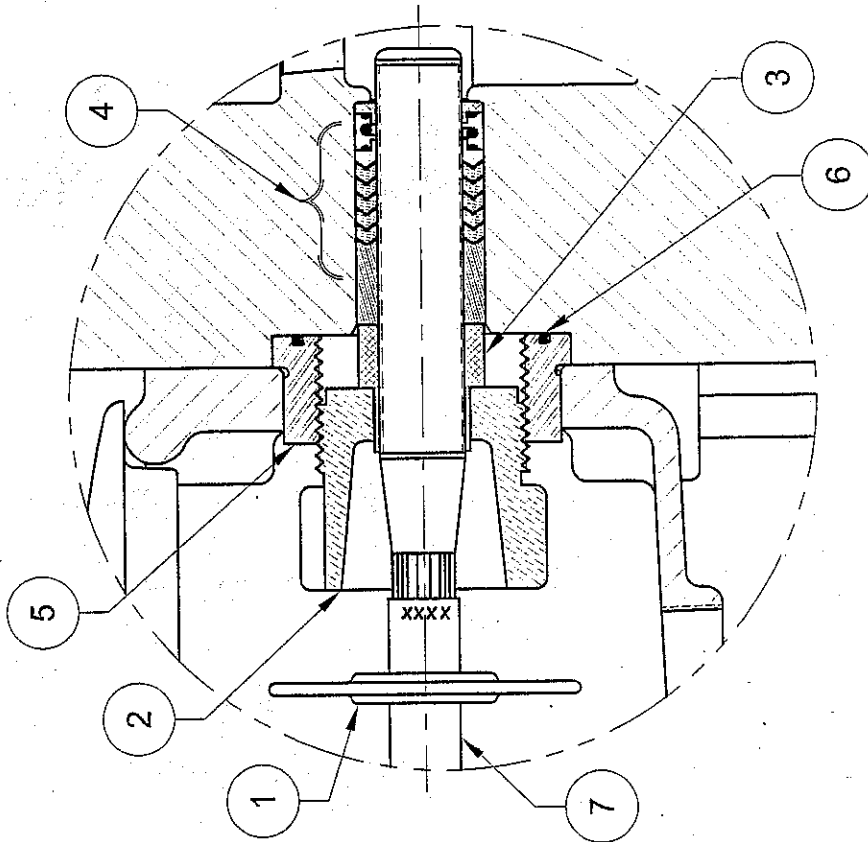


**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE: ASSEMBLY, PLUNGER KIT  
 1068-4 PACKING, 1-1/8 - 1-3/4 PLG  
 2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117609      SCALE: NONE      REV: A      SHT: 6 OF 6





31

REQ'D	Part No.	DESCRIPTION	ITEM
1	001-014266-402	PONY ROD	(SS) 7
1	110-000232-200	O-RING	6
1	001-019879-310	ADAPTER	(BRZ) 5
1	297-034258-397	PACKING	805-4 4
	001-017049-235	FOLLOWER	(STL) 3
1	001-017049-302	FOLLOWER	(BRZ) 3
	001-014278-351	GLAND NUT	(DI) 2
1	001-014278-304	GLAND NUT	(BRZ) 2
1	001-008910-201	BAFFLE DISC	1

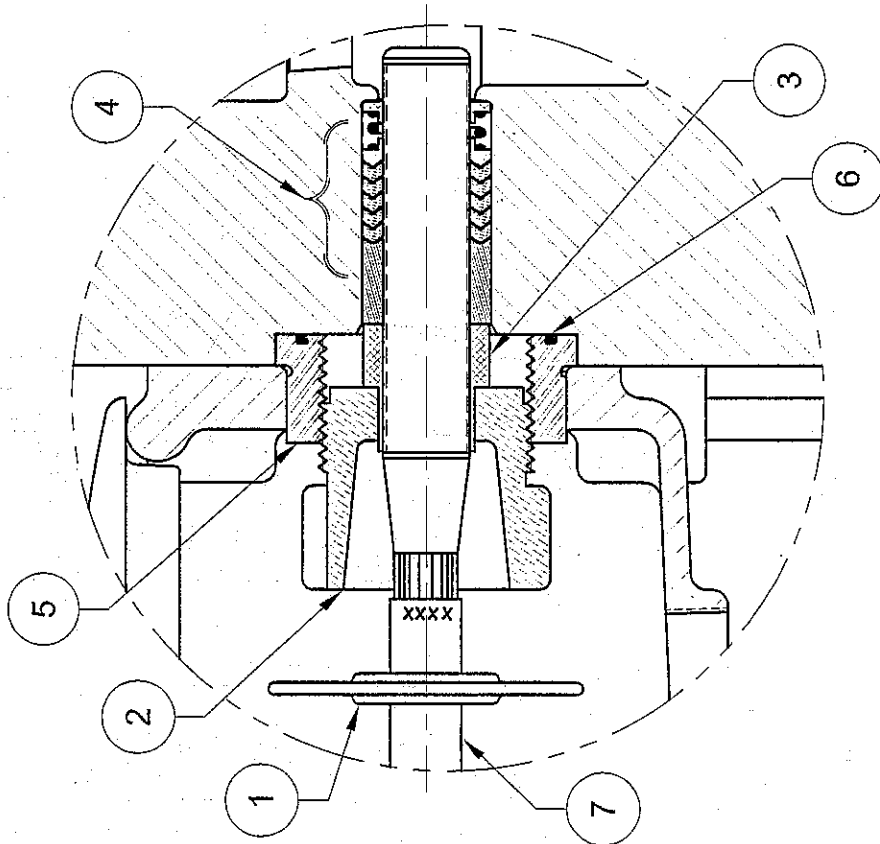
( 3/4" PLUNGER )

**BILL OF MATERIAL**

**NOTE**

1) FOR ALL " 805-4 STYLE" PACKING SEE DRAWING 117610, SHEETS 1 THRU 6.

HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA	
<b>TITLE:</b> ASSEMBLY, PLUNGER KIT 805-4 STYLE PKG FOR 3/4" - 1" PLUNGER 2S-1H / 5S-2H ( P50H )	
<b>DWG No.:</b> 117610	<b>SCALE:</b> NONE
<b>REV:</b> A	<b>SHT.:</b> 1
<b>3</b>	



REQ'D	Part No.	DESCRIPTION	ITEM
1	001-014266-402	PONY ROD (SS)	7
1	110-000232-200	O-RING	6
1	001-019879-310	ADAPTER (BRZ)	5
1	297-078258-397	PACKING 805-4	4
1	001-014719-235	FOLLOWER (STL)	3
1	001-014719-302	FOLLOWER (BRZ)	3
1	001-014278-351	GLAND NUT (DI)	2
1	001-014278-304	GLAND NUT (BRZ)	2
1	001-008910-201	BAFFLE DISC	1
(7/8" PLUNGER)			
BILL OF MATERIAL			

NOTE

1) FOR ALL " 805-4 STYLE" PACKING SEE DRAWING 117610, SHEETS 1 THRU 6.



**NATIONAL OILWELL**

HOUSTON, TEXAS, U.S.A.

ENGINEERING, TULSA, OKLAHOMA

TITLE:

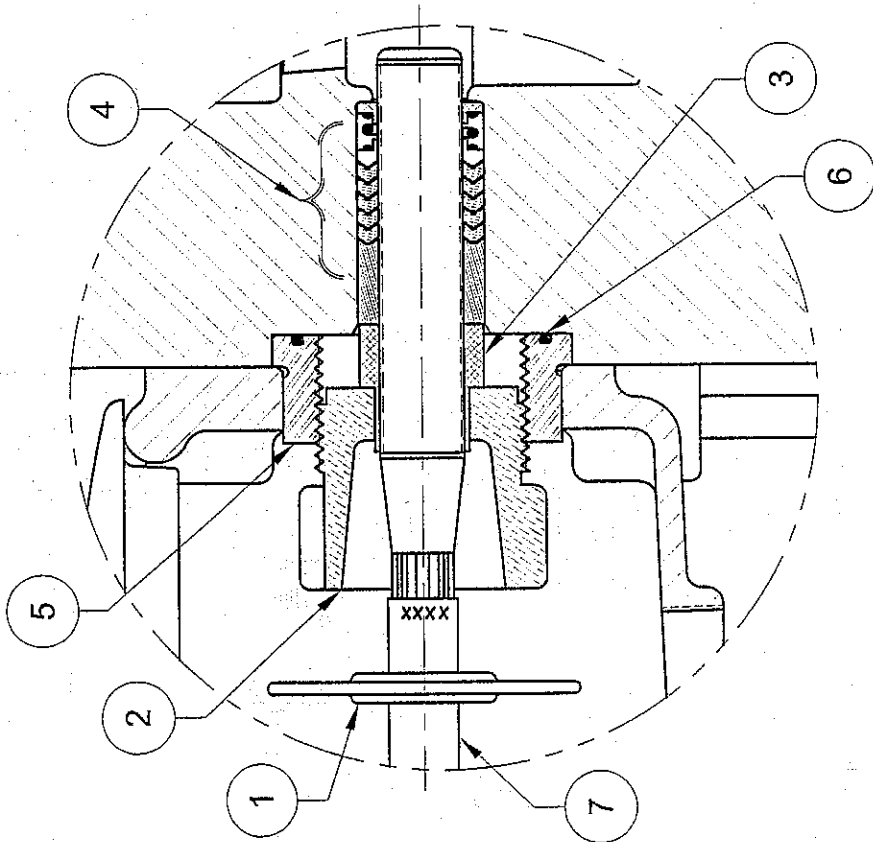
ASSEMBLY, PLUNGER KIT  
 805-4 STYLE PKG FOR 3/4" - 1" PLUNGER  
 2S-1H / 5S-2H ( P50H )

DWG No: 117610

SCALE: NONE

REV: A


SHT.: 2 OF 3



REQ'D	Part No.	DESCRIPTION	ITEM
1	001-014266-402	PONY ROD	(SS) 7
1	110-000232-200	O-RING	6
1	001-019879-310	ADAPTER	(BRZ) 5
1	297-100258-397	PACKING	805-4 4
	001-017050-235		(STL)
1	001-017050-302	FOLLOWER	(BRZ) 3
	001-014278-351		(DI)
1	001-014278-304	GLAND NUT	(BRZ) 2
1	001-008910-201	BAFFLE DISC	1
(1" PLUNGER)			
BILL OF MATERIAL			

NOTE:

1) FOR ALL "805-4 STYLE" PACKING SEE DRAWING 117610, SHEETS 1 THRU 6.

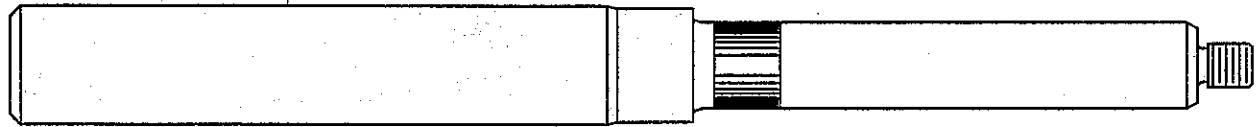


**NATIONAL OILWELL**  
ENGINEERING, TULSA, OKLAHOMA

HOUSTON, TEXAS, U.S.A.

TITLE:  
**ASSEMBLY, PLUNGER KIT**  
**805-4 STYLE PKG FOR 3/4" - 1" PLUNGER**  
**2S-1H / 5S-2H ( P50H )**

DWG No.: 117610    SCALE: NONE    REV: A    SHEET: 3    3



PLUNGER DIA.  
( REF.)

1	002-025838-999	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	AFC-115977-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-011347-E22	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-011347-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-3/4" DIA. PLUNGERS )			
1	002-025372-E24	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	AEC-115977-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-011346-E22	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-011346-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-5/8" DIA. PLUNGERS )			
1	002-025694-999	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	002-009539-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-009539-E22	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-009539-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-1/2" DIA. PLUNGERS )			
1	002-025373-999	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	002-011638-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-011638-999	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-011638-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-3/8" DIA. PLUNGERS )			
1	002-025847-E24	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	ABC-115977-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-011637-999	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-011637-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-1/4" DIA. PLUNGERS )			
1	002-025831-999	PLUNGER, HARD COAT ( CHROME OXIDE)	1
1	002-011636-E23	PLUNGER, HARD COAT ( STELLITE 157 )	1
1	002-011636-E22	PLUNGER, HARD COAT ( COLMONOY )	1
1	002-011636-E26	PLUNGER, HARD COAT ( TUNGSTEN / S157 )	1
( 1-1/8" DIA. PLUNGERS )			
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL



HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:

PLUNGERS 1-1/8 TO 1-3/4  
HARD SURFACE  
2S-1M / 5S-2M ( P50A, P50B )

DWG No.: 117611

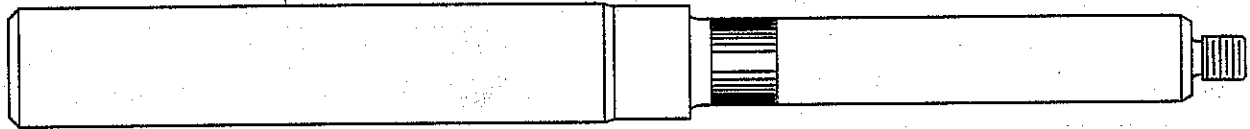
SCALE:

NONE

REV: A

SHT: 1

OF 1



← PLUNGER DIA.  
(REF.)

1	002-011365-999	PLUNGER, CERAMIC (1-3/4" DIA. PLUNGERS )	1
1	002-011364-999	PLUNGER, CERAMIC (1-5/8" DIA. PLUNGERS )	1
1	002-011363-999	PLUNGER, CERAMIC (1-1/2" DIA. PLUNGERS )	1
1	002-011366-999	PLUNGER, CERAMIC (1-3/8" DIA. PLUNGERS )	1
1	002-011362-999	PLUNGER, CERAMIC (1-1/4" DIA. PLUNGERS )	1
1	002-001753-999	PLUNGER, CERAMIC (1-1/8" DIA. PLUNGERS )	1
REQ'D	Part No.	DESCRIPTION	ITEM

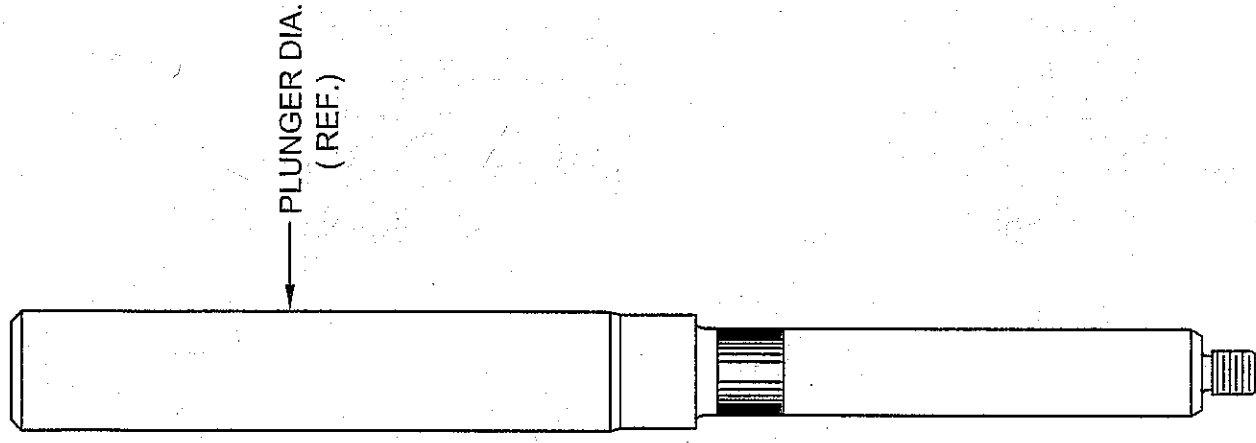
BILL OF MATERIAL



HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
PLUNGERS 1-1/8 TO 1-3/4  
CERAMIC  
2S-1 / 5S-2 ( P50A, P50B )

DWG No.: 117612 SCALE: NONE REV: A SHT.: 1



1	002-002252-999	PLUNGER, HARD COAT ( COLMONOY )	1
	002-002252-E26	PLUNGER, HARD COAT ( TUNGSTEN )	
( 1" DIA. PLUNGERS )			
1	002-011068-999	PLUNGER, HARD COAT ( COLMONOY )	1
	002-011068-E26	PLUNGER, HARD COAT ( TUNGSTEN )	
( 7/8" DIA. PLUNGERS )			
1	002-011067-999	PLUNGER, HARD COAT ( COLMONOY )	1
	002-011067-E26	PLUNGER, HARD COAT ( TUNGSTEN )	
( 3/4" DIA. PLUNGERS )			
REQ'D	Part No.	DESCRIPTION	ITEM

BILL OF MATERIAL



HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA


TITLE:  
 PLUNGERS 3/4 TO 1  
 HARD SURFACE  
 2S-1H / 5S-2H ( P50H )

DWG No.: 117617 SCALE: NONE REV: A SHT.: 1 OF 1

REQ'D	Part No.	DESCRIPTION	ITEM
1	GAS-105265-000	SIGHT GLASS	19
1	GAS-105264-000	PUMP ASSEMBLY W/ GASKET	18
REPLACEMENT PARTS			
4	186-130112-220	SPACER	17
4	100-516212-290	CAP SCREW 5/16" x 2-1/2" LG.	16
4	154-516059-220	LOCK WASHER, 5/16"	15
1	GAS-105240-000	CHECK VALVE, 1/8" NPT	14
2	113-010938-220	MACHINE SCREW, RND HD	13
1	001-008783-405	LINE CLAMP	12
60"	330-002003-365	TUBING, 1/4"	11
1	001-011513-999	SHEAVE, LUBRICATOR	10
1	001-011632-999	SHEAVE, PUMP DRIVER	9
3	100-058412-290	CAP SCREW, 5/8" x 4-1/2" LG.	8
3	154-038068-220	LOCK WASHER 3/8"	7
3	104-038300-286	STUD, 3/8" x 3" LG	6
6	133-038016-286	NUT, ZINC PLATED 3/8"	5
1	001-011617-999	V-BELT	4
1	004-001977-231	BELT GUARD	3
1	001-012229-231	LUBRICATOR BRACKET L/H/RH	2
1	001-014067-999	LUBRICATOR RHD, (1) FEED	
1	001-014657-999	LUBRICATOR LHD, (1) FEED	1

BILL OF MATERIAL

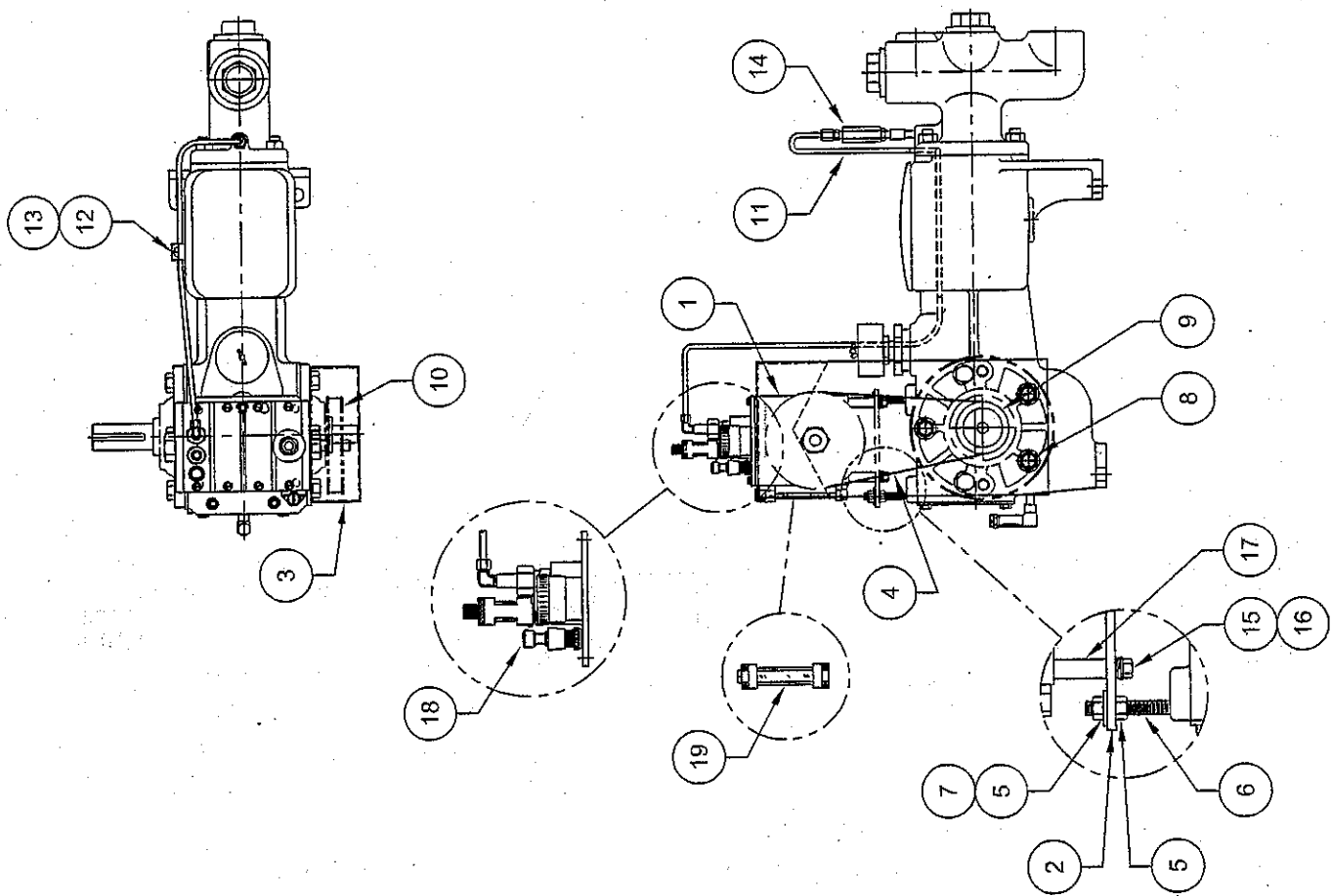
LEFT HAND DRIVE POWER PUMP (SHOWN) REQUIRES  
RIGHT HAND DRIVE LUBRICATOR.



**NATIONAL OILWELL**  
HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

TITLE: **ASSEMBLY, PACKING LUBRICATOR  
(RHD or LHD) LHD SHOWN  
2S-1 / 5S-2 / P50**

DWG No.: 117591      SCALE: NONE      REV: A      SRT: 1



SAME PLUMBING FOR CASTINGS AND BILLETS (CIRCLING SHOWN).

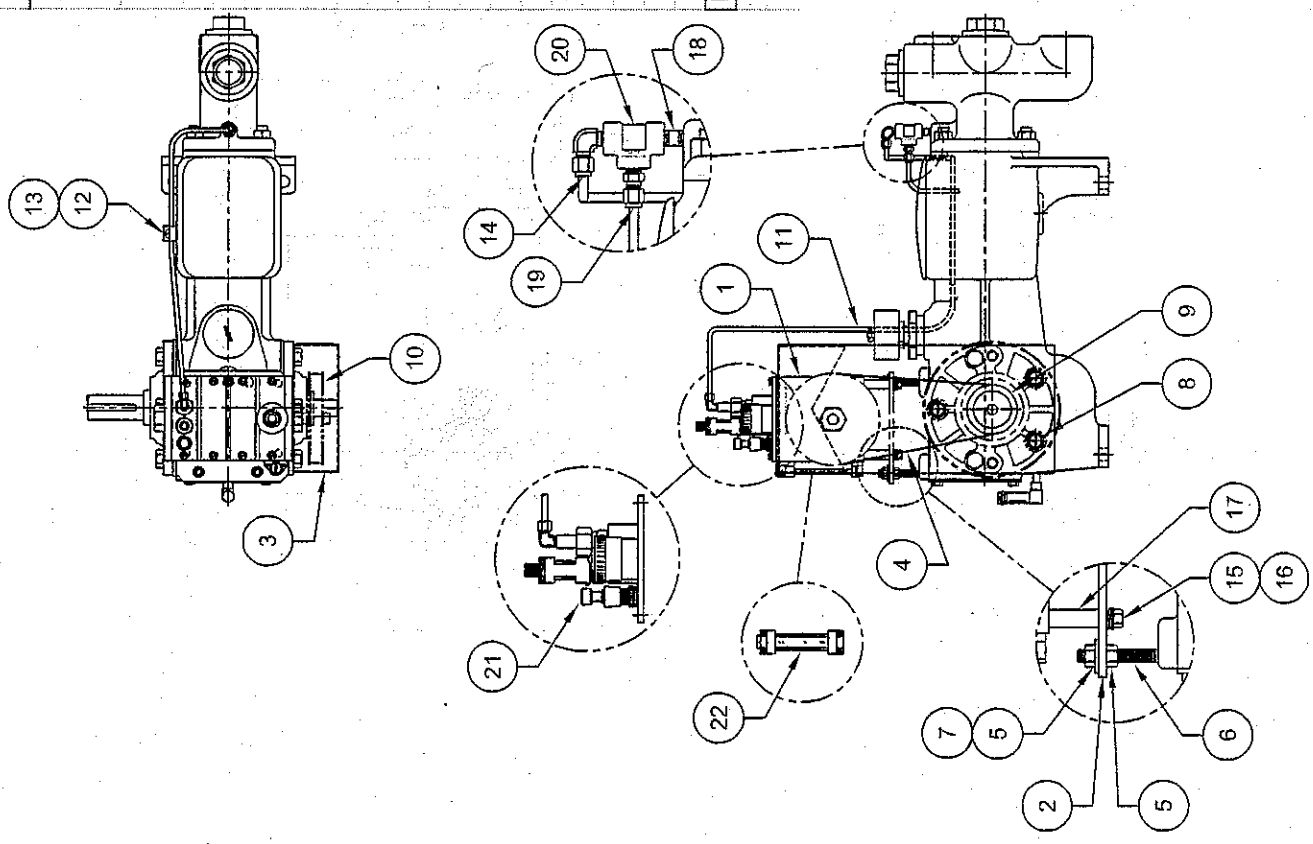
1 105265-000 SIGHT GLASS  
 1 GAS-105264-000 PUMP ASSEMBLY W/ GASKET  
 REPLACEMENT PARTS

REQ'D	Part No.	DESCRIPTION	ITEM
1	469-020002-278	TEE, 1/8" NPT	20
1	462-040012-278	MALE CONNECTOR, 1/4" TUBE x 1/8" NPT	19
1	157-018112-278	PIPE NIPPLE	18
4	186-130112-220	SPACER	17
4	100-516212-290	CAP SCREW 5/16" x 2-1/2" LG.	16
4	154-516089-220	LOCK WASHER, 5/16"	15
1	462-040022-278	TUBE FITTING, 90 DEG ELBOW 1/4" TUBE x 1/8" NPT	14
2	113-010038-220	MACHINE SCREW, RND HD	13
1	001-008783-405	LINE CLAMP	12
60"	330-002003-365	TUBING, 1/4"	11
1	001-011513-999	SHEAVE, LUBRICATOR	10
1	001-011632-999	SHEAVE, PUMP DRIVER	9
3	100-058412-290	CAP SCREW, 5/8" x 4-1/2" LG.	8
3	154-038068-220	LOCK WASHER 3/8"	7
3	104-038300-286	STUD, 3/8" x 3" LG	6
6	133-038016-286	NUT, ZINC PLATED 3/8"	5
1	001-011617-999	V-BELT	4
1	004-001977-231	BELT GUARD	3
1	001-012229-231	LUBRICATOR BRACKET LH/RH	2
1	001-014087-999	LUBRICATOR R/H, (1) FEED	
1	001-014687-999	LUBRICATOR L/H, (1) FEED	1

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BILL OF MATERIAL

LEFT HAND DRIVE POWER PUMP (SHOWN) REQUIRES  
 RIGHT HAND DRIVE LUBRICATOR.



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

TITLE:  
 ASSEMBLY, D.O.H. LUBRICATOR  
 (DRIP ON THE HEEL) - (RHD or LHD)  
 LHD SHOWN, 2S-1 / 5S-2 / P50

DWG No.: 117603 SCALE: NONE REV A SHT: 1 OF 1

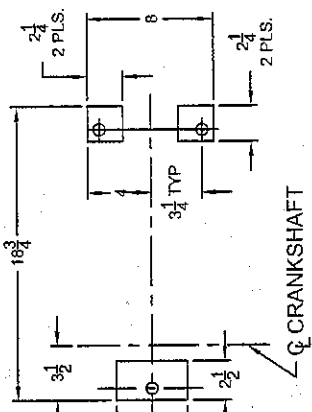
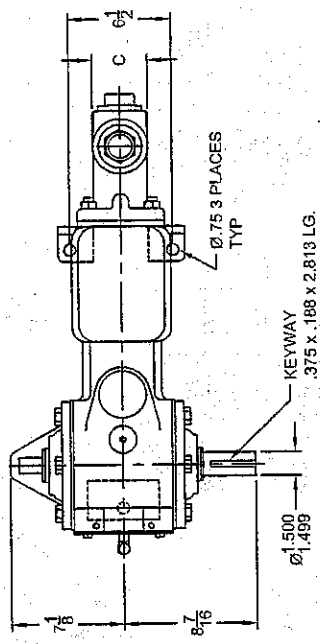
SAME PLUMBING FOR CASTINGS AND BILLETS (CASTING SHOWN).



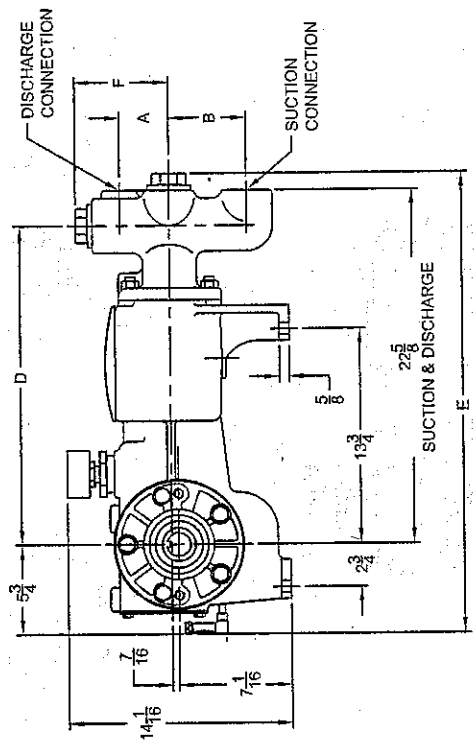
FIELD CONNECTIONS

PUMP TYPE	DIMENSIONS IN INCHES	
	DISCHARGE CONNECTION SIZE	SUCTION CONNECTION SIZE
2S-1L	1 (25.4)-11 1/2 FNPT	2 (50.8)-11 1/2 FNPT
2S-1M	1 (25.4)-11 1/2 FNPT	2 (50.8)-11 1/2 FNPT

PUMP TYPE	DIMENSIONS IN INCHES					
	A	B	C	D	E	F
5S-2L	3-1/8	4-7/8	3-1/2	20 3/8	29-9/16	5-15/16
5S-2M	3-1/8	4-7/8	3-1/2	20 3/8	29-9/16	5-15/16



PUMP FOOTPRINT



**NATIONAL OILWELL**  
 HOUSTON, TEXAS, U.S.A.      ENGINEERING, TULSA, OKLAHOMA

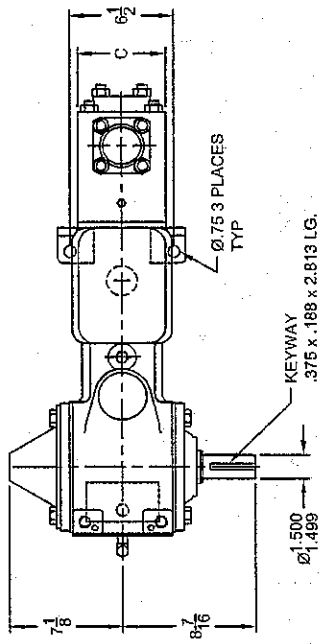
TITLE:  
 GENERAL DIMENSION  
 RHD, CAST FLUID END  
 2S-1L & M / 5S-2L & M ( P-50A, P50-B)

DWG No: 117589      SCALE: NONE      REV: A      SHT: 1

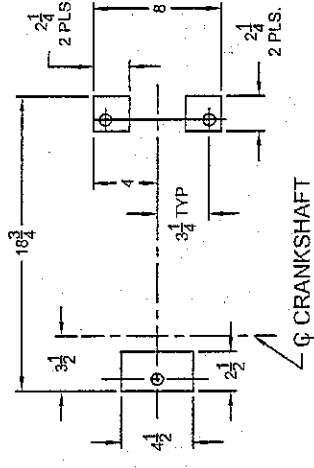
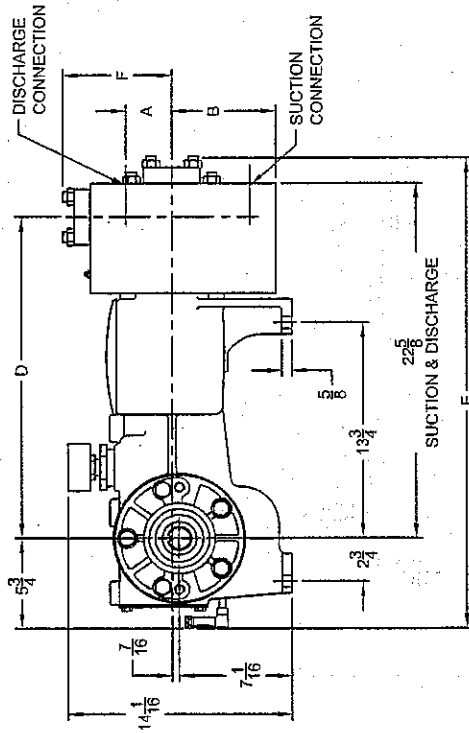
FIELD CONNECTIONS

PUMP TYPE	DIMENSIONS IN INCHES	
	DISCHARGE CONNECTION SIZE	SUCTION CONNECTION SIZE
2S-1L	1 (25.4)-11 1/2 FNPT	2 (50.8)-11 1/2 FNPT
2S-1M	1 (25.4)-11 1/2 FNPT	2 (50.8)-11 1/2 FNPT

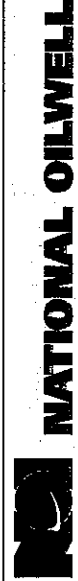
PUMP TYPE	DIMENSIONS IN INCHES					
	A	B	C	D	E	F
5S-2L	2-7/8	4-7/8	5-1/2	20-1/2	30-1/8	6-7/8
5S-2M	2-7/8	4-7/8	5-1/2	20-1/2	30-1/8	6-7/8



40



PUMP FOOTPRINT



HOUSTON, TEXAS, U.S.A. ENGINEERING, TULSA, OKLAHOMA

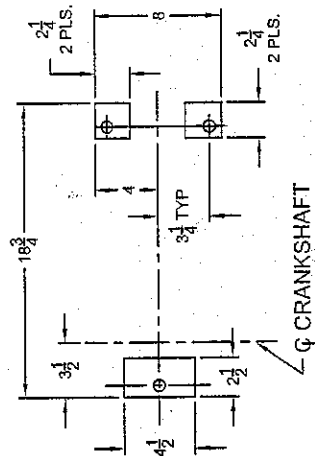
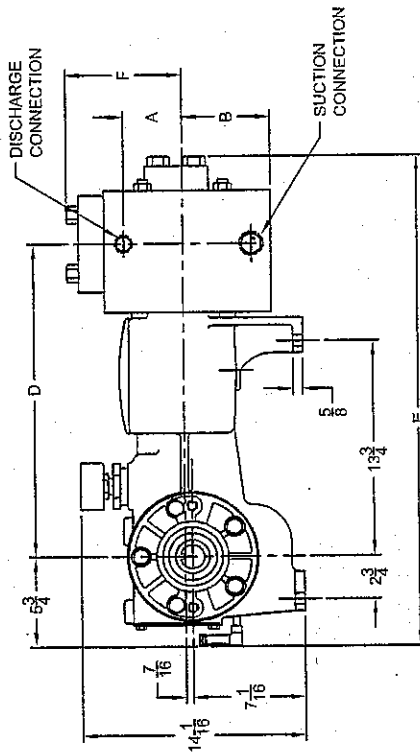
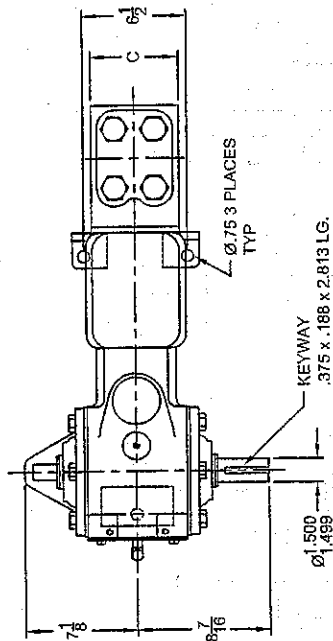
TITLE: GENERAL DIMENSION  
RHD, BILLET FLUID END  
2S-1L & M / 5S-2L & M ( P-50A & P-50B )

DWG No.: 117590 SCALE: NONE REV: A SHIT: 1 OF 1

FIELD CONNECTIONS

PUMP TYPE	DIMENSIONS IN INCHES (MM)	
	DISCHARGE CONNECTION SIZE	SUCTION CONNECTION SIZE
2S-1H	3/4 (19.05)-14 NPT	1 1/4 (31.75)-11 1/2 THDS
5S-2H	3/4 (19.05)-14 NPT	1 1/4 (31.75)-11 1/2 THDS

PUMP TYPE	DIMENSIONS IN INCHES					
	A	B	C	D	E	F
2S-2H	3-3/4	4-1/4	5-1/2	20	31-5/16	7-3/8
5S-2H	3-3/4	4-1/4	5-1/2	20	31-5/16	7-3/8



PUMP FOOTPRINT



**NATIONAL OILWELL**

ENGINEERING, TULSA, OKLAHOMA

HOUSTON, TEXAS, U.S.A.

TITLE:

GENERAL DIMENSION  
 RHD, BILLET FLUID END  
 2S-1H / 5S-2H ( P50H )

DWG No: 117592

SCALE: NONE

REV A

SHEET: 1

1

P-655 A/B

# National Oilwell Varco

## Inspection Data Book

Client:	Edmonton DSC
Client Contract/P.O.:	0010684594
Equipment Description:	Multiplex Pumps
Model Number:	P50BSP
Client Serial/Tag Number:	N/A
Job No.:	T491402
Sales Order No.:	9116273
Serial No.:	55460

# National Oilwell Varco

## Quality Assurance

### Final Inspections/Test Report

Number: 9116273

Date: May 11, 2005

The below listed equipment has successfully completed all required inspections and tests and is hereby released for:

Customer/Third Party Acceptance  
 Inspections/Tests  
 Packaging Preservation and Shipment

Comments: N/A

Client: Edmonton DSC  
Equipment: National Oilwell Varco Multiplex Pumps  
Equipment Serial No: 55460

*Felicia Miller*  
Multiplex Tulsa Representative

# National Oilwell Varco

## Manufactures Certificate of Authenticity And Quality Control

Date: May 11, 2005

It is hereby certified that the products identified hereon are genuine National Oilwell Varco Products manufactured in the United States of America conforming to all National Oilwell Varco Quality Standards.

It is further certified that the products are in complete compliance with the applicable product engineering, Technical specifications, material specifications and product regulatory codes and standards, and that all regulations Regarding the use of asbestos, mercury, radium and alpha contamination have been observed during manufacturing.

**Sales Order Number:**

**9116273**

**Customer:**

**Edmonton DSC**

**Customer P.O.:**

**0010684594**

*Leticia Miller*  
National Oilwell Varco Representative

# National Oilwell Varco

## Certificate of Conformance

Date: May 11, 2005

It is hereby certified that the products identified herein conform to the applicable engineering drawings and specifications. Raw materials used in the manufacture of these products are in compliance with the specifications. It is further certified that all requirements regarding asbestos, mercury, radium and alpha contamination have been observed. Objective quality evidence supporting this certification is on file at National Oilwell Varco, Tulsa, and available for verification.

Client	Edmonton DSC	Client Purchase Order:	0010684594
Sales Order:	9116273	Job Number:	T491402
Equipment Type:	Multiplex Pumps	Equipment Size:	P50BSP
Equipment Serial No:	55460		

*Julia Miller*  
Multiplex Tulsa Representative

# National Oilwell Varco

## Certificate of Hydrostatic Testing

Date: May 11, 2005

It is hereby certified that the equipment identified hereon has been hydrostatic tested by competent authority in accordance with approved National Oilwell Varco procedures and the test results as presented herein are true and accurate in all respects.

Client:	Edmonton DSC	Client Purchase Order:	0010684594
Sales Order:	9116273	Job No.:	T491402
Equipment Type:	National Oilwell Varco Multiplex Pump	Equipment Size:	P50BSP
Pump Serial No.:	55460	Fluid End Serial No.:	55461

Hydrostatic Test No:		Test Medium:	Water	Test Liquid Temp.:	70° F
F.E.: 55461		Duration:	30 Minutes	Test Witnessed By:	N/A
		Hydrostatic Test Pressure:	425 psig suction 3080 psig discharge		

CLIENT ITEM/TAG NO: N/A

TEST RESULTS: No detectable leaks or seepage.

TEST LOCATION: National Oilwell Varco - Tulsa, Oklahoma

TEST DATE: 04-15-05

*Felicia Miller*  
Multiplex Tulsa Representative



# BILL OF MATERIAL

PART NO: 630-2CAB08-000 P50BSP BASCI PUMP C316SS

SERIAL NUMBER: 55460 FE 55461

SALES ORDER: 9116273

<u>PART NUMBER</u>	<u>DESCRIPTION</u>	<u>ST UM</u>	<u>QUANTITY REQUIRED</u>
001-001699-999	SHELL BEARING,STD SIZE	EA	1
001-001982-350	EXTENSION GUARD	EA	1
001-003672-204	GASKET	EA	1
001-003676-231	CRANKCASE COVER	EA	1
001-003948-278	ADAPTER,PF-FE,P50A/T225M,SS	EA	1
001-008532-999	SHIM GASKET .005 (PFS)	EA	4
001-008906-283	GLAND	EA	1
001-008916-302	FOLLOWER, WIPER BOX	EA	1
001-008920-236	WRIST PIN	EA	1
001-008921-302	BUSHING	EA	1
001-011409-999	OIL GAUGE	EA	1
001-011613-206	SHIM GASKET 1/32" (PFS)	EA	4
001-011614-206	SHIM GASKET 1/64" (PFS)	EA	4
001-011616-381	PACKING, WIPER BOX	EA	1
002-008905-350	CROSSHEAD,P200B	EA	1
002-008907-283	WIPER BOX	EA	1
002-013798-E16	CH-VC,SS W/XYLAN,P200B	EA	2
004-000085-571	BEARING HOUSING, SHAFT	EA	2
004-003608-350	PF,P50A/P50B,MACH	EA	1
004-003656-350	BARREL COVER	EA	1
004-006068-280	OIL TROUGH	EA	1
004-012554-351	CRANKSHAFT,P50B	EA	1
004-022535-350	PF,P50A/P50B,MACH F/TMM	EA	1
008-028742-261	FE, P50SP SPCL SIDE PORT	EA	1
100-038012-290	CAP SCREW (CFS)	EA	4
100-038214-290	CAP SCREW CFS	EA	2
100-058112-290	CAP SCREW CFS	EA	2
100-058114-290	CAP SCREW CFS	EA	8
102-038214-286	STUD, ZINC PLTD (CFS)	EA	2
102-058214-288	STUD, ZINC PLTD NACE	EA	4
110-000232-200	O-RING (PFS)	EA	1
110-000232-201	O-RING (CFS)	EA	1
113-014038-220	MACH SCREW, RND HD (CFS)	EA	2
126-006516-405	DRIVE SCREW, #6 X 5/16" (PFS)	EA	4
133-058011-288	NUT, ZINC PLTD	EA	4
145-218300-999	OIL SEAL	EA	2
146-038200-236	KEY	EA	1
150-038016-306	NUT, FLEXLOC (CFS)	EA	2
152-014050-220	LOCK WASHER, EXT TOOTH (CFS)	EA	2
154-038068-220	LOCK WASHER (PFS)	EA	2
155-014034-220	WASHER (CFS)	EA	2

157-018112-220	PIPE, THD STD. WT. (CFS)	EA	1
161-200034-353	PIPE BUSHING, HEX 2" X 3/4"	EA	1
170-038005-353	PIPE PLUG (CFS)	EA	1
180-165000-220	LUB FITTING (CFS)	EA	1
202-000007-999	BEARING CUP	EA	2
203-000007-999	BEARING CONE {CONE & CUP:	EA	2
204-000090-206	GASKET (PFS)	EA	2
998-016200-012	CONN. ROD KIT, P200	EA	1
AAA-030436-999	BREATHING, 3/4" NPT	EA	1
AAB-115716-405	NAME PLATE, WG, STD	EA	1



NATIONAL OILWELL

Multiplex Pump History / Check Sheet

Job No. 491402 Part No. 630-2 CAB08-000 Date 4-12-05

Serial No. 55460 Pump Model P50 BSP EQR No. NA

Tested to Standard: NA

Table with columns for inspection items (Crank Shaft End Play, Shims Used Right Side, Conn Rod Bearings, etc.) and checkboxes for N/A, CK, and By.

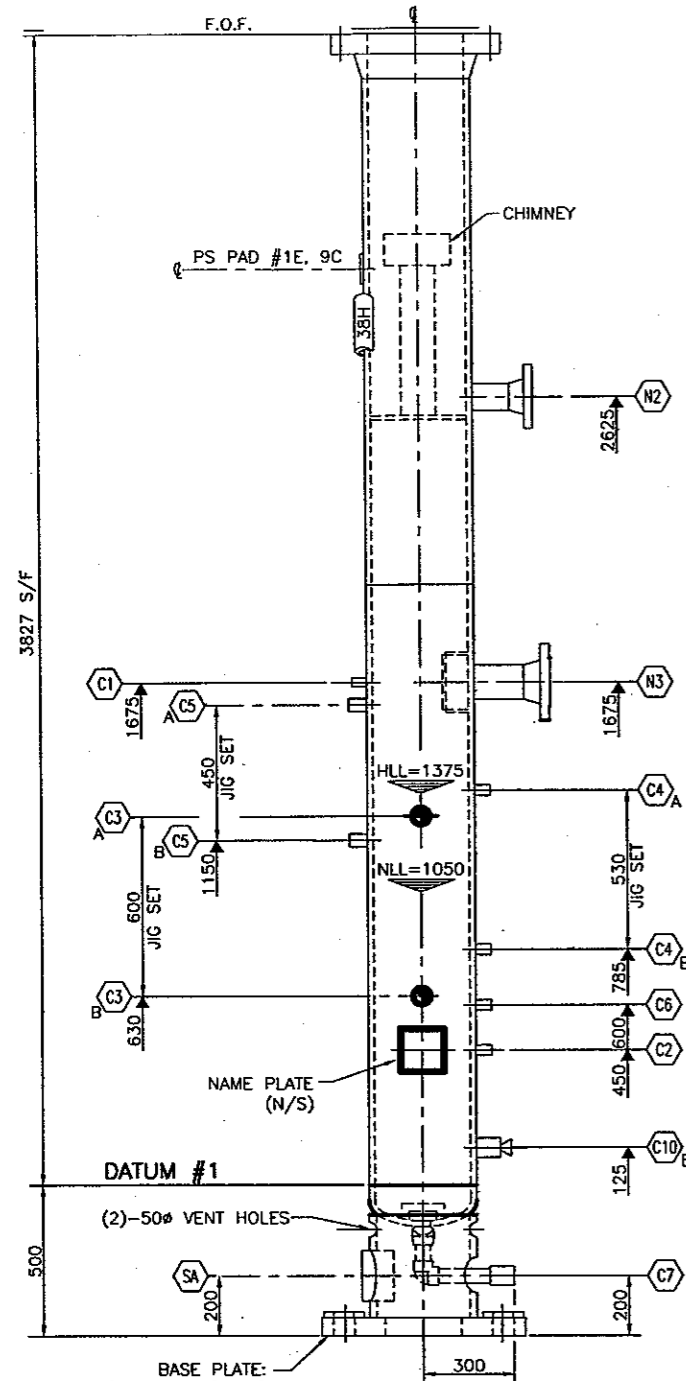
FLUID END INFORMATION RECORD table with 8 rows detailing assembly person, material, pressure, and identification numbers.

TEST RECORD table with 8 rows detailing test dates, pressures, temperatures, and acceptance signatures.

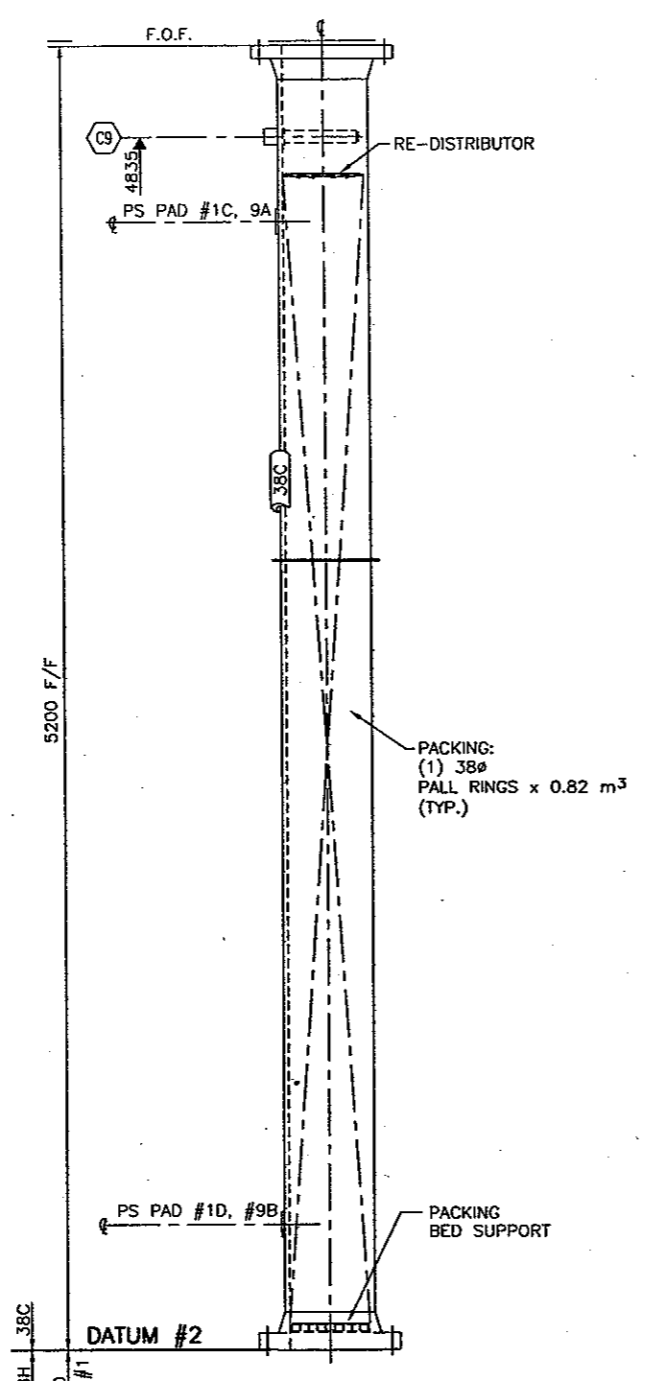
Note: All Lines Must be Filled Out. If Not Applicable Use (N/A)

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : DEETHANIZER									
JOB NO. : XXXXXX TAG NO: T-630									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106B	N1	GAS OUTLET	60	3000#	RFWN	
3	HEADS		SA-516-70	N2	REBOILER FEED	89	3000#	RFWN	
4	SKIRTS		SA-106B	N3	REBOILER RETURN	114	3000#	RFWN	
5	SADDLES		--	N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES		SA-105	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS		SA-193-B7	N9					
11	NUTS		SA-194-2H	N10					
12	GASKETS		304SS	N11					
13	COIL		--	N12					
14	RISER		--						
15	PACKING SUPPORT		SA-36	C1	PI-630	21	3000#	CPLG	
16	TRAY SUPPORTS		--	C2	TIC-630	27	3000#	CPLG	
17	BAFFLES		--	C3A/B	LC-630	48	3000#	CPLG	
18	INLET BAFFLE		SA-36	C4A/B	LG-630	27	3000#	CPLG	
19	VORTEX BREAKER		SA-36	C5A/B	LSH-630	33	3000#	CPLG	
20	SYPHON DRAIN		--	C6	TI-630	27	3000#	CPLG	
21	DEMISTER		304SS	C7	DRAIN	48	3000#	NPT X SW	
22	DISTRIB. SPIDER		--	C8	LTS LIQUID IN	48	3000#	NPT X SW	
23	PACKING	38 DIA. PALL RINGS	CS	C9	SEP LIQUID IN	48	3000#	NPT X SW	
24	TRAYS		--	C10A/B	INSPECTION C/W PLUG	48	3000#	CPLG	
25	PLATFORM		--	C11					
26	LADDER		--	C12					
27	DAVIT		--						
28	INSULATION RINGS		SA-36	M1					
29	LIFTING LUGS		SA-516-70	M2					
30	PIPE CLIPS		SA-36						
31	PIPE SUPPORTS		SA-36						
32	SKIRT VENTS		YES						
33	SKIRT ACCESS		YES						
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD (mm)	356	NOTES:				
37	S/S (mm)	14583							
38	DES PRESS (kPa)	3792	OPER. PRESS (kPa)	1638					
39	DES TEMP °C	204	OPER. TEMP °C	89					
40	HYDROTEST		CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)	160	EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	38H/38C					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	TOP PNT 11 / BTM PNT 12					
48	ASME SEC. VIII DIV.	1	FINISH COAT						
49	STAMP REQ'D	YES	FINISH COLOR						
50									
51	WEIGHT EMPTY ((kg)	3500	HYDRO WEIGHT (kg)	4970					
52	LSD								
53									
54									
55									
56									
57									

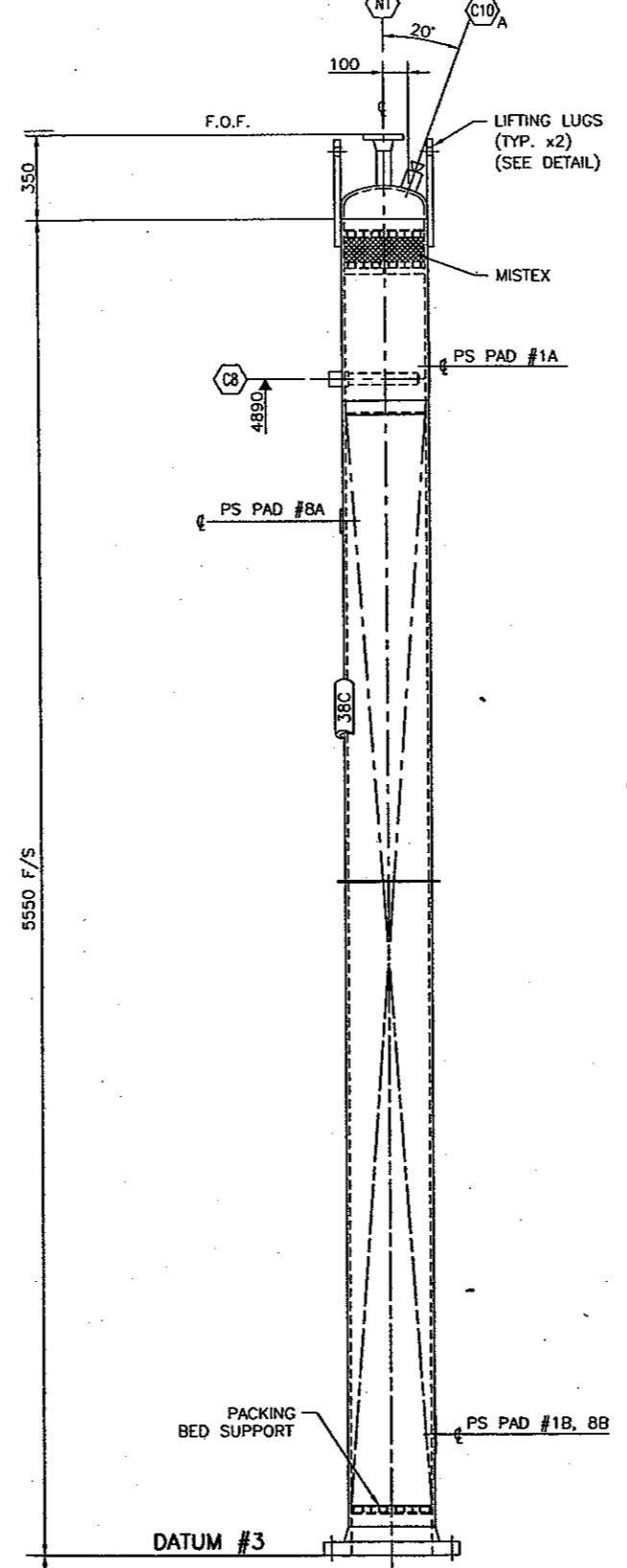
THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAK SYSTEMS LTD., AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAK.



**ELEVATION (BTM. SECT.)**  
SCALE 1:12.5

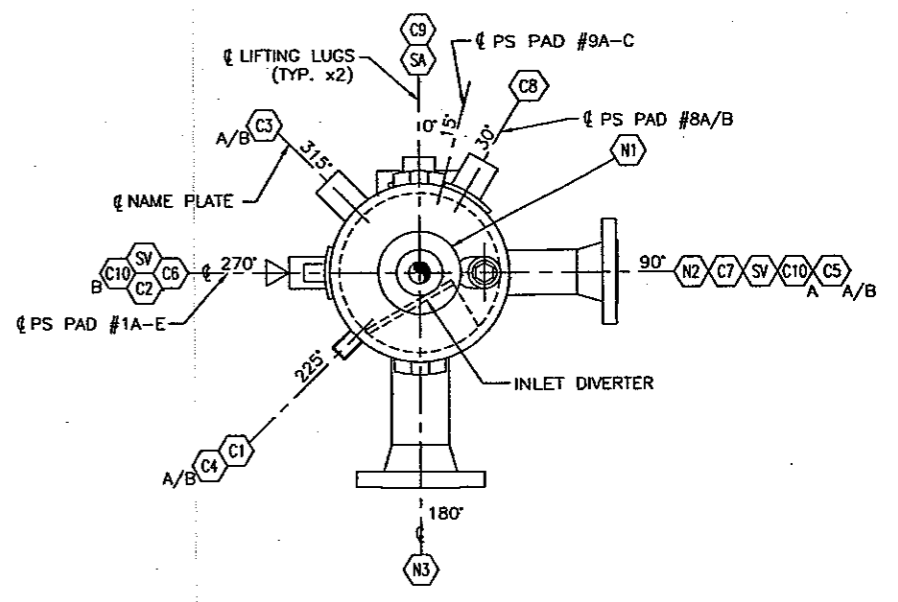


**ELEVATION (MIDDLE SECT.)**  
SCALE 1:15



**ELEVATION (TOP SECT.)**  
SCALE 1:15

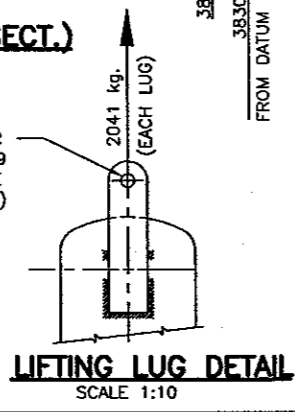
NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE		EXT. PROJ	WELD	
N1	2 NPS	300#	RFWN	160	GAS OUTLET		SPEC.	-	
N2	3 NPS	300#	RFWN	XH	REBOILER FEED		200	-	
N3	4 NPS	300#	RFWN	XH	REBOILER RETURN		250	-	
C1	1/2 NPS	3000#	CPLG.	-	PI		44 MIN	-	
C2	3/4 NPS	3000#	CPLG.	-	TIC		44 MIN	-	
A/B C3	1/2 NPS	3000#	CPLG.	-	LC		44 MIN	-	
A/B C4	3/4 NPS	3000#	CPLG.	-	LG		44 MIN	-	
A/B C5	1 NPS	3000#	CPLG.	-	LSH		44 MIN	-	
C6	3/4 NPS	3000#	CPLG.	-	TI		44 MIN	-	
C7	1/2 NPS	3000#	SOL	-	DRAIN		-	-	
C8	1/2 NPS	3000#	NPTxSW	-	LTS LIQUID IN		SPEC	-	
C9	1/2 NPS	3000#	NPTxSW	-	SEP LIQUID IN		SPEC	-	
A/B C10	1/2 NPS	3000#	CPLG.	-	INSPECTION (PLUGGED)		44 MIN	-	
SA	6 NPS	-	PIPE	STD	SKIRT ACCESS		25	-	



**ORIENTATION**  
SCALE 1:7.5

BASE PLATE:  
57 THK. x 660 O/D x 254 I/D w/  
(4)-64mm HOLES ON A 520 B.C.D.  
(STRADDLE CL.) c/w WASHER

35mm HOLE FOR  
CROSBY S-209  
(OR EQUAL) SHACKLE  
(9.5 TON - 19,000#)



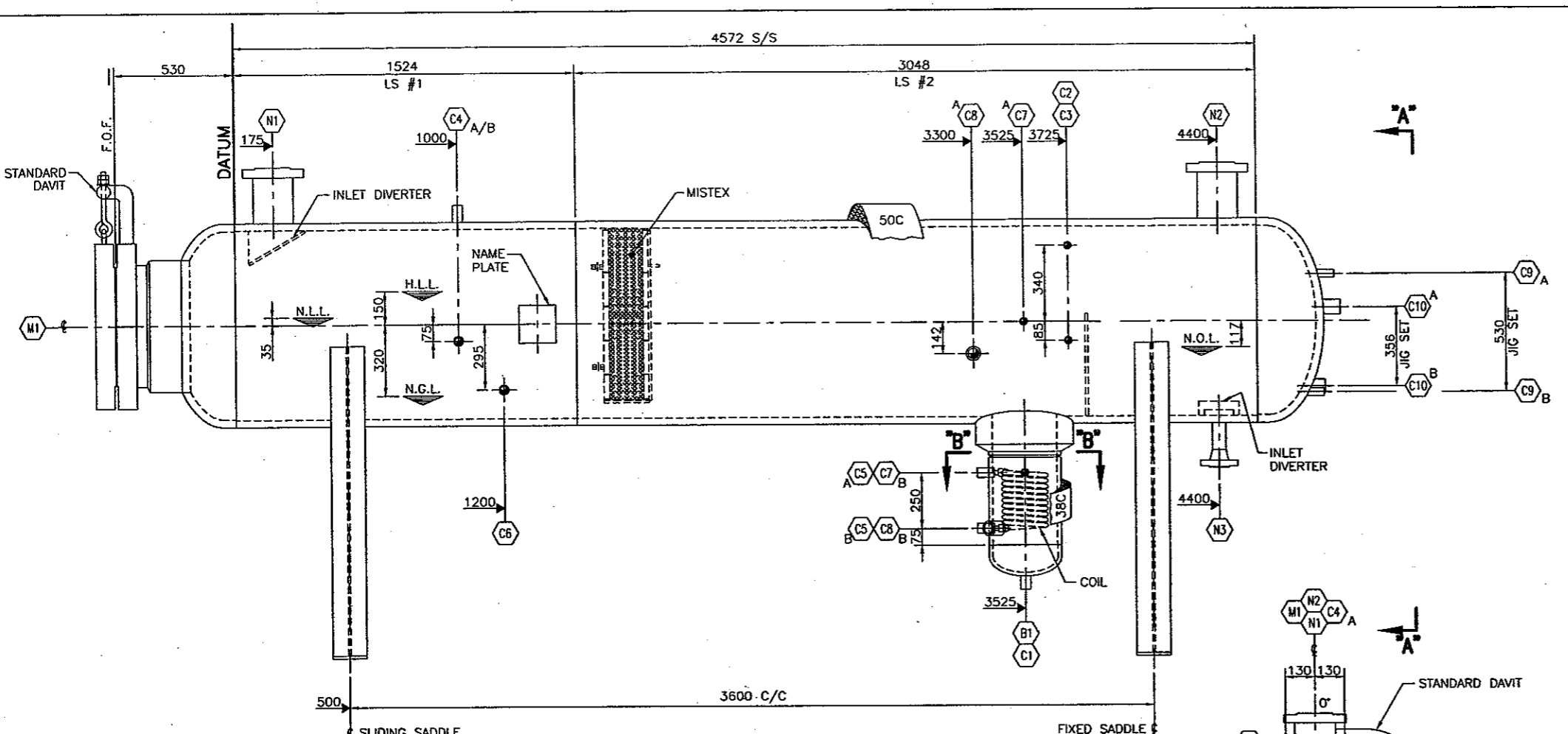
**LIFTING LUG DETAIL**  
SCALE 1:10

SERVICE: HYDROCARBONS LOADINGS PER UG-22(e) CONSIDERED: NO PRODUCTION IMPACT TEST REQ'D: NO IMPACT TESTING: NO - PER UG-20(f)(1-5) CAPACITY: 1.47 m <sup>3</sup> WEIGHT EMPTY: 3500 kg WEIGHT FULL OF WATER: 4970 kg PAINT SPEC: TOP: PNT-11/BOTTOM: PNT-12 INSULATION: TOP PORTION: 38C FOAMGLASS w/ ALUM. CLADDING BOTTOM PORTION: 38H FIBERGLASS w/ALUM. CLADDING SHIP LOOSE: TOP & MIDDLE: YES/BOTTOM: NO	SERIAL NO: 054468-110 CRN: P2998.2 YEAR BUILT: 2005 LSD #: - CODE: ASME SECT. VIII DIV I, '01, ADDENDA '03 DESIGN PRESSURE: 3792 kPag NOTE: DES. PRESS. IS MAWE DESIGN TEMPERATURE: 204°C M.D.M.T.: -28.8°C @ 3792 kPag HYDROTEST PRESSURE: 4930 kPag MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B (SMLS) RADIOGRAPHY: LONG: N/A CIRC: SPOT UWII(c)5(b)/UW12(d) P.W.H.T. MIN TEMP / TIME: NO CORR. ALLOWANCE: 1.59mm TAG NO: T-630
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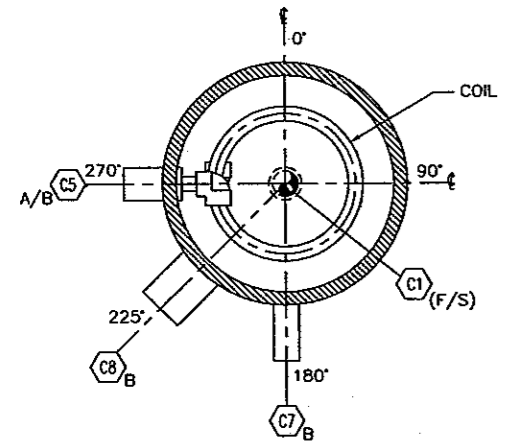
<b>GENERAL NOTES</b> DATE: 2005/09/30 10:12 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\DET-054468-110-SKT-01.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION No. REVISION BY DATE CKD ENG		A. LOW 05/09/30 YK MZ		<b>APPROVED</b> MECH/STRUCT. BY DATE ELECTRICAL BY DATE PROJECT BY DATE DATE SCALE AS NOTED		<b>DRAWN</b> CHECKED BY DATE DATE SCALE AS NOTED		<b>FORT ENERGY CORP.</b> 88 REFRIGERATION UNIT DEETHANIZER (T-630) 356 O/D x 14583 S/S DWG. No.: D-DET-054468-110-SKT SHT. 1 OF 1 REV. SKT		<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
---	--	--	--	-----------------------	--	---	--	--	--	--	--	---	--

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : LOW TEMP. SEPARATOR									
JOB NO. : XXXXXX TAG NO: V-620									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516-70N	N1	GAS INLET	114	600#	RFHB	
3	HEADS		SA-516-70N	N2	GAS OUTLET	114	600#	RFHB	
4	SKIRTS		--	N3	CONDENSATE OUTLET	60	600#	RFLWN	
5	SADDLES		SA-36	N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES		SA-350LF2	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS		SA-193-B7	N9					
11	NUTS		SA-194-2H	N10					
12	GASKETS		SPIRAL WND 304SS	N11					
13	COIL		SA-179	N12					
14	RISER		--						
15	PACKING SUPPORT		--	C1	GLYCOL OUTLET	33	3000#	CPLG	
16	TRAY SUPPORTS		--	C2	PI-620	21	3000#	CPLG	
17	BAFFLES		--	C3	TI-620	27	3000#	CPLG	
18	INLET BAFFLE		SA-36	C4/A/B	LSH-620	33	3000#	CPLG	
19	VORTEX BREAKER		SA-36	C5/A/B	GLYCOL COIL IN	33X21	3000#	NPT X SW	
20	SYPHON DRAIN		--	C6	FUTURE C/W PLUG	33	3000#	CPLG	
21	DEMISTER	152MM 193 KG/M3	304SS	C7/A/B	LG-620B (GLYCOL)	27	3000#	CPLG	
22	DISTRIB. SPIDER		--	C8/A/B	LC-620B (GLYCOL)	48	3000#	CPLG	
23	PACKING		--	C9/A/B	LG-620A (OIL)	27	3000#	CPLG	
24	TRAYS		--	C10A/B	LC-620A (OIL)	48	3000#	CPLG	
25	PLATFORM		--	C11					
26	LADDER		--	C12					
27	DAVIT		C.S.						
28	INSULATION RINGS		--	M1	MANWAY	457	600#	RFHB	
29	LIFTING LUGS		--	M2					
30	PIPE CLIPS		--						
31	PIPE SUPPORTS		--						
32	SKIRT VENTS		--						
33	SKIRT ACCESS		--						
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD: (mm)	914	NOTES:				
37	S/S (mm)	4572							
38	DES PRESS (kPa)	8963	OPER. PRESS (kPa)	6760					
39	DES TEMP °C	66	OPER. TEMP °C	-23					
40	HYDROTEST	13444	CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	FULL	STRESS RELIEVE	PER CODE					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	50C					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	PNT11					
50									
51	WEIGHT EMPTY ((kg)	5545	HYDRO WEIGHT (kg)	8525					
52	LSD								
53									
54									
55									
56									
57									

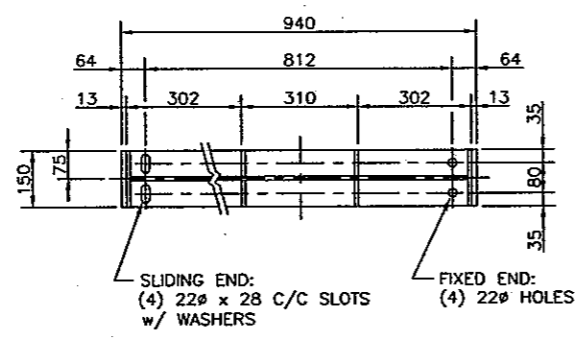
THIS DRAWING AND THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAK SYSTEMS LTD. AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAK.



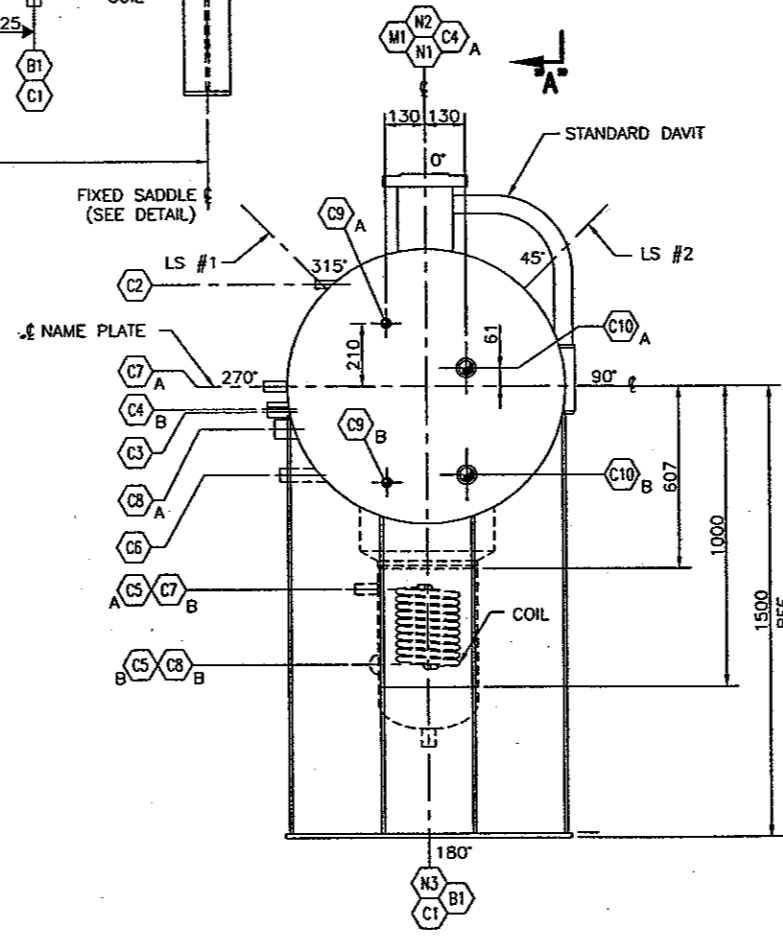
**ELEVATION**  
SCALE 1:12.5



**SECTION 'B-B'**  
SCALE 1:5



**FIXED & SLIDING SADDLE PLATE DETAIL**  
SCALE 1:10



**VIEW 'A-A'**  
SCALE 1:12.5

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ.	WELD		
N1	4 NPS	600#	RFHB	WT=41.02	GAS INLET	250	-		
N2	4 NPS	600#	RFHB	WT=41.02	GAS OUTLET	250	-		
N3	2 NPS	600#	RFWN	160	CONDENSATE OUTLET	200	-		
C1	1 NPS	3000#	CPLG	-	GLYCOL OUTLET	44 MIN	-		
C2	1/2 NPS	3000#	CPLG	XL	PI	56 MIN	-		
C3	3/4 NPS	3000#	CPLG	XL	TI	56 MIN	-		
A/B C4	1 NPS	3000#	CPLG	XL	LSH	56 MIN	-		
A/B C5	1/2 NPS	3000#	NPT x SW	XL	GLYCOL COIL	44 MIN	-		
C6	1 NPS	3000#	CPLG	XL	FUTURE (PLUGGED)	85 MIN	-		
A/B C7	3/4 NPS	3000#	CPLG	XL	LG (GLYCOL)	56 MIN	-		
A/B C8	1/2 NPS	3000#	CPLG	XL	LG (GLYCOL)	56 MIN	-		
A/B C9	3/4 NPS	3000#	CPLG	XL	LG (OIL)	70 MIN	-		
A/B C10	1/2 NPS	3000#	CPLG	XL	LC (OIL)	75 MIN	-		
M1	18 NPS	600#	RFHB	WT=65.91	MANWAY c/w BLIND & STD DAVIT	SPEC	-		
B1	12 NPS	-	FORGING	WT=74.68	BOOT	SPEC	-		

SERVICE: GAS  
 LOADINGS PER UG-22(e) CONSIDERED GOVERNS: NO  
 PRODUCTION IMPACT TEST REQ'D: NO  
 IMPACT TESTING:  
 NO-PER UG20(f)(1-5)  
 -PER UCS-66(c)  
 -LOW TEMP. MAT'L - PER UG-66(g)  
 -PER FIG. UCS-66  
 CAPACITY: 2.63 m<sup>3</sup>  
 WEIGHT EMPTY: 5545 kg  
 WEIGHT FULL OF WATER: 8525 kg  
 PAINT SPEC: PNT-11  
 INSULATION: 50C (VESSEL) / 38C (BOOT)  
 FOAMGLASS c/w ALUM. CLADDING  
 SHIP LOOSE: NO  
 COIL HYDROTEST: 13445 kPag

SERIAL NO: 054468-106 CRN: P3175.2  
 YEAR BUILT: 2005  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '01, ADDENDA '03  
 DESIGN PRESSURE: 8963 kPag  
 NOTE: DES. PRESS. IS MAWP  
 DESIGN TEMPERATURE: 65.5°C  
 M.D.M.T.: -28.8°C @ 8963 kPag  
 HYDROTEST PRESSURE: 11652 kPag  
 MATERIAL: HEAD: SA-516-70N  
 SHELL: SA-516-70N  
 RADIOGRAPHY: LONG: FULL UW11(o)  
 CIRC: FULL UW11(o)  
 P.W.H.T. MIN TEMP / TIME: NO  
 CORR. ALLOWANCE: 1.59mm  
 TAG NO: V-620

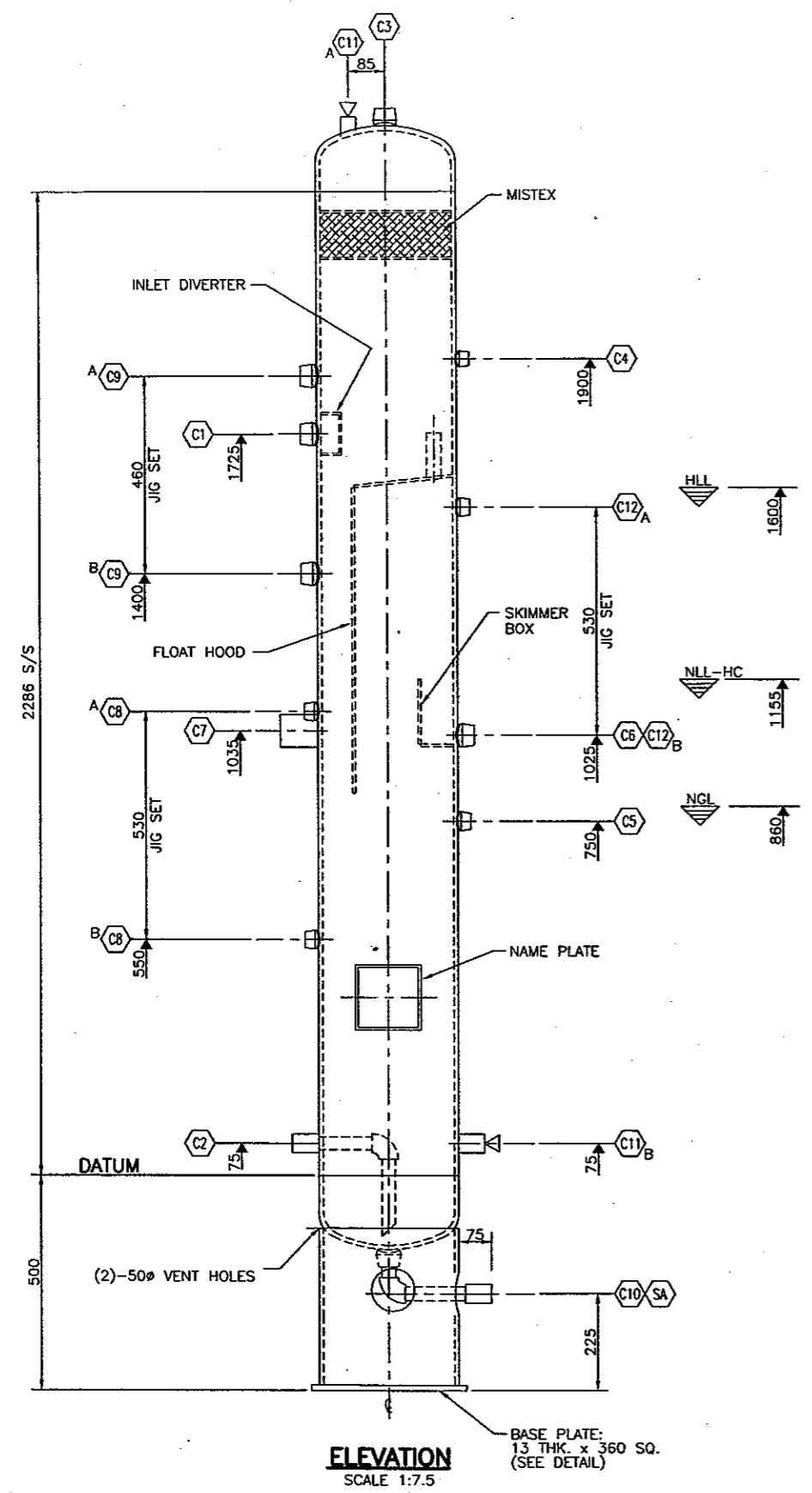
APPROVED		DRAWN		FORT ENERGY CORP.	
MECH/STRUCT.	BY	BY	DATE	88 REFRIGERATION UNIT	
DATE	DATE	CHECKED		LOW TEMPERATURE SEPARATOR (V-620)	
ELECTRICAL				914 O/D x 4572 S/S	
DATE	BY	DATE		DWG. No.: D-LTS-054468-106-SKT SHT. 1 OF 1 REV. SKT	
PROJECT	DATE	SCALE	AS NOTED		
GENERAL NOTES		GENERAL NOTES		No.	
ISSUED FOR DOCUMENTATION		A. LOW 05/09/30		YK MZ	
REVISION		BY DATE CKD ENG			

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

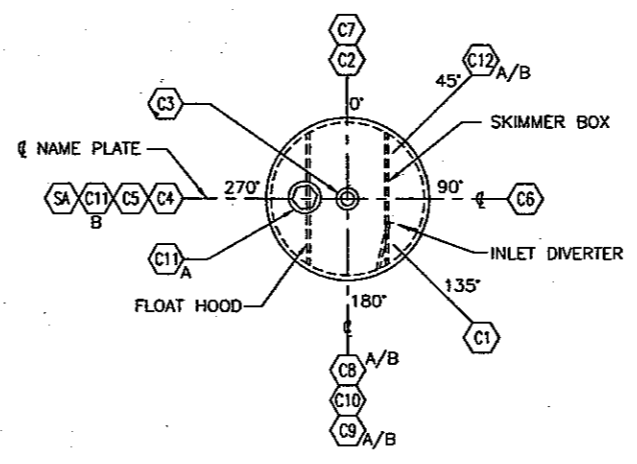
PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : GLYCOL FLASH TANK									
JOB NO. : XXXXXX TAG NO: V-640									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106B	N1					
3	HEADS		SA-234-WPB	N2					
4	SKIRTS		SA-106B	N3					
5	SADDLES			N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES			N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS			N9					
11	NUTS			N10					
12	GASKETS			N11					
13	COIL			N12					
14	RISER		--						
15	PACKING SUPPORT		--	C1	GLYCOL INLET	33	3000#	CPLG	
16	TRAY SUPPORTS		--	C2	GLYCOL OUTLET	33	3000#	NPT X SW	
17	BAFFLES		--	C3	GAS OUTLET	33	3000#	CPLG	
18	INLET BAFFLE		SA-36	C4	PI	21	3000#	CPLG	
19	VORTEX BREAKER			C5	TI	27	3000#	CPLG	
20	SYPHON DRAIN		--	C6	HC OUTLET	33	3000#	CPLG	
21	DEMISTER	102MM 193 KG/M3	304SS	C7	LC (GLYCOL)	60	3000#	CPLG	
22	DISTRIB. SPIDER		--	C8/A/B	LG (GLYCOL)	27	3000#	CPLG	
23	PACKING		--	C9/A/B	LSH	33	3000#	CPLG	
24	TRAYS		--	C10	DRAIN	33	3000#	NPT X SW	
25	PLATFORM		--	C11/A/B	INSPECTION	48	3000#	CPLG	
26	LADDER		--	C12/A/B	FUTURE LG (HC)	27	3000#	CPLG	
27	DAVIT		--						
28	INSULATION RINGS		--						
29	LIFTING LUGS		--						
30	PIPE CLIPS		--						
31	PIPE SUPPORTS		--						
32	SKIRT VENTS		YES						
33	SKIRT ACCESS		YES						
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD: (mm)	324	NOTES:				
37	S/S (mm)	2286							
38	DES PRESS (kPa)	1724	OPER. PRESS (kPa)	345					
39	DES TEMP °C	93	OPER. TEMP °C	54					
40	HYDROTEST		CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	NONE					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	PNT11					
50									
51	WEIGHT EMPTY ((kg)	285	HYDRO WEIGHT (kg)	465					
52	LSD								
53									
54									
55									
56									
57									



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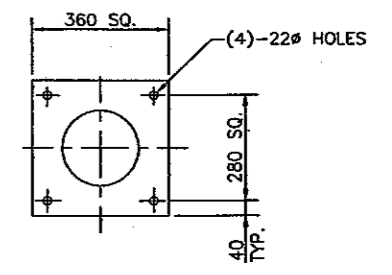


**ELEVATION**  
SCALE 1:7.5



**ORIENTATION**  
SCALE 1:7.5

NOZZLE SCHEDULE							
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD
C1	1 NPS	3000#	TOL	-	GLYCOL INLET	-	-
C2	1 NPS	3000#	NPTxSW	-	GLYCOL OUTLET	-	-
C3	1 NPS	3000#	TOL	-	GAS OUTLET	-	-
C4	1/2 NPS	3000#	TOL	-	P.I. / BLANKET GAS	-	-
C5	3/4 NPS	3000#	TOL	-	T.I.	-	-
C6	1 NPS	3000#	TOL	-	HC OUTLET	-	-
C7	2 NPS	3000#	CPLG	-	L.C. (GLYCOL)	-	-
A/B C8	3/4 NPS	3000#	TOL	-	L.G. (GLYCOL)	-	-
A/B C9	1 NPS	3000#	TOL	-	L.S.H.	-	-
C10	1 NPS	3000#	SOL	-	DRAIN	SPEC	-
A/B C11	1 1/2 NPS	3000#	CPLG	-	INSPECTION (PLUGGED)	-	-
A/B C12	3/4 NPS	3000#	TOL	-	LG (H.C.)	-	-
SA	100	-	-	-	SKIRT ACCESS	-	-



**BASE PLATE DETAIL**  
SCALE 1:10

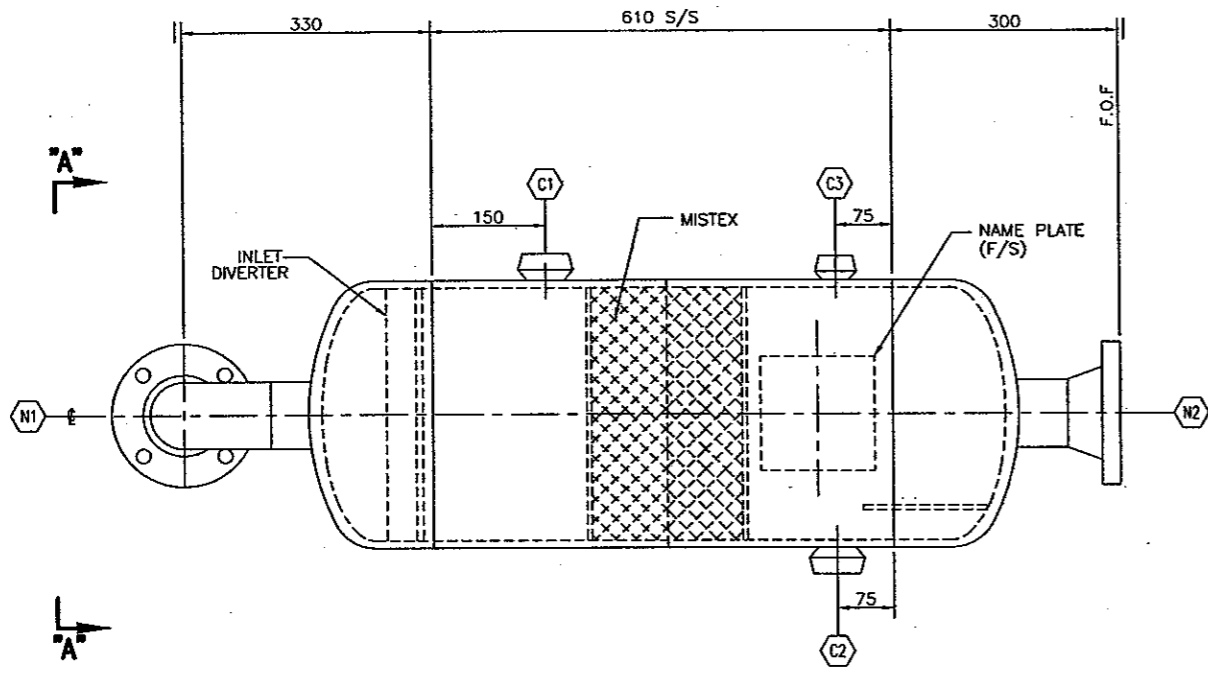
SERVICE: GLYCOL	SERIAL NO: 054468-115	CRN: P2864.2
LOADINGS PER UG-22(e) CONSIDERED GOVERNS: NO	YEAR BUILT: 2005	
PRODUCTION IMPACT TEST REQ'D: NO	LSD #:	
IMPACT TESTING: NO - PER UG20(f)(1-5)	CODE:	ASME SECT. VIII DIV I, '01, ADDENDA '03
CAPACITY: 0.18 m <sup>3</sup>	DESIGN PRESSURE	1724 kPag
WEIGHT EMPTY: 285 kg	NOTE: DES. PRESS. IS MAWP	
WEIGHT FULL OF WATER: 465 kg	DESIGN TEMPERATURE	93°C
PAINT SPEC: PNT-11	M.D.M.T.	-28.8°C @ 1724 kPag
INSULATION: NONE	HYDROTEST PRESSURE	2241 kPag
SHIP LOOSE: NO	MATERIAL:	HEAD: SA-234-WPB
		SHELL: SA-106-B
	RADIOGRAPHY:	LONG: N/A
		CIRC: SPOT UWII(b)
	P.W.H.T.	NO
	MIN TEMP / TIME	
	CORR. ALLOWANCE	1.59mm
	TAG NO: V-640	

GENERAL NOTES		GENERAL NOTES		SKT	ISSUED FOR DOCUMENTATION	C. YU	05/09/30	VK	MZ	APPROVED		DRAWN		FORT ENERGY CORP.		<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3
DATE: 2005/09/30 10:07 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\GFT-054468-115-SKT-01.DWG hmeng		No.		REVISION	BY	DATE	CKD	ENG	MECH/STRUCT.	BY	DATE	ELECTRICAL	CHECKED	BB REFRIGERATION UNIT GLYCOL FLASH TANK (V-640) 324 O/D x 2286 S/S		
									PROJECT	BY	DATE	DATE		DWG. No.: D-GFT-054468-115-SKT SHT. 1 OF 1		
									SCALE	AS NOTED				REV. SKT		

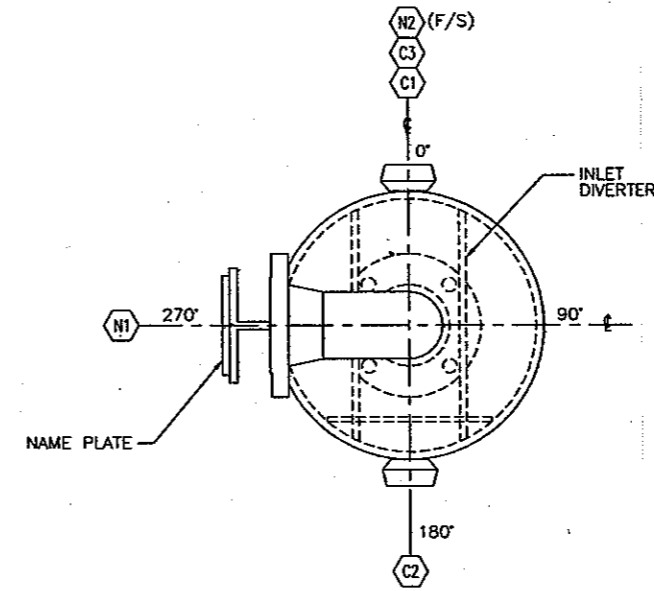
PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : DISCHARGE OIL SCRUBBER									
JOB NO. : XXXXXX TAG NO: V-660									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106B	N1	PROPANE INLET	89	150#	RFWN	
3	HEADS		SA-516-70	N2	PROPANE OUTLET	89	150#	RFWN	
4	SKIRTS			N3					
5	SADDLES			N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES		SA-105	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS			N9					
11	NUTS			N10					
12	GASKETS			N11					
13	COIL			N12					
14	RISER		--						
15	PACKING SUPPORT		--	C1	PI-660/INSPECTION	48	3000#	TOL	
16	TRAY SUPPORTS		--	C2	OIL OUTLET/INSPECTION	48	3000#	TOL	
17	BAFFLES		--	C3	VENT	33	3000#	TOL	
18	INLET BAFFLE			C4					
19	VORTEX BREAKER			C5					
20	SYPHON DRAIN		--	C6					
21	DEMISTER	204MM 193 KG/M3	304SS	C7					
22	DISTRIB. SPIDER		--	C8					
23	PACKING		--	C9					
24	TRAYS		--	C10					
25	PLATFORM		--	C11					
26	LADDER		--	C12					
27	DAVIT		--	C13					
28	INSULATION RINGS		--	C14					
29	LIFTING LUGS		--						
30	PIPE CLIPS		--						
31	PIPE SUPPORTS		--						
32	SKIRT VENTS								
33	SKIRT ACCESS								
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD: (mm)	356	NOTES:				
37	S/S (mm)	610							
38	DES PRESS (kPa)	1724	OPER. PRESS (kPa)	1450					
39	DES TEMP °C	93	OPER. TEMP °C	68					
40	HYDROTEST		CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	NONE					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	PNT11					
50									
51	WEIGHT EMPTY ((kg)	110	HYDRO WEIGHT (kg)	186					
52	LSD								
53									
54									
55									
56									
57									

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NOZZLE SCHEDULE							
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PRW	WELD
N1	3 NPS	150#	RFWN	XH	INLET	SPEC	-
N2	3 NPS	150#	RFWN	XH	OUTLET	SPEC	-
C1	1 1/2 NPS	3000#	TOL	-	PI / INSP. OPENING	-	-
C2	1 1/2 NPS	3000#	TOL	-	OIL OUT / INSP. OPENING	-	-
C3	1 NPS	3000#	TOL	-	VENT	-	-



**ELEVATION**  
SCALE 1:5



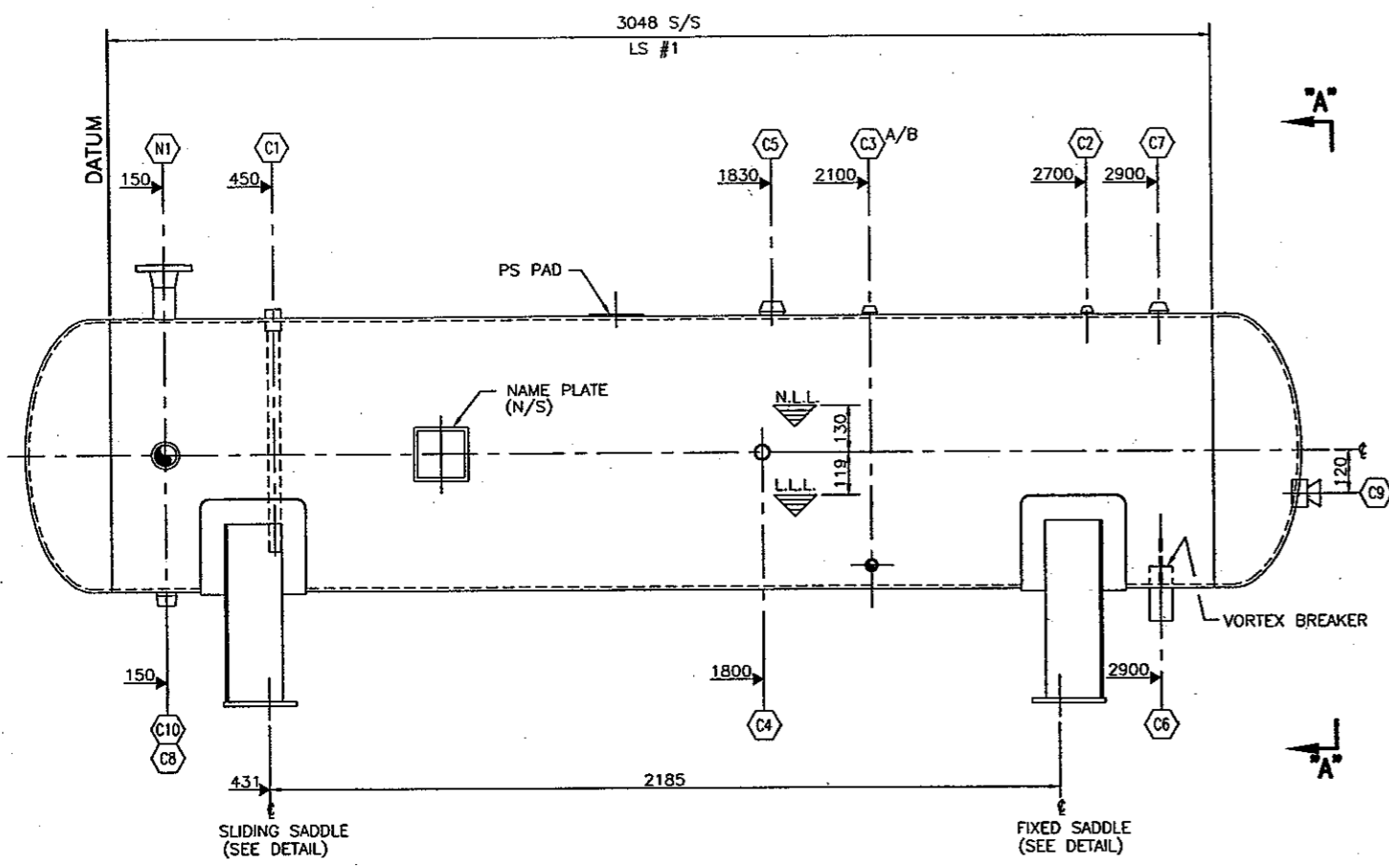
**VIEW 'A-A'**  
SCALE 1:5

SERVICE: PROPANE	SERIAL NO: 054468-109	CRN: P2865.2
LOADINGS PER UG-22(e) CONSIDERED GOVERNS: NO	YEAR BUILT: 2005	
PRODUCTION IMPACT TEST REQ'D: NO	LSD #: -	
IMPACT TESTING: NO - PER UG-20(f)(1-5)	CODE: ASME SECT. VIII DIV I, '01, ADDENDA '03	
CAPACITY: 0.076 m <sup>3</sup>	DESIGN PRESSURE: 1724 kPag	NOTE: DES. PRESS. IS MAWP
WEIGHT EMPTY: 110 kg	DESIGN TEMPERATURE: 93.3°C	
WEIGHT FULL OF WATER: 186 kg	M.D.M.T.: -28.8°C @ 1724 kPag	
PAINT SPEC: PNT-11	HYDROTEST PRESSURE: 2241 kPag	
INSULATION: NONE	MATERIAL: HEAD: SA-516-70N	
SHIP LOOSE: NO	SHELL: SA-106-B	
	RADIOGRAPHY: LONG: N/A	
	CIRC: SPOT UWII(b)	
	P.W.H.T. NO	
	MIN TEMP / TIME	
	CORR. ALLOWANCE: 1.59mm	
<b>TAG NO: V-660</b>		

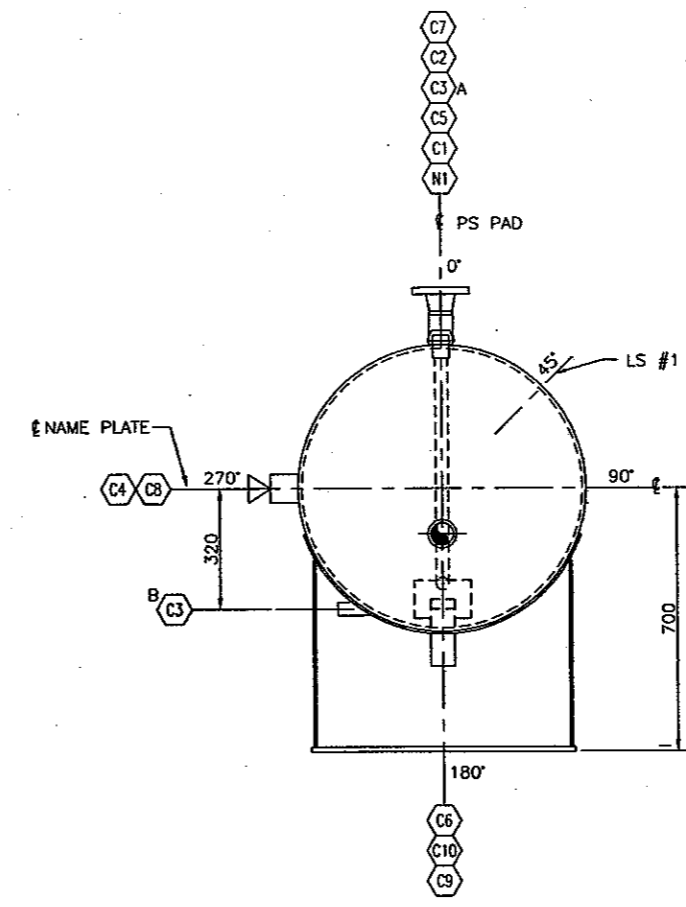
<b>GENERAL NOTES</b> DATE: 2005/09/30 10:06 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\SCR-054468-109-SKT-01.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION		A. LOW 05/09/30 VK NZ		<b>APPROVED</b> MECH/STRUCT. BY DATE ELECTRICAL BY CHECKED DATE PROJECT BY DATE DATE		<b>DRAWN</b> BY DATE CHECKED DATE		<b>FORT ENERGY CORP.</b> 88 REFRIGERATION UNIT DISCHARGE OIL SCRUBBER (V-660) 356 O/D x 610 S/S		<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
<b>REVISION</b> No. BY DATE CKD ENG		No. BY DATE CKD ENG		No. BY DATE CKD ENG		No. BY DATE CKD ENG		No. BY DATE CKD ENG		DWG. No.: D-SCR-054468-109-SKT SHT. 1 OF 1 REV. SKT		TAG NO: V-660	

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : REFRIGERANT ACCUMULATOR									
JOB NO. : XXXXXX TAG NO: V-680									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516-70	N1	PROPANE INLET	60	150#	RFWN	
3	HEADS		SA-516-70	N2					
4	SKIRTS			N3					
5	SADDLES		SA-36	N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES		SA-105	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS			N9					
11	NUTS			N10					
12	GASKETS			N11					
13	COIL			N12					
14	RISER		SA-106B						
15	PACKING SUPPORT	--		C1	HOT GAS BYPASS	33	3000#	CPLG	
16	TRAY SUPPORTS	--		C2	PI-680	21	3000#	CPLG	
17	BAFFLES	--		C3A/B	LG-680	27	3000#	CPLG	
18	INLET BAFFLE	--		C4	TI-680	27	3000#	CPLG	
19	VORTEX BREAKER		SA-36	C5	PSV-680	48	3000#	CPLG	
20	SYPHON DRAIN	--		C6	PROPANE OUTLET	48	3000#	CPLG	
21	DEMISTER			C7	EQUALIZING	33	3000#	CPLG	
22	DISTRIB. SPIDER	--		C8A/B	INSPECTION C/W PLUG	60	3000#	CPLG	
23	PACKING	--		C9	FUTURE C/W PLUG	60	3000#	CPLG	
24	TRAYS	--		C10	DRAIN	33	3000#	CPLG	
25	PLATFORM	--		C11					
26	LADDER	--		C12					
27	DAVIT	--		C13					
28	INSULATION RINGS	--		C14					
29	LIFTING LUGS	--							
30	PIPE CLIPS	--							
31	PIPE SUPPORTS	--							
32	SKIRT VENTS								
33	SKIRT ACCESS								
34									
35 DESIGN DATA									
36	SIZE: ID (mm)		OD: (mm)	762	NOTES:				
37	S/S (mm)	3048							
38	DES PRESS (kPa)	1724	OPER. PRESS (kPa)	1440					
39	DES TEMP °C	66	OPER. TEMP °C	43					
40	HYDROTEST		CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	NONE					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	PNT11					
50									
51	WEIGHT EMPTY ((kg)	776	HYDRO WEIGHT (kg)	2248					
52	LSD								
53									
54									
55									
56									
57									

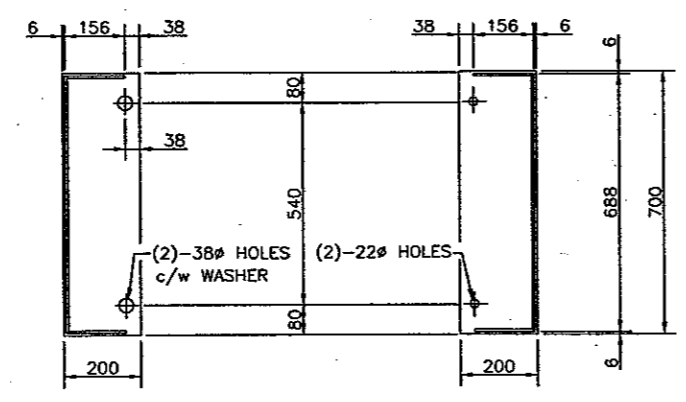
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**ELEVATION VIEW**  
SCALE 1:10



**VIEW 'A-A'**  
SCALE 1:10



**FIXED & SLIDING SADDLE DETAIL**  
SCALE: 1:10

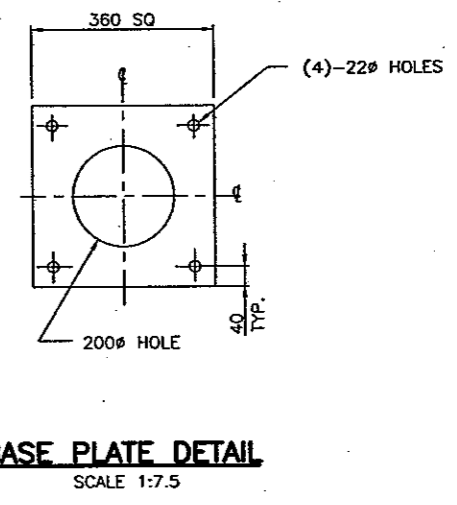
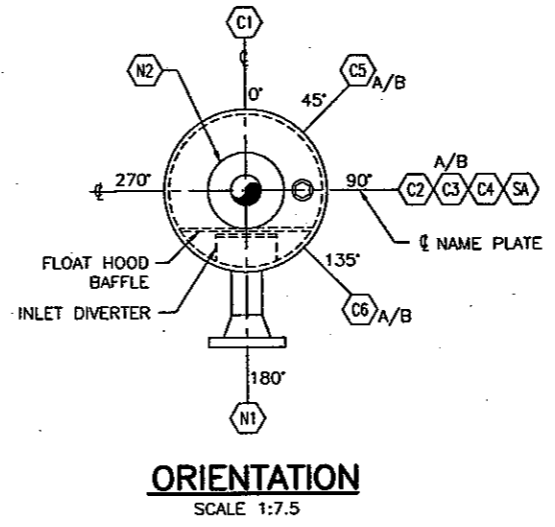
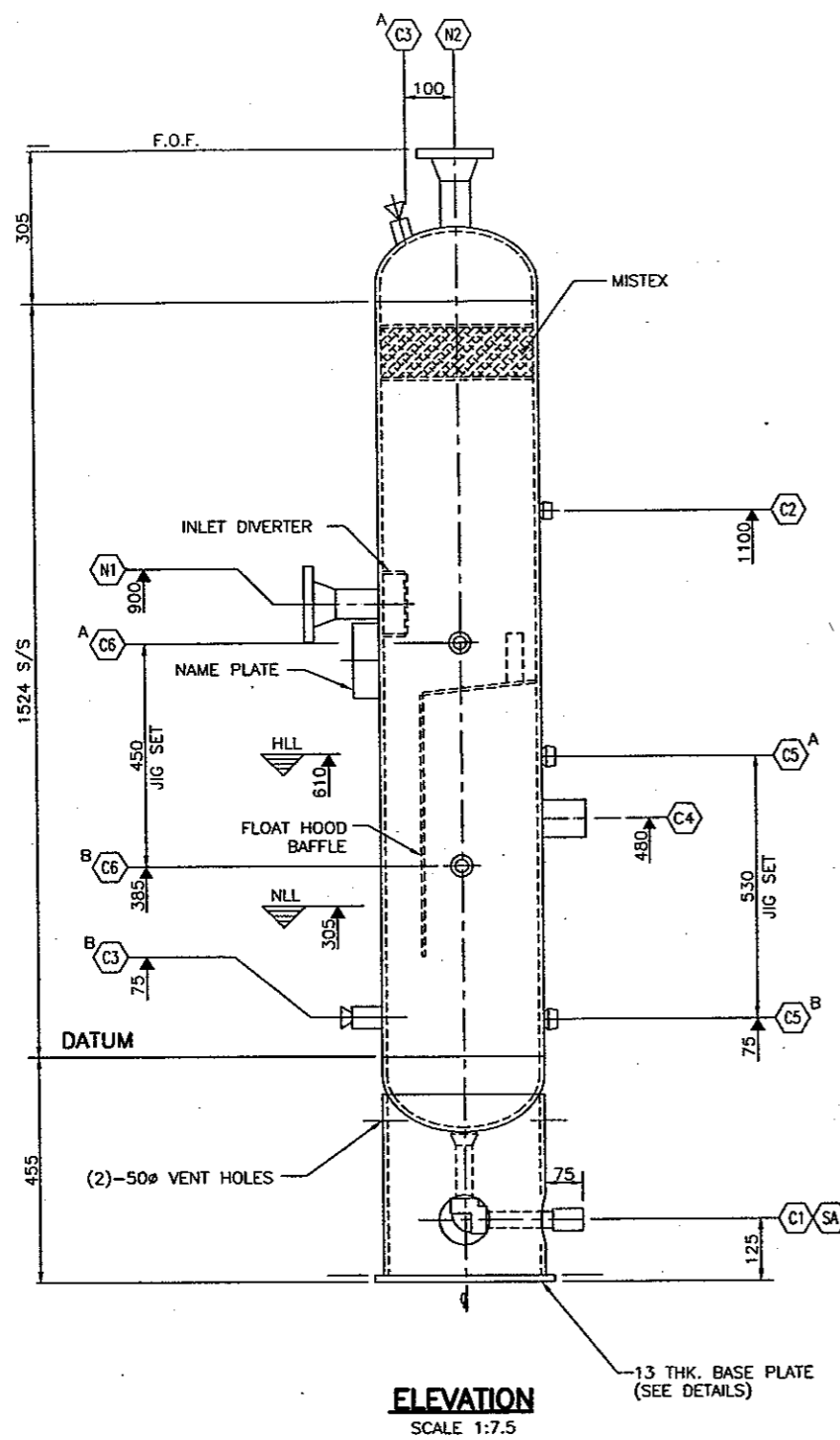
NOZZLE SCHEDULE							
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ	WELD
N1	2 NPS	150#	RFWN	160	INLET	150	-
C1	1 NPS	3000#	CPLG	-	HOT GAS BYPASS	-	-
C2	1/2 NPS	3000#	TOL	-	PI	-	-
C3	3/4 NPS	3000#	CPLG	XL	LG	-	-
C3	3/4 NPS	3000#	TOL	-	LG	-	-
C4	3/4 NPS	3000#	TOL	-	TI	-	-
C5	2 NPS	3000#	TOL	-	PSV	-	-
C6	1 1/2 NPS	3000#	CPLG	XL	OUTLET	-	-
C7	1 NPS	3000#	TOL	-	EQUALIZER	-	-
C8	2 NPS	3000#	CPLG	-	INSPECTION (PLUGGED)	-	-
C9	2 NPS	3000#	1/2CPLG	-	FUTURE LSL / INSP (PLUGGED)	-	-
C10	1 NPS	3000#	TOL	-	DRAIN	-	-

SERVICE: PROPANE	SERIAL NO: 054468-201	CRN: P1708.2
LOADINGS PER UG-22(e) CONSIDERED GOVERNS: NO	YEAR BUILT: 2005	LSD #: -
PRODUCTION IMPACT TEST REQ'D: NO	CODE: ASME SECT. VIII DW I, '01, ADDENDA '03	
IMPACT TESTING: NO-PER UG20(f)(1-5)	DESIGN PRESSURE: 1724 kPag	NOTE: DES. PRESS. IS MAWP
CAPACITY: 1.47 m <sup>3</sup>	DESIGN TEMPERATURE: 65.5°C	
WEIGHT EMPTY: 800 kg	MAXIMUM TEST PRESSURE: 2241 kPag	
WEIGHT FULL OF WATER: 2270 kg	RADIOGRAPHY: HEAD: SA-516-70N	
PAINT SPEC: PNT-11	RADIOGRAPHY: SHELL: SA-516-70N	
INSULATION: NONE	LONG: SPOT UWII(b)	
SHIP LOOSE: NO	P.W.H.T. CIRC: SPOT UWII(b)	
	MIN TEMP / TIME: NO	
	CORR. ALLOWANCE: 1.59mm	
	TAG NO: V-680	

<b>GENERAL NOTES</b> DATE: 2005/09/30 10:08 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\ACC-054468-201-SKT-01.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION		C. YU 05/09/30 VK MZ		<b>APPROVED</b> MECH/STRUCT. BY DATE ELECTRICAL BY DATE PROJECT BY DATE DATE SCALE AS NOTED		<b>DRAWN</b> BY DATE CHECKED BY DATE DATE SCALE AS NOTED		<b>FORT ENERGY CORP.</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
<b>GENERAL NOTES</b> No. REVISION		No. REVISION		BY DATE CKD ENG		DWG. No.: D-ACC-054468-201-SKT SHT. 1 OF 1 REV. SKT					

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
				REV		DATE		REVISION DESCRIPTION	
CUSTOMER : XXXXX									
PLANT : REFRIGERATION PLANT 8B									
SERVICE : FUEL GAS SCRUBBER									
JOB NO. : XXXXX TAG NO: V-690									
MFR. : PSL MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106B	N1	GAS INLET	60	150#	RFWN	
3	HEADS		SA-516-70	N2	GAS OUTLET	60	150#	RFWN	
4	SKIRTS		SA-106B	N3					
5	SADDLES			N4					
6	PIPE		SA-106B	N5					
7	PIPE FITTINGS			N6					
8	FLANGES		SA-105	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS			N9					
11	NUTS			N10					
12	GASKETS			N11					
13	COIL			N12					
14	RISER		--						
15	PACKING SUPPORT		--	C1	LIQUID OUTLET	33	3000#	NPT X SW	
16	TRAY SUPPORTS		--	C2	PI-690	21	3000#	TOL	
17	BAFFLES		--	C3	LC-690	60	3000#	CPLG	
18	INLET BAFFLE		SA-36	C4AB	LG-690	27	3000#	TOL	
19	VORTEX BREAKER			C5AB	LSH-690	33	3000#	TOL	
20	SYPHON DRAIN		--	C6AB	INSPECTION	48	3000#	CPLG	
21	DEMISTER	102MM 193 KG/M3	304SS	C7					
22	DISTRIB. SPIDER		--	C8					
23	PACKING		--	C9					
24	TRAYS		--	C10					
25	PLATFORM		--	C11					
26	LADDER		--	C12					
27	DAVIT		--	C13					
28	INSULATION RINGS		--	C14					
29	LIFTING LUGS		--						
30	PIPE CLIPS		--						
31	PIPE SUPPORTS		--						
32	SKIRT VENTS		YES						
33	SKIRT ACCESS		YES						
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD: (mm)	324	NOTES:				
37	S/S (mm)	1524							
38	DES PRESS (kPa)	1724	OPER. PRESS (kPa)	700					
39	DES TEMP °C	66	OPER. TEMP °C	38					
40	HYDROTEST		CORR. ALLOW. (mm)	1.59					
41	MDMT	-28.8	CYCLIC LOAD						
42	X-RAY	CODE	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)		EARTHQUAKE ZONE						
44	SOUR SERVICE	NO	INSUL THK (mm)	NONE					
45	FIREPROOF		REFRACTORY THK (mm)						
46	INT. SURFACE PREP.		EXT. SURFACE PREP.	SSPC-SP6					
47	INT. COATING		PRIMER COAT	PNT11					
48	ASME SEC. VIII DIV.	1	FINISH COAT	PNT11					
49	STAMP REQ'D	YES	FINISH COLOR	PNT11					
50									
51	WEIGHT EMPTY ((kg)	210	HYDRO WEIGHT (kg)	335					
52	LSD								
53									
54									
55									
56									
57									

THIS DRAWING AND THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAX SYSTEMS LTD. AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAX.



NOZZLE SCHEDULE						
MK	SIZE	RATING	FACING	SCH	SERVICE	EXT. PROJ WELD
N1	2 NPS	150#	RFWN	XH	GAS INLET	150
N2	2 NPS	150#	RFWN	XH	GAS OUTLET	SPEC
C1	1 NPS	3000#	SOL	-	LIQUID OUT	-
C2	1/2 NPS	3000#	TOL	-	P.I.	-
A/B C3	1 1/2 NPS	3000#	CPLG	-	INSPECTION (PLUGGED)	-
A/B C4	2 NPS	3000#	CPLG	-	L.C.	-
A/B C5	3/4 NPS	3000#	TOL	-	L.G.	-
A/B C6	1 NPS	3000#	TOL	-	L.S.H.	-
SA	100	-	-	-	SKIRT ACCESS	-

SERVICE: GAS	SERIAL NO: 054468-108	CRN: P0945.21
LOADING PER UG 22(e) CONSIDERED GOVERNS: NO	YEAR BUILT: 2005	
PRODUCTION IMPACT TEST REQ'D: NO	LSD #: -	
IMPACT TESTING: NO - PER UG20(f)(1-5)	CODE: ASME SECT. VIII DIV I, '01, ADDENDA '03	
CAPACITY: 0.126 m <sup>3</sup>	DESIGN PRESSURE	1724 kPag
WEIGHT EMPTY: 210 kg	DESIGN TEMPERATURE	65.5°C
WEIGHT FULL OF WATER: 335 kg	M.D.M.T.	-28.8°C @ 1724 kPag
PAINT SPEC: PNT-11	HYDROTEST PRESSURE	2241 kPag
STACK: -	MATERIAL: HEAD: SA-234-WPB SMLS	
INSULATION: NONE	SHELL: SA-106-B SMLS	
SHIP LOOSE: NO	RADIOGRAPHY: LONG: N/A	
	CIRC: SPOT UWII(b)	
	P.W.H.T. MIN TEMP / TIME	NO
	CORR. ALLOWANCE	1.59mm
	TAG NO: V-690	

<b>GENERAL NOTES</b> DATE: 2005/09/30 10:05 AM J:\JOBS05\054468\20-DRAWINGS\FAB\MISC\FGS-054468-108-SKT-01.DWG hmeng		<b>GENERAL NOTES</b> SKT ISSUED FOR DOCUMENTATION		F. DEL 05/09/30 VK MZ BY DATE CKD ENG		<b>APPROVED</b> MECH/STRUCT. BY DATE ELECTRICAL BY DATE PROJECT BY DATE DATE		<b>DRAWN</b> BY DATE CHECKED BY DATE SCALE AS NOTED		<b>FORT ENERGY CORP.</b> BB REFRIGERATION UNIT FUEL GAS SCRUBBER (V-690) 324 O/D x 1524 LG.		<b>PROPAX</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
<b>REVISION</b> No.		REVISION		DWG. No.: D-FGS-054468-108-SKT SHT. 1 OF 1		REV. SKT							

Fort Energy - 8B Refrigeration Unit

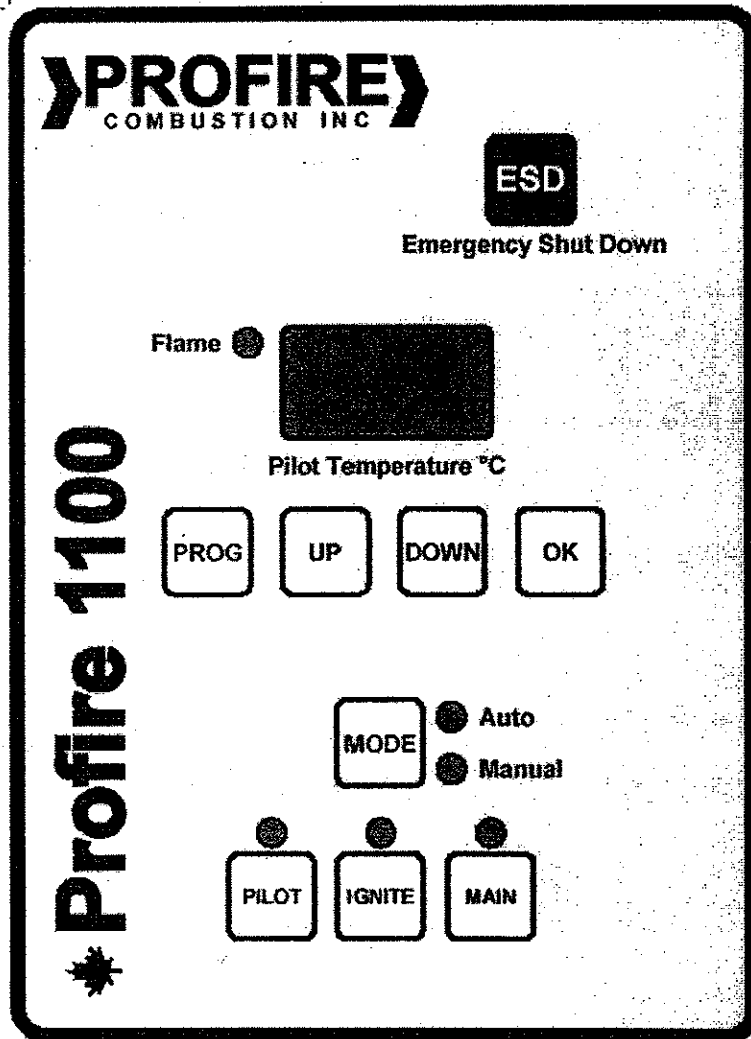
REV	1	RDD								
DATE	29-Jul-05									
REV	TAG	MFS	RANGE	ENG	SET	INSTRUMENT	MANUFACTURER	MODEL #	COMMENTS	AREA
#	#	#		UNIT	POINT	TYPE				#
1	BE-633	4				PROFIRE FLAME SAFETY SYSTEM	PROFIRE			152
1	BE-650	6				PROFIRE FLAME SAFETY SYSTEM	PROFIRE			152
1	BY-633	4				PROFIRE FLAME SAFETY SYSTEM	PROFIRE			152
1	BY-650	6				PROFIRE FLAME SAFETY SYSTEM	PROFIRE			152
0	BPV-640	6	345-655	Kpa	420	BACK PRESSURE VALVE	FISHER	630R-103	33mm NPT, 12.7mm PORT	152
0	DPI-601	6	0-200	kPa		DIFF. PRESSURE INDICATOR	MIDWEST	120-AA-00-00		152
0	DPI-602	6	0-200	kPa		DIFF. PRESSURE INDICATOR	MIDWEST	120-AA-00-00		152
0	DPT-670	5	0-1750	kPa		DIFF. PRESSURE TRANSMITTER	ROSEMOUNT	3051CD4A22A1AS5C6	305 Element, 316 SS Element	152
0	ESDV-600	3	20-100	kPa		EMERGENCY SHUTDOWN	FISHER	357-40	33mmNPT 12.5mm PORT	152
0	FCV-671A/B	5	20-100	kPa		3-WAY SWITCHING VALVE	FISHER	164A	21mm NPT STD TRIM	152
0	FCV-672	5	20-100	kPa		3-WAY SWITCHING VALVE	FISHER	164A	21mm NPT STD TRIM	152
0	FE-690	6	0-100	in WC		FLOW ELEMENT	DANIEL	ORIFICE FLANGES W/JACK BOLTS	25.4mm DIAM.BORE	152
0	FI-601	3	0.5-3.75	l/m		FLOW INDICATOR	HEDLAND	H613A-001	21mm NPT	152
0	FI-602	3	0.5-3.75	l/m		FLOW INDICATOR	HEDLAND	H613A-001	21mm NPT	152
0	FI-611	3	0.5-3.75	l/m		FLOW INDICATOR	HEDLAND	H613A-001	21mm NPT	152
0	FM/FQI-630	4	22.7-283	l/m		TURBINE METER	BARTON	8001 C/W FIRST RATE + TOTALIZER	33mmNPT	152
0	FR/PR/TR-690	6	0-100	in WC	60	FLOW RECORDER	BARTON	202E.3 PEN RECORDER	0-1400 kPag, -29-65 C RANGE	152
0	H-670	5	10-120	°C	34	HEATER	CALORITECH	#CXFT103P1X	33mmNPT, XP, CSA APPROVED	152
0	LC-610	3	20-100	kPa		LEVEL CONTROLLER	FISHER	2500-249B PARTIAL	76 O.D. X 356mm LG. SS DISPLACER	152
0	LC-620A	3	20-100	kPa		LEVEL CONTROLLER	FISHER	2500-249B PARTIAL	76 O.D. X 356mm LG. SS DISPLACER	152
0	LC-620B	3	20-100	kPa		LEVEL CONTROLLER	FISHER	2500-249B PARTIAL	76 O.D. X 356mm LG. SS DISPLACER	152
0	LC-630	4	20-100	kPa		LEVEL CONTROLLER	FISHER	2500-249B PARTIAL	76 O.D. X 356mm LG. SS DISPLACER	152
0	LC-640	6	20-100	kPa		LEVEL CONTROLLER	FISHER	2680	48 O.DX 305mm LG. PVC DISPLACER	152
0	LC-690	6	20-100	kPa		LEVEL CONTROLLER	FISHER	2680	48 O.DX 305mm LG. PVC DISPLACER	152
0	LCV-610	3	20-100	kPa		FLOW CONTROL VALVE	FISHER	667-D-34	33mmNPT, 19.0mm PORT	152
0	LCV-620A	4	20-100	kPa		FLOW CONTROL VALVE	FISHER	667-D-34	33mmNPT, 12.5mm PORT	152
0	LCV-620B	3	20-100	kPa		FLOW CONTROL VALVE	FISHER	667-D-30	33mmNPT, 1 FLUTE 6.4mm PORT	152
0	LCV-630	4	20-100	kPa		FLOW CONTROL VALVE	FISHER	667-D-30	33mmNPT, 12.5mm PORT	152
0	LCV-640	6	20-100	kPa		FLOW CONTROL VALVE	FISHER	357-20	33mmNPT 6.4mm PORT	152
0	LCV-690	6	20-100	kPa		FLOW CONTROL VALVE	FISHER	128PQC	33mmNPT, 6.4mm PORT	152
0	LD-660	5				LEVEL DRAINER	ARMSTRONG	LD-11		152
0	LG-610	3				LEVEL GAUGE	PENBERTHY	1RL9 / 330J	C/W FROST SHIELD	152
0	LG-620A	3				LEVEL GAUGE	PENBERTHY	1RL9 / 330J	C/W FROST SHIELD	152
0	LG-620B	3				LEVEL GAUGE	PENBERTHY	1TH9 / 330J	C/W FROST SHIELD	152
0	LG-630	4				LEVEL GAUGE	PENBERTHY	1RL9 / 330J		152
0	LG-633	4				LEVEL GAUGE	PENBERTHY	2RL9 / 330J		152
0	LG-640	6				LEVEL GAUGE	PENBERTHY	1TL9 / 330J		152
0	LG-641	6				LEVEL GAUGE	PENBERTHY	1RL9 / 330J		152
0	LG-650	6				LEVEL GAUGE	PENBERTHY	TUBULAR	N7A GAUGE COCKS	152
0	LG-680	5				LEVEL GAUGE	PENBERTHY	2RL9 / 330J		152
0	LG-690	6				LEVEL GAUGE	PENBERTHY	1RL9 / 330J		152
0	LSH-610	3				LEVEL SWITCH HIGH	SOR	1510B-G2A-C-W9-ES	60mm NPT Connection	152
0	LSH-620	3				LEVEL SWITCH HIGH	SOR	1510B-G2A-C-W9-ES	60mm NPT Connection	152
0	LSH-630	4				LEVEL SWITCH HIGH	SOR	1510B-G2A-C-W9-ES	60mm NPT Connection	152
0	LSH-640	6				LEVEL SWITCH HIGH	SOR	1510B-G2A-C-W9-ES	60mm NPT Connection	152
0	LSH-690	6				LEVEL SWITCH HIGH	SOR	1510B-G2A-C-W9-ES	60mm NPT Connection	152
0	PC-630	4	0-3447	kPa		PRESSURE CONTROLLER	FISHER	4150	STD TRIM,21-103KPa OUTPUT	152
0	PC-670	5	0-207	kPa		PRESSURE CONTROLLER	FISHER	4152K	21-103KPa OUTPUT	113
0	PC-680	5	0-2068	kPa		PRESSURE CONTROLLER	FISHER	4150	STD TRIM,21-103KPa OUTPUT	152
0	PCV-630	4	20-100	kPa		PRESSURE CONTROL VALVE	FISHER	667-ET-34 C/W 3582 POSITIONER	48mm NPT, 47.6mm Port	152
0	PCV-631	4	20-100	kPa		PRESSURE CONTROL VALVE	FISHER	667-D-30 C/W 3582 POSITIONER	33mmNPT 19mm Port	152
0	PCV-680	5	20-100	kPa		PRESSURE CONTROL VALVE	FISHER	667-ET-34	48mmNPT 47.6mm Port	152
0	PD-656	6				PULSATION ACCUMULATOR	OILAIR	1qt.-100-1	33mm FNPT	152



0	PD-657	6				PULSATION ACCUMULATOR	OILAIR	1qt.-100-1	33mm FNPT	152
0	PDSH-670	5	241-2586	kPa	1482	DIFFERENTIAL PRESSURE SWITCH	SOR	13RB-KA5-N4-F1A-PP		113
0	PDSL-670	5	55-276	kPa	138	DIFFERENTIAL PRESSURE SWITCH	SOR	101AG-EF3-N4-C1A-PP		113
0	PI-600	3	0 - 10,000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-601	3	0 - 10,000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-610	3	0-1600	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-620	3	0 - 10,000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-630	4	0-4000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-633	4	0-250	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-640	6	0-1000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			112
0	PI-650	6	0-250	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PI-655A	6	0 - 10,000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL	LIQUID FILLED		152
0	PI-655B	6	0 - 10,000	kPa		PRESSURE INDICATOR	WIKA OR EQUAL	LIQUID FILLED		152
0	PI-660	5	0-2500	kPa		PRESSURE INDICATOR	WIKA OR EQUAL	LIQUID FILLED		112
0	PI-670	5	0 - 400	kPa		PRESSURE INDICATOR	HYDROPOISE OR EQUAL	PANEL MOUNT	OIL FILLED,14mm NPT	113
0	PI-671	5	0 - 2800	kPa		PRESSURE INDICATOR	HYDROPOISE OR EQUAL	PANEL MOUNT	OIL FILLED,14mm NPT	113
0	PI-672	5	0 - 2800	kPa		PRESSURE INDICATOR	HYDROPOISE OR EQUAL	PANEL MOUNT	OIL FILLED,14mm NPT	113
0	PI-680	5	0-2500	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			112
0	PI-690	6	0-1600	kPa		PRESSURE INDICATOR	WIKA OR EQUAL			152
0	PRV/PI-635	4	20-103	kPa	14	PRESSURE REGULATOR	FISHER	67CFR C/W P.I.	14mmNPT,3.2mmPORT	152
0	PRV/PI-651	6	20-103	kPa	14	PRESSURE REGULATOR	FISHER	67CFR C/W P.I.	14mmNPT,3.2mmPORT	152
0	PRV-610	5	70-830	kPa	82	PRESSURE REGULATOR	REFRIG SPECIALTIES	A4A0	33mmNPT,25mm PORT	152
0	PRV-633	4	34-138	kPa	82	PRESSURE REGULATOR	FISHER	627	33mmNPT,3.2mmPORT	152
0	PRV-634	4	7-17	kPa	7	PRESSURE REGULATOR	FISHER	Y690H	33mmNPT,6.4mm PORT	152
0	PRV-641	6	413-700	kPa	400	PRESSURE REGULATOR	FISHER	67CFR	14mmNPT,3.2mmPORT	152
0	PRV-650	6	34-138	kPa	82	PRESSURE REGULATOR	FISHER	627	33mmNPT,3.2mmPORT	152
0	PRV-681	5	517-1930	kPa	700	PRESSURE REGULATOR	REFRIG SPECIAL TIES	A4A0	33mmNPT,25mm PORT	152
0	PRV-690	6	482-1034	kPa	700	PRESSURE REGULATOR	FISHER	627	33mmNPT,4.8mm PORT	152
0	PRV-691	6	482-1034	kPa	650	PRESSURE REGULATOR	FISHER	627	33mmNPT,4.8mm PORT	152
0	PRV-INST		35-200	kPa		PRESSURE REGULATOR	FISHER	67CFR	FOR INSTRUMENT AIR SERVICE	152
0	PSH-670	5	172-1896	kPa	1640	PRESSURE SWITCH	SOR	6BA-KB45-N4-F1A-PP		113
0	PSHH-633	4	62-517	kPa	210	PRESSURE SWITCH	CCS DUAL SNAP	6900GZE14	XP,CSA,24VDC	152
0	PSLL-633	4	7-124	kPa	35	PRESSURE SWITCH	CCS DUAL SNAP	6900GZE12	XP,CSA,24VDC	152
0	PSL-670	5	7-110	kPa	40	PRESSURE SWITCH	SOR	12BA-KB45-N4-B1A-PP		113
0	PSV-600	3		kPa	8963	PRESSURE RELIEF VALVE	CONSOLIDATED	1912GC	48mmRF-600#-x 73mmRF-150#	152
0	PSV-601	6		kPa	1000	PRESSURE RELIEF VALVE	CONSOLIDATED	3/4-19096Lc	27mm NPT x 33mm NPT	152
0	PSV-602	6		kPa	1000	PRESSURE RELIEF VALVE	CONSOLIDATED	3/4-19096Lc	27mm NPT x 33mm NPT	152
0	PSV-610	3		kPa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	1905LC	89mm RF-150#x114mmRF-150#	152
0	PSV-615	3		kPa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	1905LC	89mm RF-150#x114mmRF-150#	152
0	PSV-630	4		kPa	3792	PRESSURE RELIEF VALVE	CONSOLIDATED	2-19567Mc	60mm NPT x 73mm NPT	152
0	PSV-633	4		kPa	14 kPa	THIEF HATCH	ENARDO	660	8" RING FLANGE VITON GASKET	152
0	PSV-640	6		kPa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	1-19226Lc	33mm-NPT x 48mmNPT	152
0	PSV-650	6		kPa	4 OZ	PRESSURE RELIEF HATCH	ENARDO	MODEL A	219mm, BUNA-N GASKET	152
0	PSV-655A	6		kPa	8963	PRESSURE RELIEF VALVE	CONSOLIDATED	3/4-19096Mc	27mm NPT x 33mm NPT	152
0	PSV-655B	6		kPa	8963	PRESSURE RELIEF VALVE	CONSOLIDATED	3/4-19096Mc	27mm NPT x 33mm NPT	152
0	PSV-670	5		kPa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	1.5-19357Lc	48mm NPT x 60mm NPT	152
0	PSV-681	5		Kpa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	2-19567Lc	60mm NPT x 73mm NPT	152
0	PSV-690	6		Kpa	1724	PRESSURE RELIEF VALVE	CONSOLIDATED	1.5-19357Lc	48mm NPT x 60mm NPT	152
0	PT-670	5	0-1750	Kpa		PRESSURE TRANSMITTER	ROSEMOUNT	3051CG4A22A1AS5C6	305 Element, 316 SS Element	152
0	SDV-633	4	20-550	Kpa		SHUTDOWN VALVE	VCI	CSA201F-66-PB-SE-V50	33mm NPT, STD TRIM	152
0	SDV-634	4	20-550			SHUTDOWN VALVE	VCI	CSA201F-66-PB-SE-V50	21mm NPT, STD TRIM	152
0	SDV-650	6	20-550	Kpa		SHUTDOWN VALVE	VCI	CSA201F-46-PB-SE-V50	33mm NPT, STD TRIM	152
0	SDV-651	6	20-550			SHUTDOWN VALVE	VCI	CSA201F-46-PB-SE-V50	21mm NPT, STD TRIM	152
0	SOV-600	3				3-WAY SOLENOID VALVE	ASCO	8320A206	14mmNPT, 24V DC,XP,	152
0	SOV-631	4				3-WAY SOLENOID VALVE	ASCO	8320A206	14mmNPT, 24V DC,XP,	152
0	SOV-633	4				3-WAY SOLENOID VALVE	ASCO	8320G714	14mmNPT, 24V DC,XP,	152
0	SOV-634	4				3-WAY SOLENOID VALVE	ASCO	8320G714	14mmNPT, 24V DC,XP,	152
0	SOV-650	6				3-WAY SOLENOID VALVE	ASCO	8320G714	14mmNPT, 24V DC,XP	152
0	SOV-651	6				3-WAY SOLENOID VALVE	ASCO	8320G714	14mmNPT, 24V DC,XP	152
0	SOV-670	5				3-WAY SOLENOID VALVE	ASCO	8320A206	14mmNPT, 24V DC,XP,	152
0	SOV-671A/B/C	5				3-WAY SOLENOID VALVE	ASCO	8320G202	14mmNPT, 24V DC,XP,	152

0	SP-01	3				SPRAY NOZZLE		S.S. 1/8 GG3	1.59mm ORIFICE,1/8 MNPT	152
0	SP-02	3				SPRAY NOZZLE		S.S. 1/8 GG1	0.79mm ORIFICE,1/8 NPT	152
0	TCV-630	4	20-100	Kpa		TEMPERATURE CONTROL VALVE	FISHER	667-ED-34	48mmNPT,47.6 PORT	152
0	TCV-633	4	20-100	Kpa		MOTOR VALVE	KIMRAY	130-SMT-DAB	33mmNPT,STD TRIM	152
0	TCV-650	6	20-100	Kpa		MOTOR VALVE	KIMRAY	130-SMT-DAB	33mmNPT,STD TRIM	152
0	TI-600	3	0-100	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	152mm STEM LENGTH	27mm NPT	152
0	TI-601	3	0-100	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	152mm STEM LENGTH	27mm NPT	152
0	TI-610	3	-50-50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-611	3	-50-50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	152mm STEM LENGTH	27mm NPT	152
0	TI-615	3	0 - 50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-616	3	-50 - 50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-620	3	-50-50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-630	4	0-200	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-631	4	-50 - 50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-633	4	0-300	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-635	3	0 - 50	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-640	6	0-100	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-650	6	0-200	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TI-651	6	0-150	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-671	5	0-150	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	102mm STEM LENGTH	27mm NPT	152
0	TI-680	5	0-100	°C		TEMPERATURE INDICATOR	TREND OR EQUAL	229mm STEM LENGTH	27mm NPT	152
0	TIC-630	4	50-200	°C		TEMP. INDICATOR CONTROLLER	FISHER	4196	C/W 27mm NPT 267mm INSERT	152
0	TIC-633	4	0-300	°C		TEMP. INDICATOR CONTROLLER	FISHER	4196	C/W 27mm NPT 267mm INSERT	152
0	TIC-650	6	50-200	°C		TEMP. INDICATOR CONTROLLER	FISHER	4196	C/W 27mm NPT 267mm INSERT	152
0	TSDH-633	4	-85 to 260	°C	225	HIGH TEMP SHUT DOWN	UNITED ELECTRIC	820E-3BS-M300-M446	27mm NPT, 191mm INSERTION	152
0	TSDH-650	6	-85 to 175	°C	140	HIGH TEMP SHUT DOWN	UNITED ELECTRIC	820E-2BS-M300-M446	27mm NPT, 191mm INSERTION	152
0	TSH-670	5	66-190	°C	121°C	TEMPERATURE SWITCH	SOR	205AG-EF-115-U9-C7A	27mmNPT 64mm INSERTION	152
0	VSD-670	5				VIBRATION SWITCH	MURPHY	VS2-EX	X.P., CSA APPROVED	152
0	VSD-671	5				VIBRATION SWITCH	MURPHY	VS2-EX	X.P., CSA APPROVED	152
0	VSH-610	5				VIBRATION SWITCH	MURPHY	VS-2EX	X.P., CSA APPROVED	214
0	VSH-620	5				VIBRATION SWITCH	MURPHY	VS-2EX	X.P., CSA APPROVED	214
0	ZSC-633	4				LIMIT SWITCH	ASCO	VR7C2YAA2NGA-LS	2-SPDT, MECH. CONTACT, XP, CSA	152
0	ZSC-650	6				LIMIT SWITCH	ASCO	VR7C2YAA2NGA-LS	2-SPDT, MECH. CONTACT, XP, CSA	152

# PROFIRE 1100



IGNITION FLAME SAFETY CONTROLLER

## **Cautions**

### **WARNING:**

**EXPLOSION HAZARD- -DO NOT SERVICE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS**

**-DO NOT OPEN WHEN ENERGIZED**

**EXPLOSION HAZARD- -SUBSTITUTION OF COMPONENTS MAY IMPAIR THE SUITABILITY FOR DIVISION 2/ ZONE 2**

**-REPLACEMENT FUSES MUST BE SAND-FILLED**

## **INSTALLATION WARNING**

### **Terminal Connections:**

**Connections must conform to the directions in this manual.**

**The unit must be properly connected to earth-ground for effective ionization operation.**

**Electrical devises connected to the controller must meet electrical standards and be within voltage limits.**

### **Contact Number**

**For any questions call:**

**780-960-5278**

## Table of Contents

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# PROFIRE 1100

Phone 780-960-5278

## IGNITION & FLAME SAFETY CONTROLLER

### WHY THE 1100?

The Profire 1100 was developed to meet the growing needs of our oilfield customers. The field parameters can be easily adjusted and operated, requiring no advanced electronics, Palm Pilots, etc.

The 1.8-second flame response provides a new safety element previously unavailable on affordable burner control units.

The Profire 1100 is compatible with both pneumatically and electrically controlled units. It was designed such that its enclosure size is similar to the most common ignition systems, thereby facilitating any change-outs and upgrading. Electricians will find the terminal connectors large and easily accessible.

From its appearance to its stable software and hardware, to its ease of operations, to its safety features, and to its more-than-reasonable price, the Profire 1100 is a sure winner!

#### Special Features

- Dual Flame sensing modes
- Under 1.8-second flame response
- Multi-solenoid connections
- Limit switch input
- Equipped with A.V.D. (Advanced Visual Display)

#### Additional Highlights:

- 12VDC or 24VDC
- Start lock out
- Remote ESD
- Remote Start

#### Certifications to:

CSA

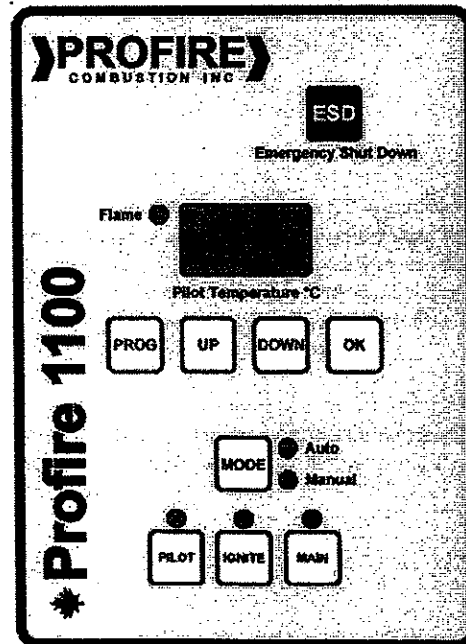
C22.2 No. 213-92

C22.2 No. 14-95

C22.2 No. 199-M89

### Rest Easy!

The Profire 1100 can easily be installed on new and existing field heaters thereby providing a comfort level to the operators, field personnel and owners alike. Its safety features make it a must for every site!



## **Features**

- ▶ **CSA compliant for:**
  - **Class 1, Division 2 locations approval (CSA 213-92).**
  - **Burner Safety approval (CSA 22.2-199).**
  - **Industrial Process Equipment approval (CSA 14-95).**
  
- ▶ **Input Power +10 to +28 VDC.**
  
- ▶ **RS-485 Modbus Communication option.**
  
- ▶ **Dual Flame-sensing for safety:**
  - **Thermocouple (type K thermocouple).**
  - **Flame Rod (ionization circuit)**
  
- ▶ **Rapid 1.8 second shut-down on flame-out.**
  
- ▶ **DC Voltage spark generator.**
  
- ▶ **Low-power design to incorporate solar panels or TEG applications.**
  
- ▶ **Auto relight or manual operation, push button selectable.**
  
- ▶ **Remote Start/Stop control.**
  
- ▶ **Remote ESD contact**
  
- ▶ **Pressure Switch monitoring**
  
- ▶ **Large, easily-accessible terminal connections.**
  
- ▶ **Equipped with AVD (Advanced Visual Display) for improved operating functions and signals.**
  
- ▶ **Programmed purge times, auto restart, and restart tries.**
  
- ▶ **START-LOCKOUT input for connections to safety interlock devices.**
  
- ▶ **All circuits are transient protected and are fail-safe.**
  
- ▶ **Alarm contact out-put**

PROFIRE COMBUSTION INC.

## **Specifications**

### **ENCLOSURE**

---

- ▶ Fiberglass 8" x 6" x 4"
- ▶ CSA and UL compliant for Class 1, Division 2 locations
- ▶ Enclosure type 4, 4X, 12, 13

### **CIRCUIT BOARDS**

---

- ▶ All solid state
- ▶ CSA compliant for Class 1, Division 2 locations

### **IGNITION BASE AND COIL**

---

- ▶ For non-hazardous area only

### **POWER REQUIREMENTS**

---

- ▶ +10 to +28 volts DC

### **SUPPLY CURRENT**

---

- ▶ 2.0 amps surge (limited), 0.015 - 2 amps run

### **POWER CONSUMPTION**

---

- ▶ 1100 only:
  - 12 volts - Display on - 106 ma or 1.3 watts
  - 12 volts - Display off - 43 ma or 0.6 watts
  - 24 volts - Display on - 66 ma or 1.6 watts
  - 24 volts - Display off - 35 ma or 0.9 watts

---

\* Constant current solenoids add power required by solenoid manufacturer.

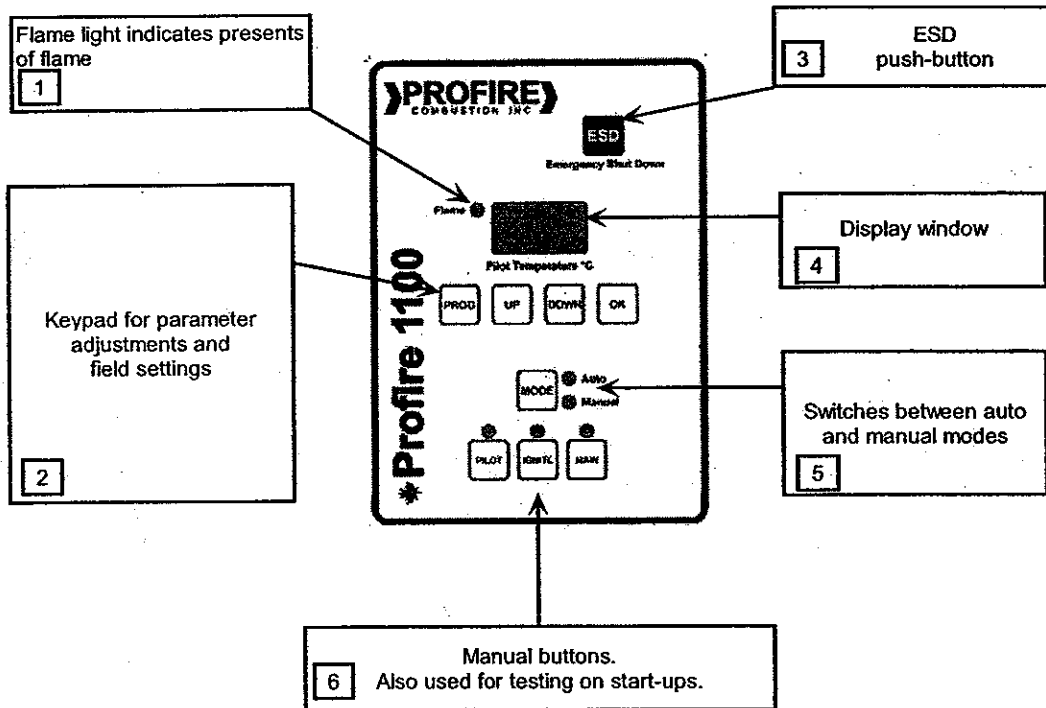
\* Power output to solenoids, Max = 30 Watts/Solenoid.

**Operating Conditions:** ▶ -40°C to +55°C

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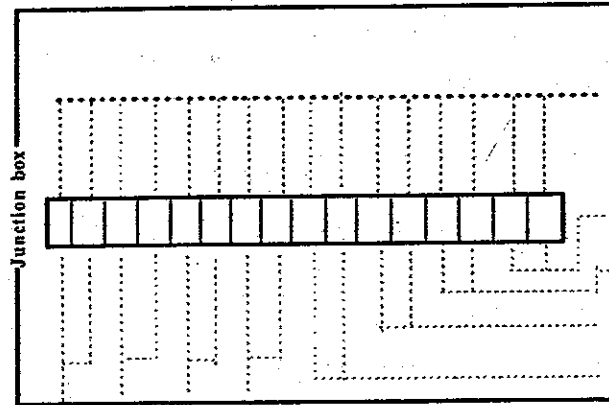
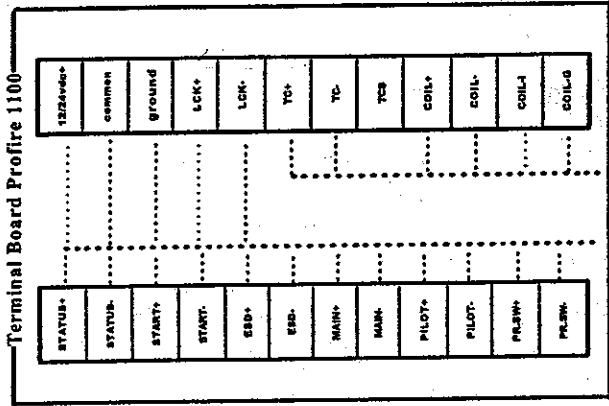
## Key-pad function



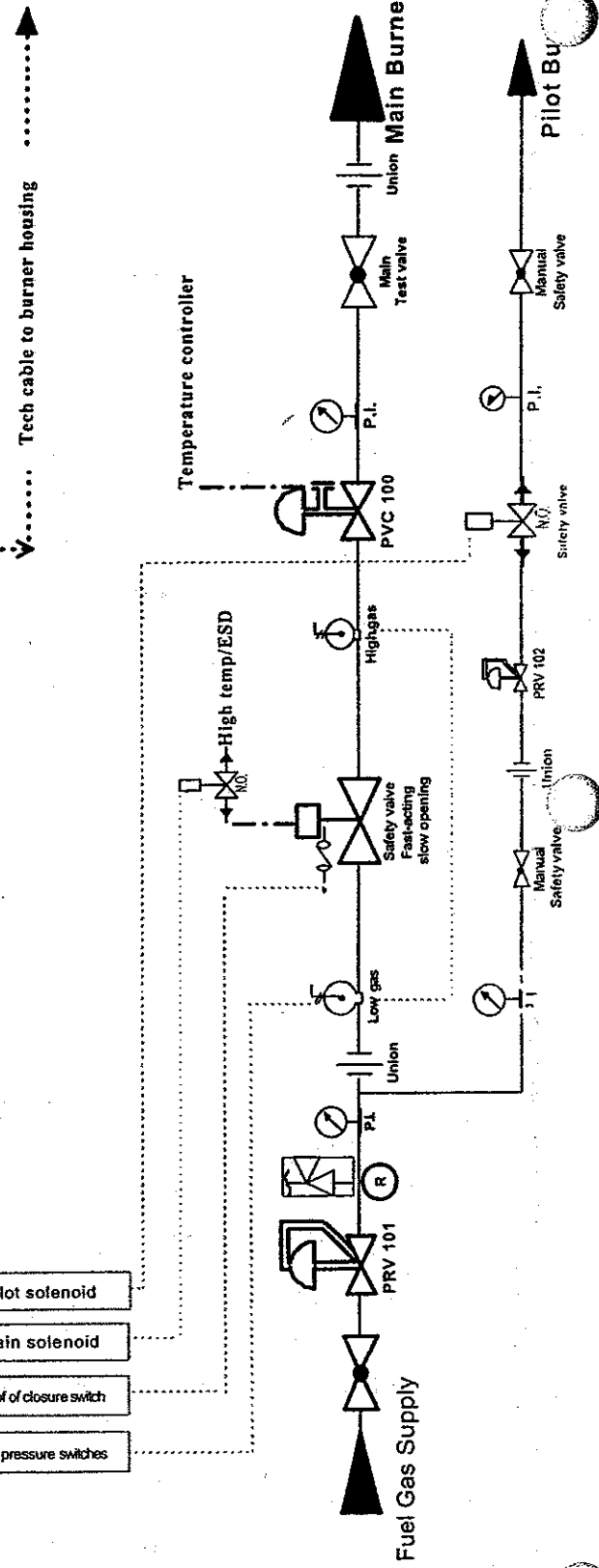
- |   |  |
|---|--|
| 1 | Flame light indication: Allows operator to see that the pilot is lit.  |
| 2 | Key-pad: Allows operator to select adjustable field parameters on the unit. Pressing the PROG button scrolls through the menu. UP and DOWN button adjusts the value or selects parameters. OK button accepts and stores the change. OK button is also used to exit the field parameter menu. |
| 3 | ESD: Allows operator to manually shut unit down and alarm.   |
| 4 | Display window: Allows operator to read pilot flame temperature, menu, and errors that have occurred.  |
| 5 | Mode: Allows operator to switch unit into a manual mode to check pilot ignitor and pilot solenoid, providing all safety interlocks have been met. LED's indicate the state the unit is in.   |
| 6 | PILOT button: Allows operator to open pilot solenoid for a period of time (45 sec) in Manual mode.<br>IGNITE button: Allows operator to activate ignition providing all safety parameters are met.<br>MAIN button: Allows operator to open Main only when pilot has been proved and stable.  |

# Hook-Up Drawing

Thermocouple to burner  
does not require TC wire



## Burner Housing

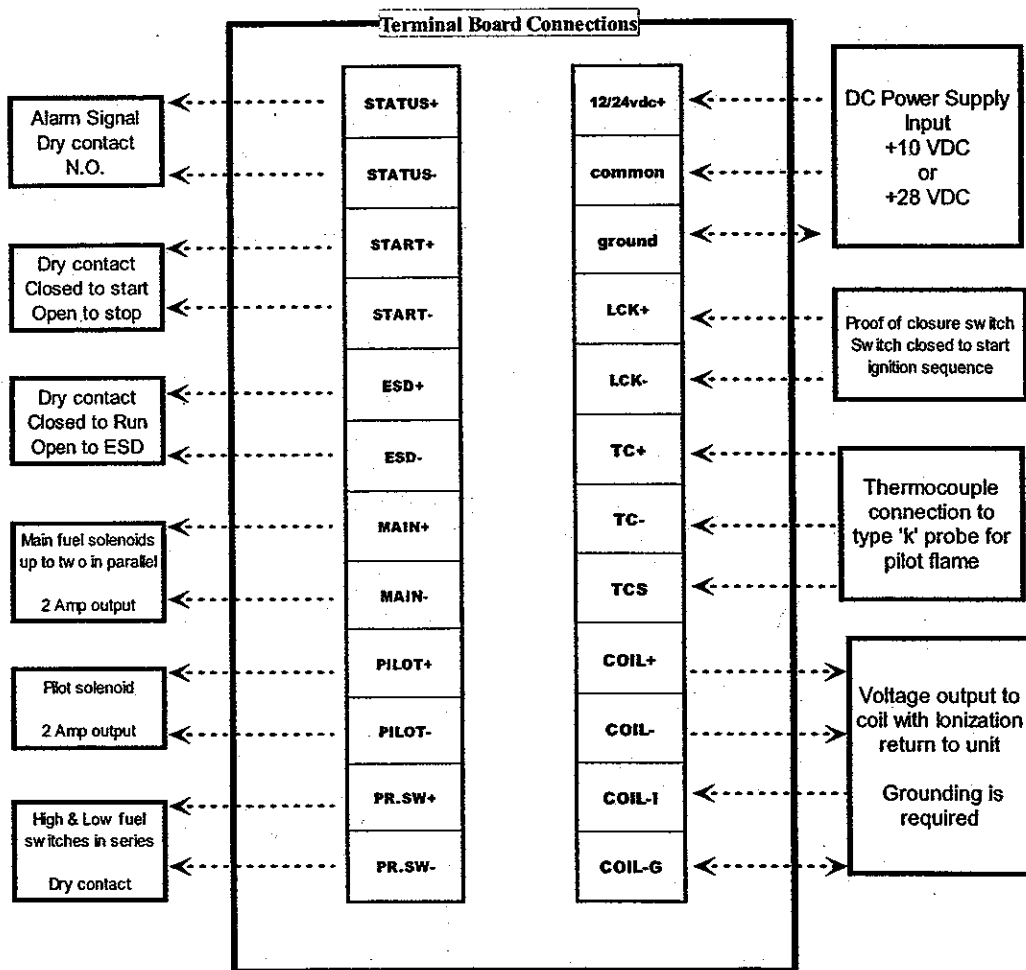


..... Tech cable to burner housing

.....TECH Cable.....

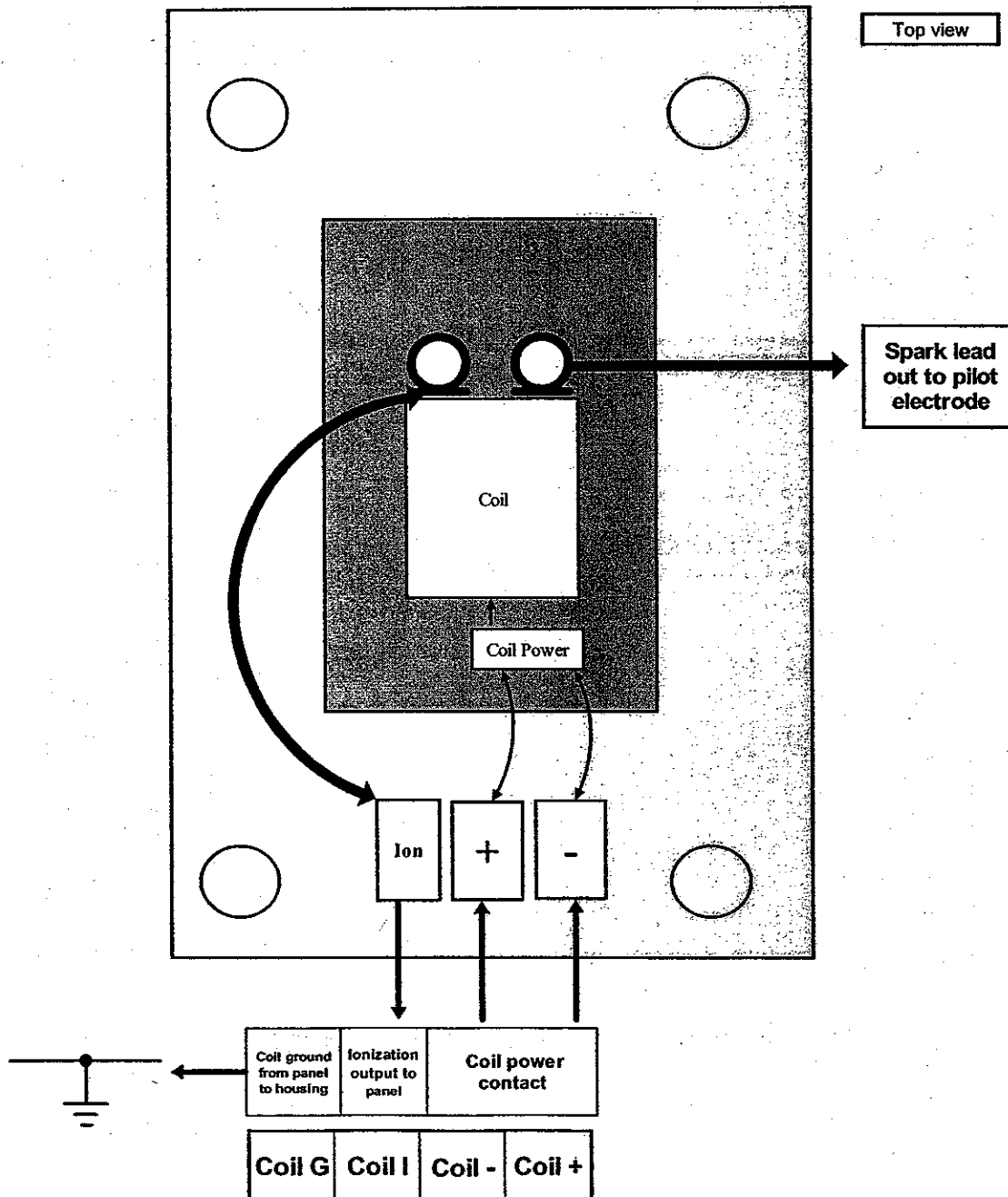
## Wiring connections for the Profire 1100

For good connections, spade connector should be used and wires should be clearly marked.



Rev 3.A  
Version

**\* Coil must be mounted in a NON-HAZARDOUS location.**  
Coil requires solid ground from Profire 1100 to ensure ionization operates properly.



## **Installation**

### **Site Selection**

The Profire 1100 system enclosure is CSA compliant for a Class 1, Division 2 (C&D) area classification. This means the system enclosure must be mounted outside any Class 1, Division 1 area. The system can be mounted on the unit skid or on a building wall as long as it does not infringe on a Class 1, Division 1 area.

The Profire 1100 system enclosure is a fiberglass box 8" x 6" x 4", complete with mounting tabs. The enclosure weighs less than 5 pounds, so heavy duty supports are not required, but the unit should be firmly mounted as the push buttons on the front panel have to be operated. The enclosure should be mounted in a location that faces away from the burner housing so that the operator is facing both the enclosure and the burner housing while operating the unit. Other considerations are panel access, traffic, wire-runs, and visibility. The enclosure should be mounted about 5 1/2 feet above ground level.

The spark generators, however, must be mounted in a non-hazardous area, as there is a potential of a spark arcing across the output terminals of the coil or along the insulated high voltage leads. The ideal location for the spark generator is inside the burner housing.

# Pilot bracket assembly



Pilot mounting bracket.  
Standard size for 1/2" pipe.  
Comes with electrode bushing  
and probe fitting.

Type "K" thermocouple probe  
2" past pilot nozzle with a 30°  
bend

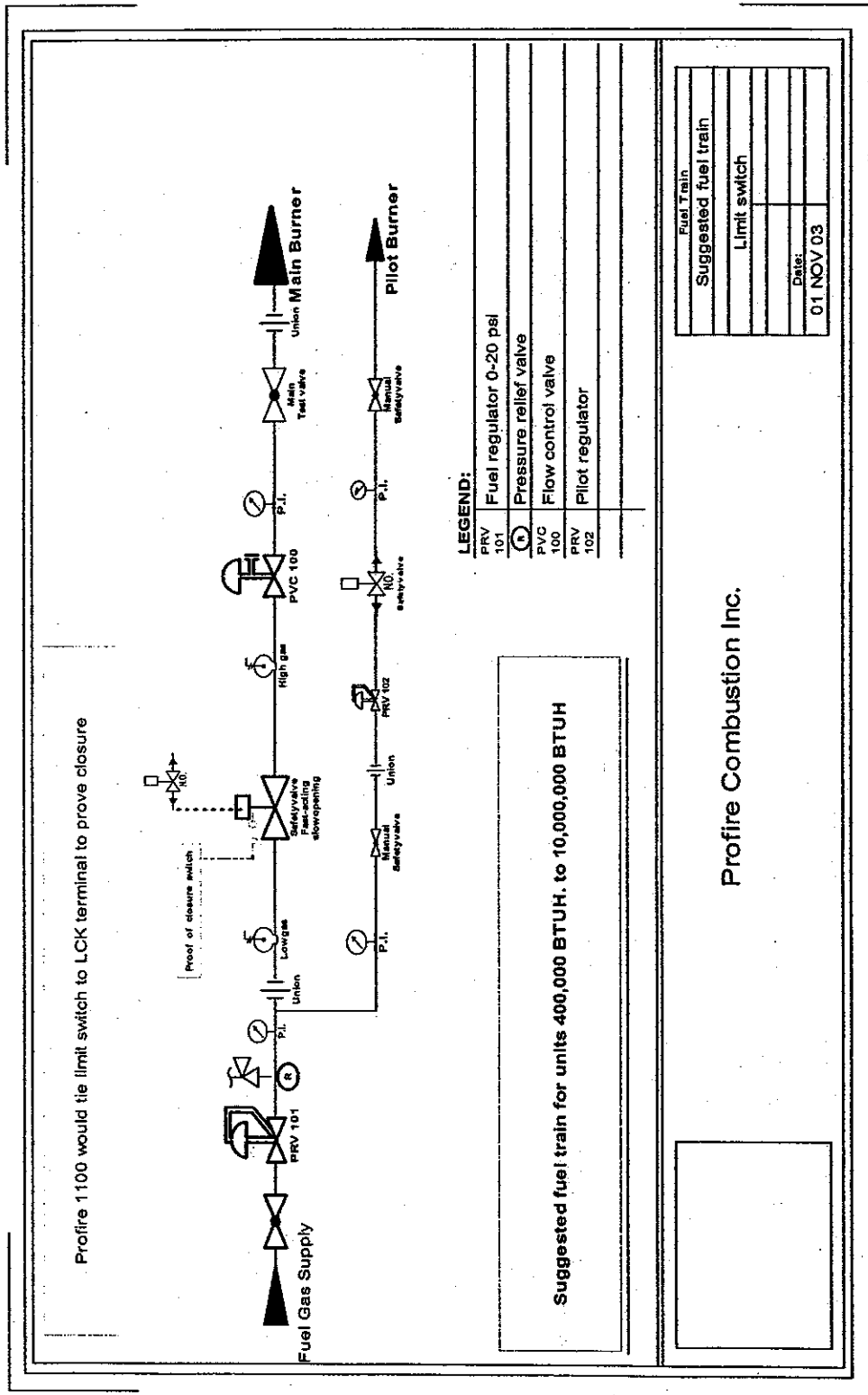
Ignition cable. Five foot carbon lead  
with end connections for electrode  
and coil.

Kanthol electrode, ignitor and  
flame rod. Bend in a fashion  
that the gas will ignite.

Pilot bracket assembly can be mounted on existing pilot. Brackets can be ordered to fit pilots 1/2" and up. Slip-stream applications are also acceptable, but may require custom length probe and ignition electrode.

Pilot burner is not included  
Available as option

### Fuel train suggestions



Profire 1100 would tie limit switch to LCK terminal to prove closure

**LEGEND:**

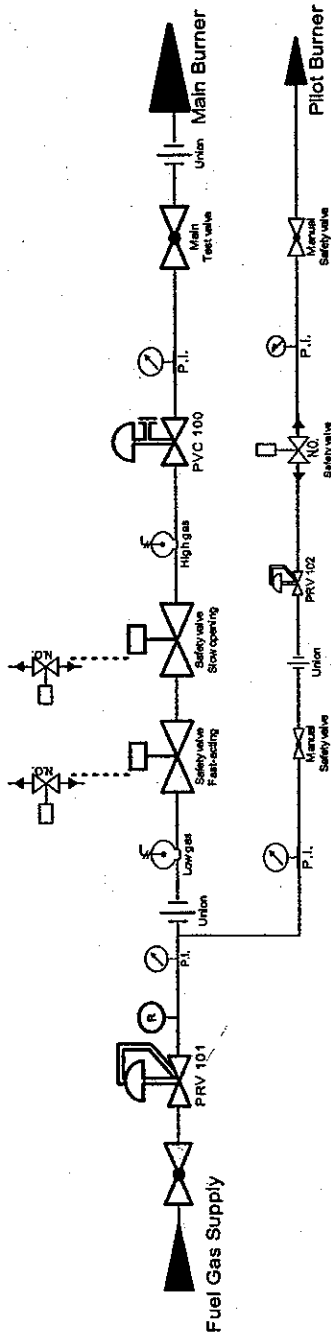
- PRV Fuel regulator 0-20 psi
- 101 Pressure relief valve
- PVC Flow control valve
- 100 Pilot regulator
- PRV 102

Suggested fuel train for units 400,000 BTUH. to 10,000,000 BTUH

Fuel Train	
Suggested fuel train	
Limit switch	
Date:	01 NOV 03

Profire Combustion Inc.

Profile 1100 would open main safety valves through main solenoids



LEGEND:

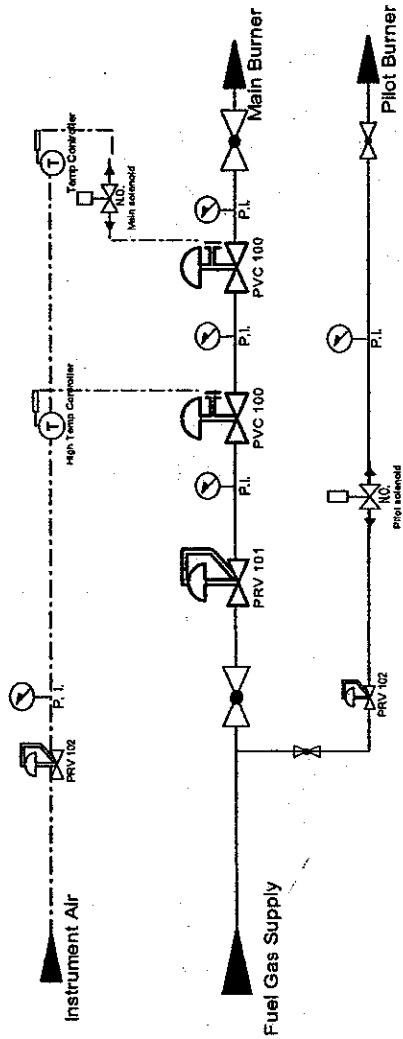
- PRV 101 Fuel regulator 0-20 psi
- Pressure relief valve
- PVC 100 Flow control valve
- PRV 102 Pilot regulator

Suggested fuel train for units 400,000 BTUH. to 10,000,000 BTUH

Fuel Train
Suggested fuel train
P&ID 1
Date:
01 NOV 03

Profire Combustion Inc.





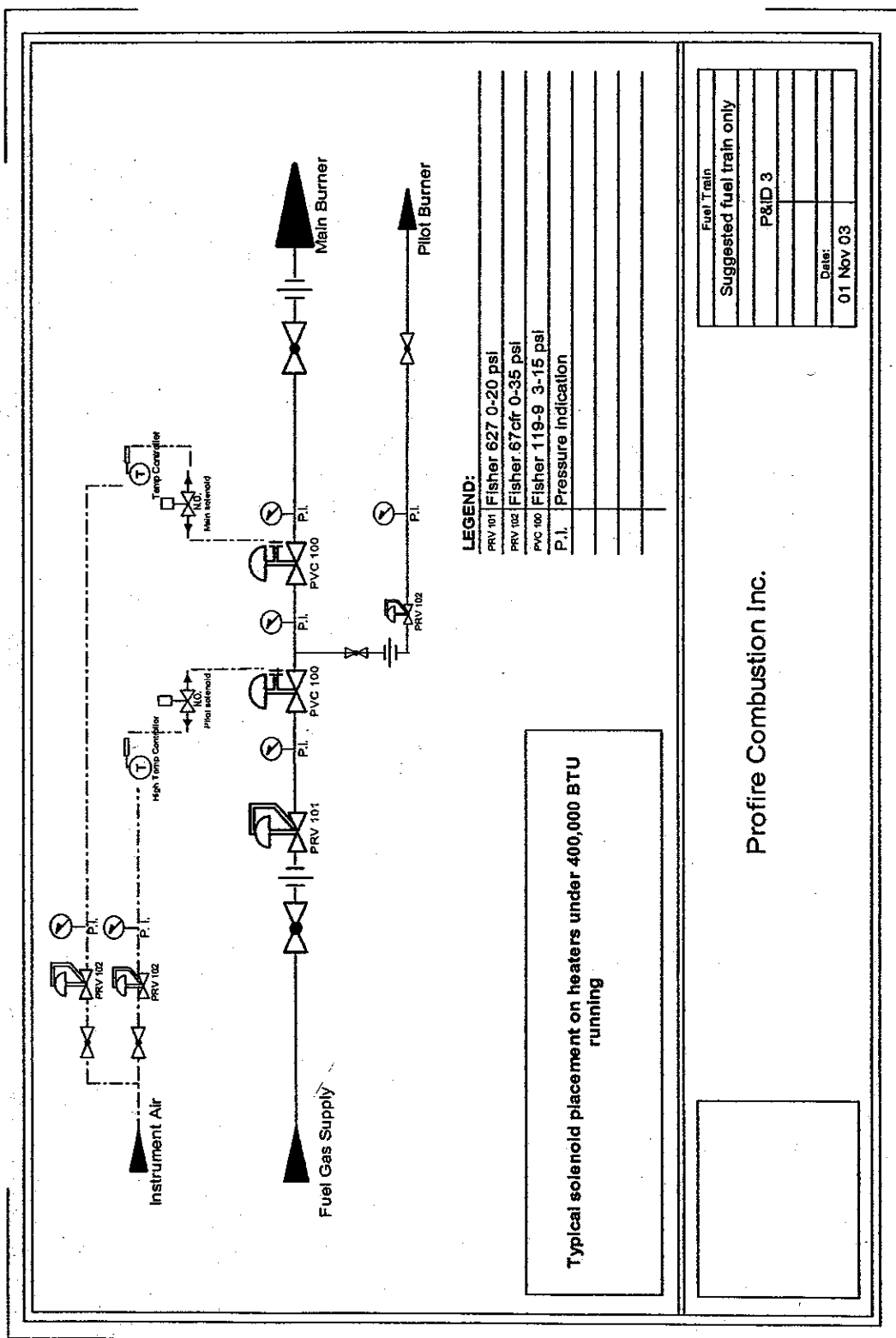
Typical solenoid placement on heaters under 400,000 BTU  
 running clean fuel gas.  
 Pilot solenoid in-line

**LEGEND:**

PRV 101	Fisher 627 0-20 psi
PRV 102	Fisher 67cfr 0-35 psi
PVC 100	Fisher 119-9 3-15 psi
P.I.	Pressure Indication

Fuel Train	
Suggested fuel train only	
P&ID: 2	
Date:	01 Nov 03

Profire Combustion Inc.



**LEGEND:**

- PRV 101 Fisher 627 0-20 psi
- PRV 102 Fisher 67cfr 0-35 psi
- PVC 100 Fisher 119-9 3-15 psi
- P.I. Pressure Indication

Typical solenoid placement on heaters under 400,000 BTU running

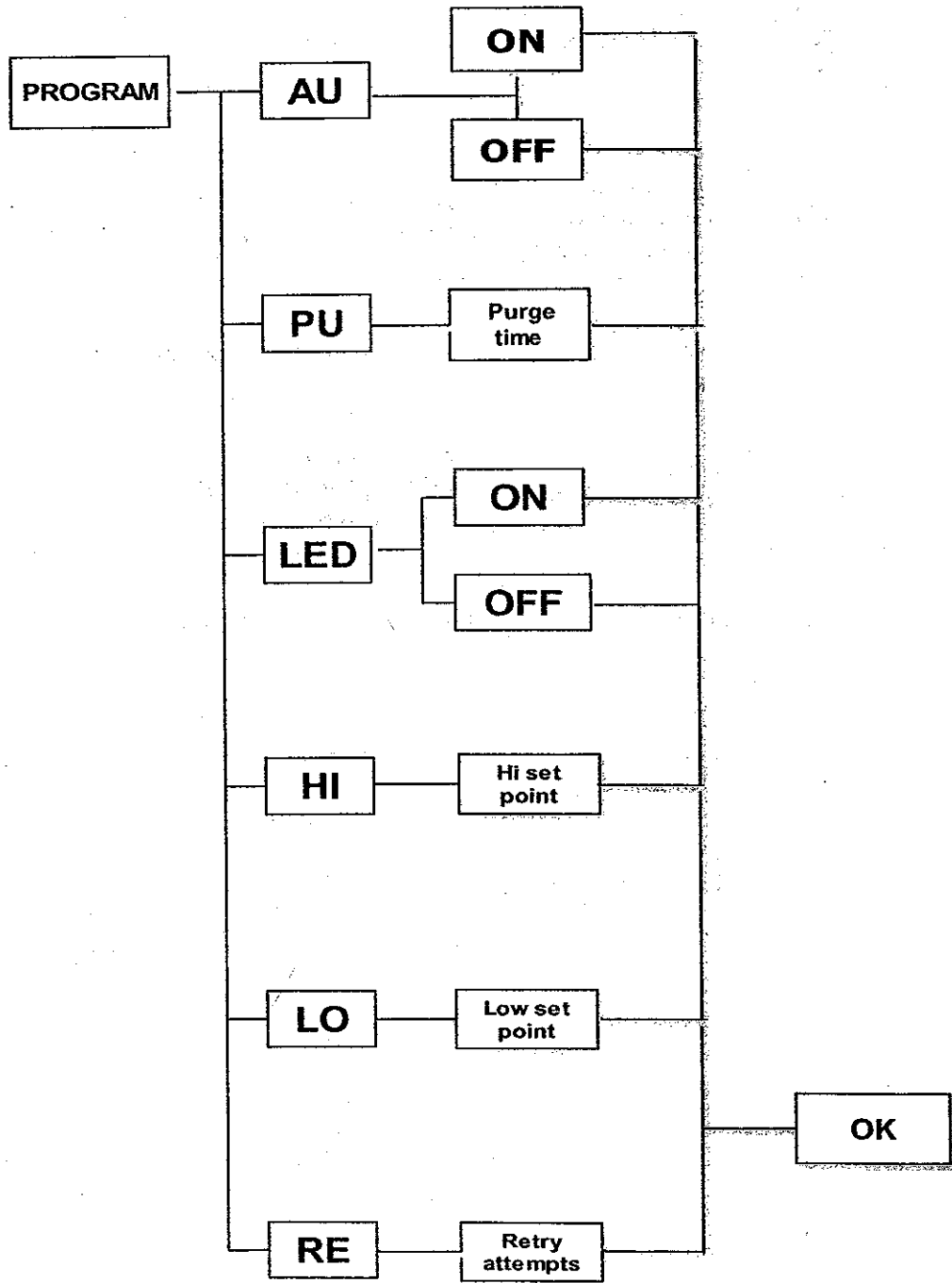
Fuel Train	
Suggested fuel train only	
P&ID 3	
Date:	01 Nov 03

Profire Combustion Inc.

## Program Mode

On Screen	Description	Function	Default setting
AU	Enables unit to automatically start on power-up	ON= Auto start enabled OFF = Auto start disabled	Off
PU	Purge time cycle	Time in seconds set for purge	10
LED	Allows unit to turn display off	ON=display always on OFF=display off after 10 min Press OK to turn on for 10 min	ON
HI	High set point	Signal setting for a fail point	600
LO	Low set point	Signal setting for a prove point	200
RE	Restart attempts	Number of times the unit will try to relight before alarming	3

# Program Menu



## Changing settings

Changing settings can only be done when unit is in manual mode and displaying **RDY**.

Using the front keypad buttons, press **PRG** to enter program mode. Repeated pressing of the **PRG** button scrolls through the menu items. Pressing the **UP** or **DOWN** buttons will modify the item selected. Press **OK** to save and exit program mode. Pressing **OK**

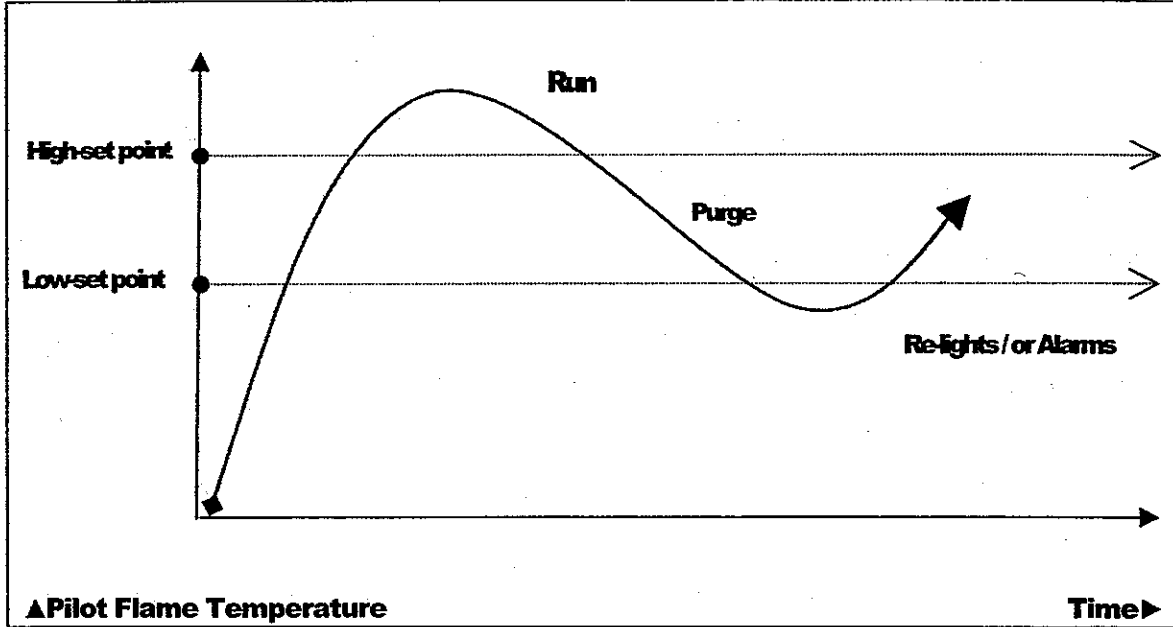
## Flame mode

The Profire 1100 use two methods of flame detection. Using a type K thermocouple probe, in conjunction with Ionization circuit. This is a safe and reliable method. The thermocouple probe provides a low and high set point that ensures a stable pilot. Running the Ionization circuit in conjunction with the probe detects a flame-out with in 1.8 seconds.

## Hi and Low set points

Setting the high set points can be done once the lowest running temperature of the flame has been established. This is done on the initial start-up of the unit. Typically the pilot temperature can be used, but on occasion the main burner can cool the flame temperature of the pilot. If that is the case, one should use the lower of the two flame temperatures as a guideline to setting the Hi set point. The unit must then be shut down to adjust and accept the new value. Only under special circumstances will the low set point need adjustment. This will occur if the operating temperature of vessel is higher than the low set point, or if the probe will not cool to a point for re-ignition. One must keep in mind that on a cold start, there is a time-frame to reach this set point.

**Function Diagram No 1**



**Type 'K' Thermocouple Output Chart**

TEMP °C	TYPE K MV	TC OUTPUT
40	1.611	.401
60	2.436	.605
100	4.095	1.015
140	5.733	1.420
160	6.539	1.620
<b>200</b>	<b>8.137</b>	<b>2.015</b>
240	9.745	2.413
260	10.560	2.614
300	12.207	3.022
340	13.874	3.434
360	14.712	3.641
400	16.395	4.057
440	18.088	4.476
460	18.938	4.686
500	20.640	5.107
540	22.346	5.529

TEMP. °C	TYPE K MV	TC OUTPUT
560	23.198	5.740
<b>600</b>	<b>24.902</b>	<b>6.161</b>
640	26.599	6.581
660	27.445	6.790
700	29.128	7.206
740	30.799	7.619
760	31.629	7.825
800	33.277	8.232
840	34.909	8.636
860	35.718	8.836
900	37.325	9.233
940	38.915	9.626
960	39.703	9.821
1000	41.269	10.209
1060	43.585	10.781
1100	45.108	11.158

Default settings are bolded.

**Standard Parts Sheet**

**Call 780-960-5278**

<b>Enclosure</b>	<b>Part Number</b>	<b>Description</b>
Profire 1100	780021	Complete standard package
Door pad with electronics	780022	Front key-pad c/w electronics
Door card	780023	Electronics only for the door
Terminal card	780024	Terminal card only
<b>Coil</b>	<b>Part Number</b>	<b>Description</b>
Coil assembly	780034	Complete coil assembly with base mount
Coil base	780038	Base mount
Coil	780040	Ignition coil
<b>Pilot</b>	<b>Part Number</b>	<b>Description</b>
Pilot bracket assembly	780086	Complete pilot assembly with probe and electrode
Probe fitting	780088	Tube fitting
Electrode	780089	Ignitor rod with porcelain
Electrode bushing	780087	Mounting bushing for electrode
Pilot bracket	780040	Welded bracket
<b>Accessories</b>	<b>Part Number</b>	<b>Description</b>
Probe	5 FT.    780010	All probes come 12" with optional extension length available.
	6 FT.    780011	
	8 FT.    780012	
	Custom    Custom	
Ignition Extension cable	5 FT.    780100	Extension wires come complete with ends. Optional lengths available.
	6 FT.    780101	
	8 FT.    780102	
	Custom    Custom	

Recommended spare parts



1 Pilot mounting bracket. Standard size for 1/2" pipe. Comes with electrode bushing and probe fitting.

2 Type "K" thermocouple probe 2" past pilot nozzle with a 30° bend

3 Ignition cable. Five foot carbon lead with end connections for electrode and coil.

4 Kanthol type electrode, ignitor and flame rod. Bend in a fashion that the gas will ignite.

1	Bracket	part# 780086
2	Probe 6'	part# 780011
3	Ignition wire extension 5'	part# 780100
4	Ignition rod	part# 780089



PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : FLOW CONTROL VALVES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
				BY	CHK'D	APPR.			
G 1	TAG NO.	FCV-672		FCV-671A		FCV-671B			
E 2	SERVICE	OIL COOLER		UNLOADER		UNLOADER			
N 3	LINE NO. / VESSEL NO.	K-670		K-670		K-670			
E 4	LINE SIZE / SCHED. NO.	21mm SCH.80		21mm SCH.80		21mm SCH.80			
5	TYPE OF BODY	GLOBE		GLOBE		GLOBE			
6	BODY SIZE	PORT SIZE	21 mm	STD mm	21 mm	STD mm	21 mm	STD mm	mm mm
7	GUIDING	NO. OF PORTS	TOP	ONE	TOP	ONE	TOP	ONE	
B 8	END CONN. & RATING	21mm NPT		21mm NPT		21mm NPT			
O 9	BODY MATERIAL	ALUMINUM		ALUMINUM		ALUMINUM			
D 10	PACKING MATERIAL	NITRILE		NITRILE		NITRILE			
Y 11	LUBRICATOR	ISOLAT. VALVE	---	---	---	---	---		
12	BONNET TYPE	BOLTED		BOLTED		BOLTED			
13	TRIM FORM	EQUAL PERCENTAGE		EQUAL PERCENTAGE		EQUAL PERCENTAGE			
14	TRIM MATERIAL	SEAT / PLUG	STD	STD	STD	STD	STD		
		SHAFT / MAT'L	STD	STD	STD	STD	STD		
15	REQUIRED SEAT TIGHTNESS	---		---		---			
16	MAX. ALLOW SOUND LEV. dBA	--- dBa		--- dBa		--- dBa			
A 17	MODEL NO. & SIZE	INTEGRAL		INTEGRAL		INTEGRAL			
C 18	TYPE OF ACTUATOR	SPRING		SPRING		SPRING			
T 19	CLOSE AT	OPEN AT	20 kPa	100 kPa	20 kPa	100 kPa	20 kPa	100 kPa	kPa kPa
U 20	FLOW ACTION TO	PORTS B TO A		PORTS B TO A		PORTS B TO A			
A 21	FAIL POSITION	PORTS A TO C		PORTS A TO C		PORTS A TO C			
T 22	HANDWHEEL & LOCATION	---		---		---			
P 23	MFR. & MODEL NO.	---		---		---			
O 24	FILT REG   GAGES   BYPASS								
S 25	INPUT SIGNAL								
I 26	OUTPUT SIGNAL								
T 27	AIR SUPPLY PRESS	kPa		kPa		kPa		kPa	kPa
T 28	MFR. & MODEL NO.								
R 29	INPUT SIGNAL								
N 30	OUTPUT SIGNAL								
O 31									
P 32									
T 33									
34	FLOW UNITS	l/m		scmh		scmh			
35	FLUID	PROPANE		INSTRUMENT AIR		INSTRUMENT AIR			
36	QUANT. MAX.	MAX. Cv							
S 37	QUANT. OPER.	OPER Cv	SMALL	---	SMALL	---	SMALL	---	
E 38	VALVE Cv	VALVE FL	15.0		15.0		15.0		
R 39	NORM IN PRES	NORM DELTA P	1450 kPa(g)	---	100 kPa(g)	---	100 kPa(g)	---	kPa(g) kPa(g)
V 40	MAX. INLET PRESS.		1724 kPa		1400 kPa		1400 kPa		kPa kPa
I 41	MAX. SHUT OFF	MAX. DELTA P	1724 kPa(g)	1724 kPa	1400 kPa(g)	1400 kPa	1400 kPa(g)	1400 kPa	kPa(g) kPa
C 42	TEMP. MAX.	OPER. TEMP	66/-28 ° C	28 ° C	66/-28 ° C	28 ° C	66/-28 ° C	28 ° C	° C ° C
E 43	OPER. SP. GR.	MOL. WT.	0.466	---	---	29	---	29	
44	OPER. VISC.	% FLASH	---	---	---	---	---	---	
45	% SUPERHEAT	% SOLIDS							
46	VAPOR PRESS	CRIT PRESS	1400 kPa(g)	4260 kPa(g)	---	kPa(g)	---	kPa(g)	kPa(g) kPa(g)
47	PREDICTED SOUND LEVEL dBA								
48	MANUFACTURER	FISHER		FISHER		FISHER			
49	MODEL NO.	164A		164A		164A			
50	P. O. NUMBER								

NOTES:

AREA. UNIT # :

# Type 164 Two-Way Regulator and Type 164A Three-Way Regulator

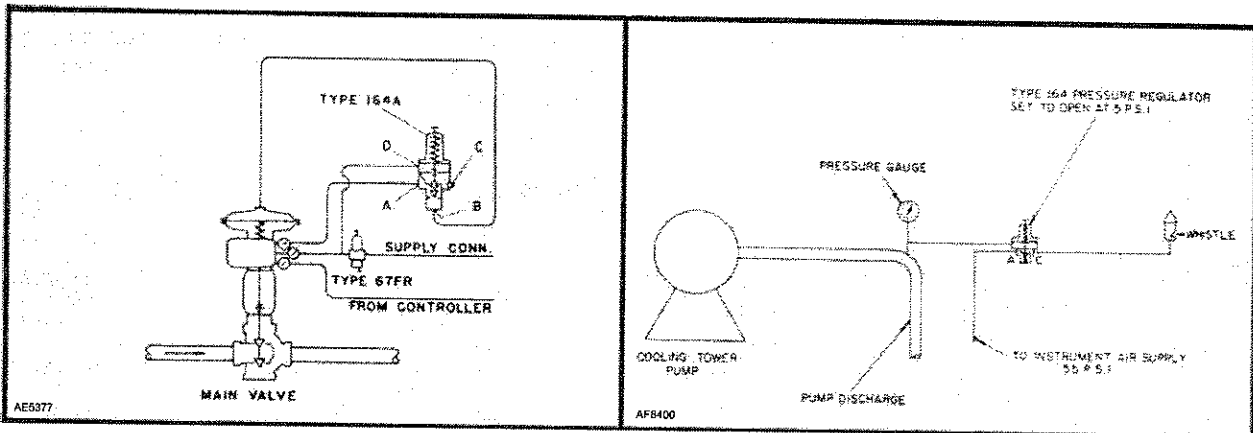


Figure 1. Type 164A

Lockup system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will remain in position it occupied at time of supply pressure failure.

Figure 2. Type 164

Warning system using Type 164 two-way valve to activate a whistle when pump discharge pressure falls.

## Type Number Explanation

Type 164—Two-way regulator, diaphragm operated, normally open valve.

Type 164A—Three-way regulator, same as above, except a special adaptor is used to provide the third outlet.

## Installation

Thoroughly clean and blow out all pipe lines to remove pipe scale and other foreign material. Make sure the regulator is clean before making the installation, and apply pipe compound to the male threads.

This valve can be installed in any position in the pipe line. The installation should be made so that moisture cannot enter the vent, but do not plug the vent. If

desirable to pipe the vent away, the vent outlet is tapped 1/4-inch x 18 NPT.

A typical installation of the Type 164A when used as a pneumatic lockup is shown in Figure 1. The three Type 164A ports are identified as A, B, and C. Flow can go from A to B, A to C, C to A, B to A, but not B to C or C to B. The control line connection is identified as D and is 1/4-inch NPT. The ports are either 1/4-inch or 1/2-inch NPT, depending on customer specifications.

Type 164A regulators can be used either as two-way or three-way valves. The bottom connection is plugged in the first use and is open on three-way applications.

The two-way Type 164 regulator is normally open, and pressure applied under the diaphragm closes the port. The Type 164 should be installed so that flow goes from port A to port C. A typical Type 164 installation is shown in figure 2. Maximum inlet pressure for both Types 164 and 164A is 250 psig (17.2 bar).



# Types 164 and 164A

Table 1. Spring Ranges

SPRING OUTLET PRESSURE RANGE, PSIG (bar)	SPRING COLOR	SPRING PART NUMBER	MAXIMUM PRESSURE CHANGE ON DIAPHRAGM FOR FULL STROKE, PSIG (bar)
3 to 15 (0,2 to 1,0)	Red	1D89232702	2(0,14)
5 to 20 (0,35 to 1,4)	Silver	1D75152702	2.5(0,17)
5 to 35 (0,35 to 2,4)	Blue	1D66592702	4(0,28)
30 to 60 (2,1 to 4,1)	Green	1D74552714	5.75(0,40)
40 to 100 (2,8 to 6,9)	Yellow	1E54362714	11(0,76)
80 to 150 (5,5 to 10,3) <sup>(2)</sup>	Brown	1P90132714	16(1,1)
130 to 200 (9,0 to 13,8) <sup>(2,3)</sup>	Brown	1P90132714	16(1,1)

1. All six springs can be adjusted to 0 psig (0 bar). The above ranges are recommended for best performance.  
 2. Only available for Type 164.  
 3. Only available with diaphragm head 1P9014.

## Adjustment

The regulator is set for the pressure shown on the paper label attached to the spring case. The spring ranges available are shown in table 1. To increase the setting within a given spring range, loosen locknut (key 13) and turn adjusting screw (key 12) clockwise. Turn adjusting screw counterclockwise to decrease pressure setting. Be sure to tighten locknut after making the pressure adjustment.

## Maintenance

If necessary to inspect or replace the Type 164 disk holder assembly (key 6), remove body plug (key 10). This allows valve disk holder (key 6), spring (key 3), and stem (key 7) to slide out. In the same manner, the body plug (key 10) can be removed on a Type 164A to replace disk holder assembly (key 6) and the inner valve O-ring (key 5).

If the diaphragm needs replacing, loosen locknut (key 13) and back off adjusting screw (key 12). Remove casing nuts (key 15) and lift the spring case (key 2) off the assembly. This exposes the spring (key 4) which can be lifted out, and the diaphragm assembly which can also be lifted out. When reassembling, replace the

adjusting screw before tightening the diaphragm casing nuts. This assures slack in the diaphragm, which is essential to proper operation.

## Ordering Parts

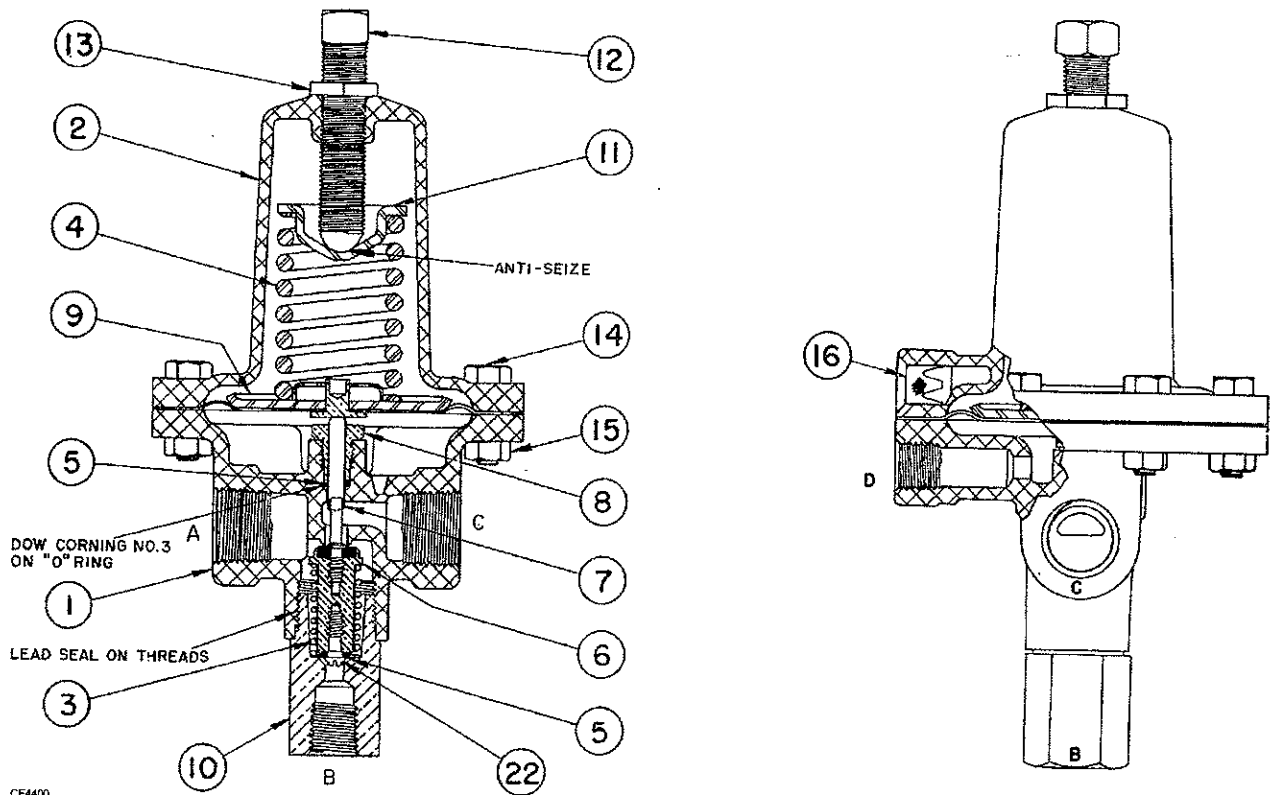
When corresponding with the factory, Sales Office or Sales Representative regarding this regulator, give the type number stamped on the body of the regulator, as well as the spring range on the paper label attached to spring case. When ordering parts, be sure to give complete parts number of desired parts.

## Parts List

Key	Description	Part Number
1	Body, Aluminum	T106380801
2	Spring Case, Aluminum	2P90150801
3	Valve Spring, Spring wire	1D66682722
4	Regulator Spring, Spring wire	
	0 to 15 psig (0 to 1,0 bar), red	1D89232702
	0 to 20 psig (0 to 1,4 bar), silver	1D75152702
	0 to 35 psig (0 to 2,4 bar), blue	1D66592702
	0 to 60 psig (0 to 4,1 bar), green	1D74552714
	0 to 100 psig (0 to 6,9 bar), yellow	1E54362714
	0 to 150 psig (0 to 10,3 bar), brown (164 only)	1P90132714
5*	O-ring, Synthetic rubber	1D68250699
6*	Valve Disk Assembly, Brass and Buna N	
	Type 164	1D6656000A
	Type 164A	1E4567000A
7	Valve Stem, Stainless steel	1D96383517
8	Stem Guide, Brass	1D66691409
9*	Diaphragm Assembly	
	For Standard Springs	1D6662000A
	For Spring 1P9013	1D66629902
10	Body Plug	
	Type 164, Aluminum	1D66520901
	Type 164A, Brass	1E43971401
11	Upper Spring Seat, Plated steel	1D66712507
12	Adjusting Screw, Plated steel	1D99544870
13	Locknut, Plated steel	1D66772898
14	Cap Screw (8 required), Steel	
	Type 164	T107602405
	Type 164A	1E43971401
15	Hex Nut (8 required), Steel	
	Type 164	1A34572412
	Type 164A	1E98532414
16	Vent Screen, Monel	0L07834306
22	O-ring Retainer Screw, Stainless steel	1E45663503

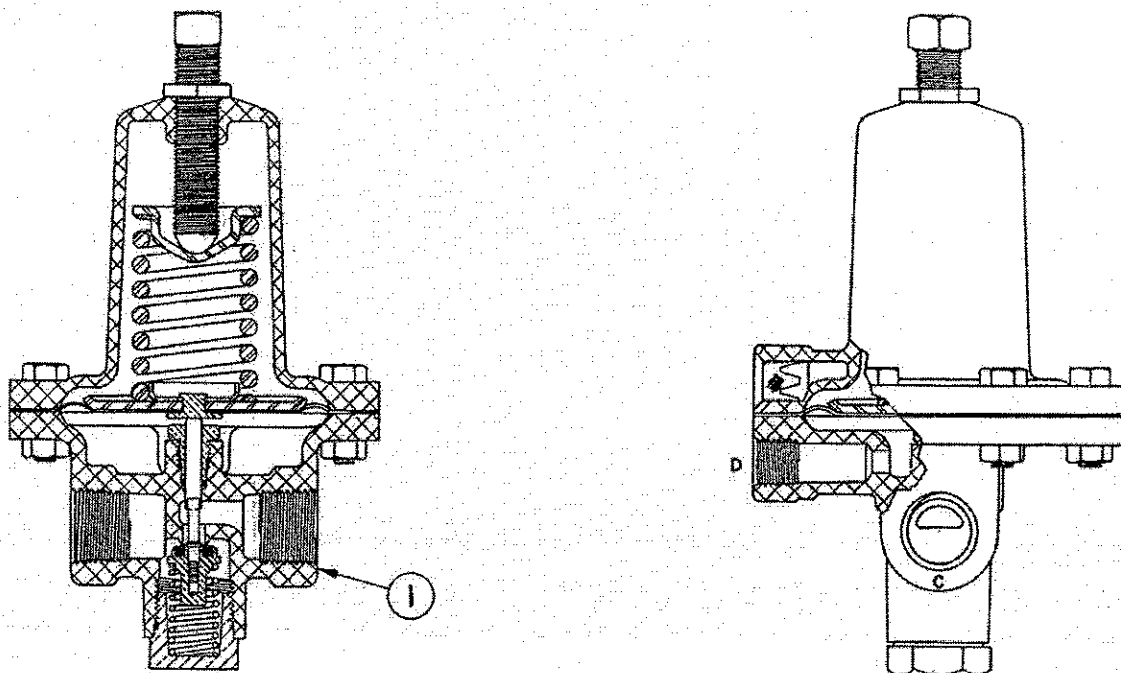
\*Recommended Spare Part

# Types 164 and 164A



CE4400

Figure 3. Type 164A



CE4615

Figure 4. Type 164

Except for the valve disk assembly (key 6) and the three-way adaptor or body plug (key 10), all parts are interchangeable with Type 164A.

# Types 164 and 164A

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PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 2			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : FLOW CONTROL VALVES				NO	BY	DATE	REVISION	JOB #	054468		
				0	RDD	03/11/05	ISSUE FOR PURCHASE	DATE			
								REQ.			
								BY	CHK'D	APPR.	
G E N E	1	TAG NO.	LCV-610		LCV-620A		LCV-620B		LCV-630		
	2	SERVICE	CHILLER		LTS-HC LEVEL		LTS-GLYCOL LEVEL		DEETHANIZER LEVEL		
	3	LINE NO. / VESSEL NO.	E-610		V-620		V-620		T-630		
	4	LINE SIZE / SCHED. NO.	33mm SCH.80		48mm SCH.80		33mm SCH.80		48mm SCH.80		
B O D Y	5	TYPE OF BODY	GLOBE		GLOBE		GLOBE		GLOBE		
	6	BODY SIZE	PORT SIZE	33 mm	19.0 mm	33 mm	12.5 mm	33 mm	6.4 mm	33 mm	12.5 mm
	7	GUIDING	NO. OF PORTS	TOP		TOP		TOP		ONE(1)FLUTE	
	8	END CONN. & RATING	33mm NPT		33mm NPT		33mm NPT		33mm NPT		
	9	BODY MATERIAL	WCB		WCB		WCB		WCB		
	10	PACKING MATERIAL	PTFE		PTFE		PTFE		PTFE		
	11	LUBRICATOR	ISOLAT. VALVE	---	---	---	---	---	---	---	
	12	BONNET TYPE	STD BONNET		STD BONNET		STD BONNET		STD BONNET		
	13	TRIM FORM	MICROFORM		MICROFORM		MICROFLUTE		MICROFORM		
	14	TRIM MATERIAL	SEAT / PLUG	STD		STD		STD		STD	
			SHAFT / MAT'L	STD		STD		STD		STD	
	15	REQUIRED SEAT TIGHTNESS	ASME IV		ASME IV		ASME IV		ASME IV		
	16	MAX. ALLOW SOUND LEV. dBA	80 dBa		80 dBa		80 dBa		80 dBa		
	A C T U A T O R	17	MODEL NO. & SIZE	667-34		667-34		667-30		667-30	
		18	TYPE OF ACTUATOR	DIAPHRAGM		DIAPHRAGM		DIAPHRAGM		DIAPHRAGM	
		19	CLOSE AT	OPEN AT	20 kPa	100 kPa	20 kPa	100 kPa	20 kPa	100 kPa	20 kPa
20		FLOW ACTION TO	OPEN		OPEN		OPEN		OPEN		
21		FAIL POSITION	CLOSED		CLOSED		CLOSED		CLOSED		
22		HANDWHEEL & LOCATION	---		---		---		---		
P O S I T I O N	23	MFR. & MODEL NO.	---		---		---		---		
	24	FILT REG   GAGES   BYPASS									
	25	INPUT SIGNAL									
	26	OUTPUT SIGNAL									
T R I P P O I N T	27	AIR SUPPLY PRESS	kPa		kPa		kPa		kPa		
	28	MFR. & MODEL NO.									
	29	INPUT SIGNAL									
	30	OUTPUT SIGNAL									
S E R V I C E	31										
	32										
	33										
	34	FLOW UNITS	KG/HR		L/M / KG/HR		L/M		L/M		
	35	FLUID	PROPANE		H.C.LIQUID / H.C. GAS		70% E.GLYCOL		H.C.LIQUID		
	36	QUANT. MAX.	MAX. Cv								
	37	QUANT. OPER.	OPER Cv	3103	2.06	39 / 314	1.184	5.70	0.052	25.0	1.56
	38	VALVE Cv	VALVE FL	12.3		6.51		0.342		6.51	
	39	NORM IN PRES	NORM DELTA P	1450 kPa(g)	1350 kPa	6780 kPa(g)	4810 kPa	6780 kPa(g)	6360 kPa	1970 kPa(g)	70 kPa
	40	MAX. INLET PRESS.		1724 kPa		8963 kPa		8963 kPa		3792 kPa	
41	MAX.SHUT OFF	MAX.DELTA P	1724 kPa(g)	1724 kPa	8963 kPa(g)	8963 kPa	8963 kPa(g)	8963 kPa	3792 kPa(g)	3792 kPa	
42	TEMP. MAX.	OPER. TEMP	66 ° C	27.2 ° C	66 ° C	21.1 ° C	66 ° C	-23.3 ° C	66 ° C	49 ° C	
43	OPER. SP. GR.	MOL. WT.	0.49		0.489		1.11		0.569		
44	OPER. VISC.	% FLASH		Flashing	---	---	---	---	---	---	
45	% SUPERHEAT	% SOLIDS									
46	VAPOR PRESS	CRIT PRESS	993 kPa(a)	4266 kPa(a)	4099 kPa(a)	4100 kPa(a)	0.07 kPa(a)	14272 kPa(a)	---	4000 kPa(a)	
47	PREDICTED SOUND LEVEL dBA										
48	MANUFACTURER	FISHER		FISHER		FISHER		FISHER			
49	MODEL NO.	667-D-34		667-D-34		667-D-30		667-D-30			
50	P. O. NUMBER										

NOTES:

- \* LCV-620A MAY AFFECT SIZING OF PSV-630 (DETHANIZER)
- \* LCV-620B MAY AFFECT SIZING OF PSV-630 (GLYCOL FLASH TANK)

AREA. UNIT # :

# Type 667 Diaphragm Actuator Sizes 30-76 and 87

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Figure 1. Type 667 or 667-4 Actuator Mounted  
on *easy-e*<sup>®</sup> Valve

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# Type 667 Size 30-76 & 87

Table 1. Specifications

SPECIFICATION <sup>(1)</sup>		ACTUATOR SIZE										
		30	34	40	45	46	50	60	70 <sup>(1)</sup>	76	87 <sup>(1)</sup>	
Nominal Effective Area	Sq Inch	46	69	69	105	156	105	156	220	156	220	
	Sq cm	297	445	445	667	1006	677	1006	1419	1006	1419	
Yoke Boss Diameter	Inch	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	3-9/16	5	
	mm	54	54	71	71	71	90	90	90	90	125	
Acceptable Valve Stem Diameter	Inch	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	3/4	1	
	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	19.1	25.4	
Maximum Allowable Output Thrust <sup>(4)</sup>	LB	2300	2300	2700	5650	7550	5650	6800	8800	6800	8800	
	N	10,230	10,230	12,010	25,131	33,582	25,131	30,246	39,142	30,246	39,142	
Maximum Travel <sup>(2)</sup>	Standard	Inch	3/4	1-1/8	1-1/2	2	2	2	2	3 <sup>(3)</sup>	2	3 <sup>(3)</sup>
	Standard	mm	19	29	38	51	51	51	51	76 <sup>(3)</sup>	51	76 <sup>(3)</sup>
	Top-Loaded	Inch	---	3/4	---	3/4	---	---	1-1/8	---	1-1/8	3
	Top-Loaded	mm	---	19	---	19	---	---	29	---	29	76
Maximum Casing Pressure for Actuator Sizing <sup>(4,6)</sup>	Psig	55	70	70	65	55	65	55	50	50	50	
	Bar	3.8	4.8	4.8	4.5	3.5	4.5	3.5	3.4	3.4	3.4	
Maximum Excess Diaphragm Pressure <sup>(4,5)</sup>	Psig	55	20	20	10	10	10	10	10	10	10	
	Bar	3.9	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Maximum Diaphragm Casing Pressure <sup>(4,6,7)</sup>	Psig	110	90	90	75	65	75	65	60	60	60	
	Bar	7.6	6.2	6.2	5.2	4.5	5.2	4.5	4.1	4.1	4.1	
Approximate Weight	Pounds	34	48	50	90	121	94	122	254	190	260	
	Kg	15	22	23	41	55	43	55	115	86	118	
Material	Nitrile Elastomers	-40 to 180°F (-40 to 82°C)										
Temperature	Silicone Elastomers	-65 to 300°F (-54 to 149°C)										
Capabilities	Fluoroelastomers	0 to 300°F (-18 to 149°C)										

1. These values also apply to the Type 667-4 actuator construction.  
2. Actuator travel may be less than the value listed after connected to the valve.  
3. Maximum actuator travel for Type 667-4 is 4 inches (102 mm).  
4. See also the Specification portion of the introduction section.  
5. Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result. See the Maximum Pressure Limitation section.  
6. Maximum diaphragm casing pressure must not be exceeded and must not produce a force on the actuator stem greater than the maximum allowable actuator output thrust or the maximum allowable stem load. See the Maximum Pressure Limitation section.  
7. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

## Introduction

### Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Type 667 actuator in sizes 30 through 76 and size 87. The Type 667-4 actuator in sizes 70 and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Only personnel qualified through training or experience should install, operate, and maintain a Type 667 actuator (see figure 1). If you have any questions about these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

### Description

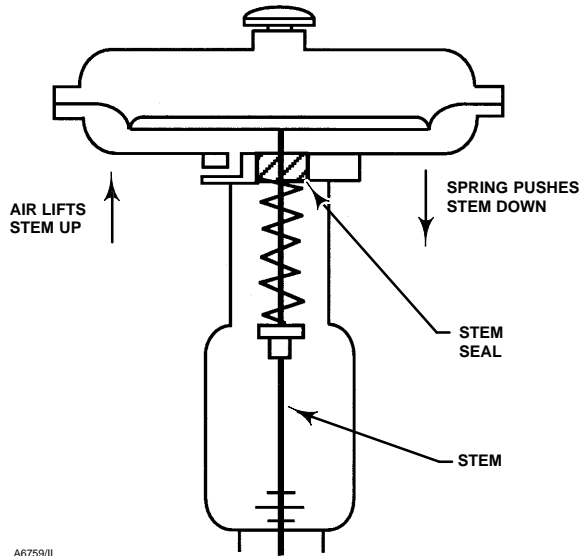
The Type 667 actuator (figure 1) and the Type 667-4 actuator are reverse-acting, spring-opposed dia-

phragm actuators. They provide automatic operation of control valves. The Type 667 actuator provides 3 inches (76 mm) maximum actuator travel. The Type 667-4 actuator provides 4 inches (102 mm) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the diaphragm. Figure 2 shows the operation of these actuators.

A Type 667 or 667-4 actuator can be furnished with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is usually used as an adjustable down travel stop. (A down travel stop limits actuator travel in the down direction. "Down" means that the stem is traveling out of the actuator. "Up" means that the stem is traveling into the actuator.) A side-mounted handwheel assembly is usually used as an auxiliary manual actuator. The side-mounted handwheel can also be used as an adjustable up or down travel stop. Casing-Mounted adjustable up or down travel stops are also available on this actuator.

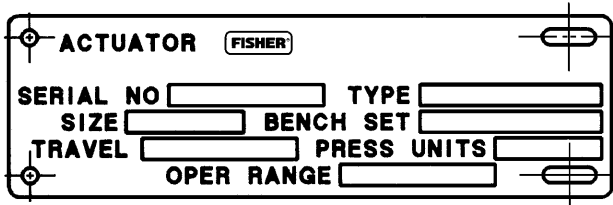


# Type 667 Size 30-76 & 87



A6759/IL

Figure 2. Schematic of Type 667 and 667-4 Actuators



12B6508-B SHT 1 / IL

Figure 3. Type 667 and 667-4 Actuator Nameplate

### Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

## Specifications

Refer to table 1 for Specifications of the Type 667 and 667-4 actuators. See the actuator nameplate (figure 3) for specific information for your actuator.

control valve, or loss of control of the process caused by excessive pressure, do not exceed the Maximum Pressures listed in table 1. Refer to the Maximum Pressure Limitations section below.

## Maximum Pressure Limitations

The casing and diaphragm of Type 667 actuators are pressure operated. This air pressure provides energy to compress the spring, to stroke the actuator, and to seat the valve. The following explanations describe the maximum pressure limits for an actuator. Refer to the nameplate or table 1 for maximum values for your actuator.

- Maximum Casing Pressure for Actuator Sizing:** This is the maximum pressure that can be applied at less than full travel of the actuator. If this stroking pressure is exceeded before the upper diaphragm plate contacts the travel stop, damage to the stem or other parts might result.

- Maximum Excess Diaphragm Pressure:** Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result.

Because the actuator has traveled its specified travel, and the diaphragm head is physically stopped from movement, the energy from any additional air pressure is transmitted to the diaphragm and diaphragm casings. The amount of air pressure that can be added once the actuator has traveled to the stops is limited by the resultant adverse effects that may occur. Exceeding this limiting factor could result in leakage or casing fatigue due to the deformation of the upper diaphragm casing.

- Maximum Diaphragm Casing Pressure:** If the Maximum Diaphragm Casing Pressure is exceeded, damage to the diaphragm, diaphragm casing, or actuator might result.

## Installation

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted. Also, refer to figure 4 for location of parts.

### WARNING

To avoid personal injury and property damage caused by bursting of parts and to avoid parts damage, malfunction of

### WARNING

To avoid personal injury or parts damage, do not exceed any of the maximum Diaphragm Pressures listed in table 1.

# Type 667 Size 30-76 & 87

- **Valve/Actuator Assembly:** If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the loading connection procedures.

- **Actuator Mounting:** If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the following actuator mounting procedures before placing the valve in service. It is recommended that you perform the bench set spring adjustment procedures in this section to confirm that the actuator is adjusted correctly for the valve travel.

- **Positioner:** If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.

- **Handwheel Cap:** If the handwheel cap (key 247, figures 10, 11, or 16) is not in place, install the cap by pushing it on by hand until it snaps into place.

## Mounting the Actuator on the Valve



- The Type 667 actuator spring load pushes the stem down out of the actuator yoke (see figure 2), and it can come in contact with the valve stem during actuator mounting.

- If the valve stem is allowed to remain in the up position (towards the actuator) during actuator mounting, it can interfere with the actuator stem during mounting. It is possible to damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

It may be necessary to apply a temporary loading pressure to the actuator to move the actuator stem away from the valve during installation.

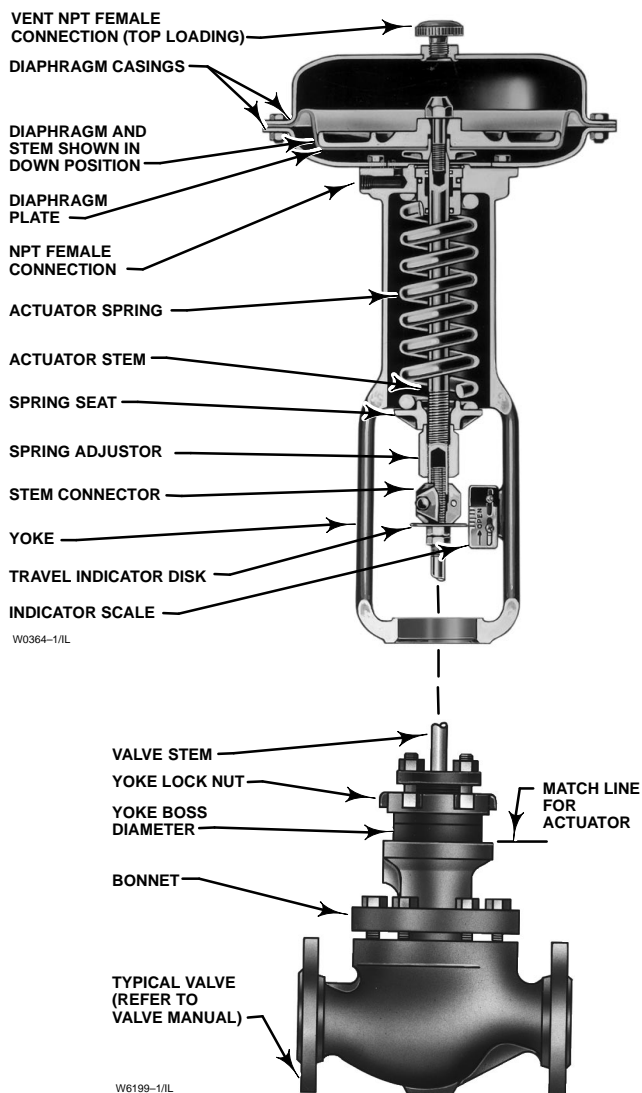


Figure 4. Actuator-Mounting Components for Size 30 through 70 Actuators

If it is not possible to provide a temporary loading pressure, be very careful when lowering the actuator over the valve stem to prevent damage to valve stem and threads.



When moving the actuator stem with loading pressure applied, exercise caution to keep hands and tools out of the actuator stem travel path. If the loading pressure is accidentally disconnected, personal injury and property damage is

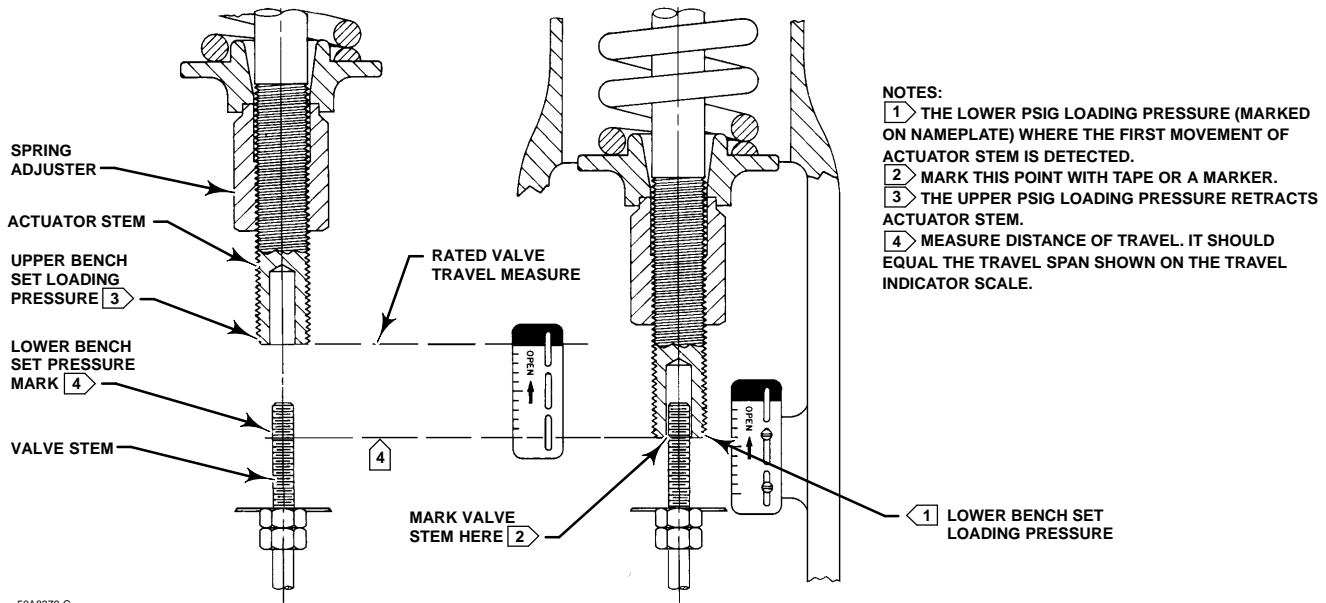


Figure 5. Bench Set Adjustment

possible if something is caught between the actuator stem and other control valve parts.

1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.

2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 34) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)

3. Lift or hoist the actuator onto the valve bonnet:

a. **For size 87 actuators:** Slowly lower the actuator down onto the valve while guiding the valve stem into the opening in the end of the the actuator stem (see figure 5). Once the actuator is in place, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.

b. **For all other size actuators:**

- Slowly lower the actuator down onto the valve. As the yoke passes over the end of the valve stem, place the yoke locknut over the valve stem. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator onto the valve because the disk will not go through the actuator yoke opening).

- Continue to lower the actuator while guiding the valve stem into the opening in the end of the actuator stem until the actuator is in place (see figure 5).

- Screw the yoke locknut onto the valve bonnet and tighten the locknut.

4. Do not connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended that you perform the *Bench Set Spring Adjustment* procedures below, to verify that the actuator is still adjusted correctly.

## Discussion of Bench Set

The bench set pressure range is used to adjust the initial compression of the actuator spring with the valve-actuator assembly “on the bench.” The correct initial compression ensures that the valve-actuator assembly will function properly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set range is established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by “loose” packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the *Bench Set Spring Adjustment Procedure*).

If you are attempting to adjust the bench set range after the actuator is connected to the valve and the

# Type 667 Size 30-76 & 87

packing tightened, you must take friction into account. Make the spring adjustment such that full actuator travel occurs at the bench set range (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

For an assembled valve-actuator assembly, the valve friction may be determined by following the procedure described below:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

## Note

**Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.**

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than its mid-travel position.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

5. Calculate the actual friction force:

$$\text{Friction Force, pounds} = 1/2 \left( \begin{array}{c} \text{Difference} \\ \text{in pressure} \\ \text{readings, psig} \end{array} \right) \times \left( \begin{array}{c} \text{Effective} \\ \text{diaphragm area,} \\ \text{inches}^2 \end{array} \right)$$

Refer to table 1 for the effective diaphragm area.

When determining valve friction, you can make diaphragm pressure readings at a travel position other than mid-travel if you desire. If you take readings at zero or at the full travel position, take extra care to ensure that the readings are taken when the travel just begins or just stops at the position selected.

It is difficult to rotate the spring adjustor (key 74, figure 7, 8, and 9) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

## Bench Set Spring Adjustment

The term “bench set” means that the actuator is **not** connected to the valve, or any other loads. Ensure that the actuator diaphragm is at the bottom of its travel as shown in figure 5. (Note: Some spring compression is required to move the diaphragm to the **bottom** of its travel.)

Also, provide a certified pressure gauge that will accurately read the diaphragm pressure from 0 through the upper bench set pressure marked on the nameplate. Apply loading pressure to the diaphragm.

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly. It is important to be sure that the actuator assembly is **not** binding or producing any friction on the actuator stem movement.

Key numbers are shown in figures 7, 8, and 9.

## For Direct-Acting Valves (PDTTC)

1. If not already accomplished, push the valve stem down away from the actuator to the closed position.
2. Set the diaphragm loading pressure to 5 psig (0.3 bar) over the upper bench set pressure. The upper travel stop should be contacting the diaphragm casing.
3. Slowly decrease the pressure towards the upper bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the upper pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the upper bench set pressure. (Note: You may need to lower the loading pressure to reduce spring compression, allowing the spring adjuster to turn.)
5. Be sure the spring adjuster is adjusted to meet the requirements of step 4 above.
6. Apply the lower bench set loading pressure to the diaphragm. This will extend the actuator stem toward the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
7. Slowly increase the diaphragm pressure until the upper bench set loading pressure is applied. Again, the travel stop should be against the diaphragm casing.
8. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
9. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
10. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that

may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## For Reverse-Acting Valves (PDTO)

1. If not already accomplished, push the valve stem down away from the actuator to the open position. Later, when installing the connector, pull up the valve stem to the closed position.
2. Set the diaphragm loading pressure to a value less than the lower bench set pressure (near zero). The down travel stop should be contacting the yoke.
3. Slowly increase the pressure towards the lower bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the lower bench set pressure.
5. Apply the upper bench set loading pressure to the diaphragm. This will retract the actuator stem away from the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
6. Slowly decrease the diaphragm pressure until the lower bench set loading pressure is applied. Again, the down-stops should be against the yoke.
7. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
8. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
9. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## Installing the Stem Connector Assembly

When installing the stem connector assembly (key 31), the actuator and valve stem threads should engage the threads of the stem connector by a distance equal to the diameter of the stem.

### Note

**Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard it, if present, before clamping the actuator and valve stems together.**

1. If necessary, push the valve stem down so that the valve plug is touching the seat ring on direct-acting valves. For reverse-acting valves, pull the stem up to the closed position. Always start with the valve plug on the seat.
2. If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 34) is on top of the locknuts.
3. Apply the diaphragm pressure to the lower bench set pressure. (Or, the upper bench set pressure for reverse-acting valves.) This should be the same pressure used in the bench set steps, and it is marked on the nameplate.
4. Place the stem connector half with the threaded holes, approximately half way between the actuator and valve stems. Refer to figures 7, 8, and 9 to help locate the connector position.

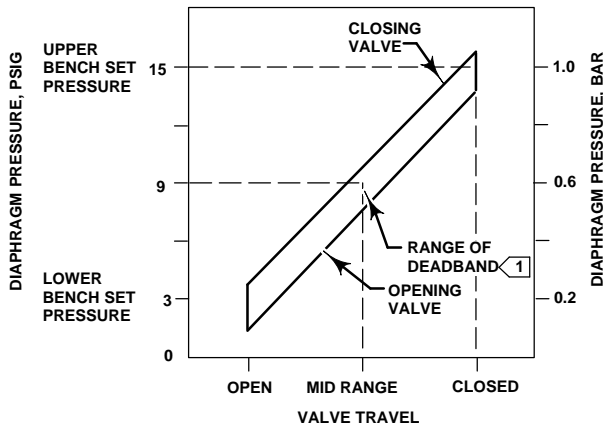
Be sure that the actuator and valve stem threads are engaging the threads of the stem connector by a distance equal to one diameter of the stem.

### CAUTION

**Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely.**

5. Install the other half of the stem connector and insert the cap screws and tighten them. If installing a positioner, also attach the feedback bracket at the same time.
6. Screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector, or for size 87 actuators, tighten the locknuts against the stem connector. Do not overtighten the locknuts.
7. Slowly increase and then decrease pressure several times, stroking the valve from the lower bench set pressure to the upper pressure.

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NOTE:  
 1 DEADBAND IS CAUSED BY FRICTION.  
 A6588 / IL

Figure 6. Typical Direct Acting Valve Response to Deadband

Be sure that the valve is in the closed position (up or down, depending on valve action). Loosen the screws on the travel scale, and align it with the travel indicator disk. Stroke the valve full travel to ensure that the travel matches the valve travel on the travel indicator plate. If valve travel is not correct, repeat the stem connector procedure.

## Note

**For push-down-to-close valves, the valve plug seat is the limit for downward travel and the actuator up-stop is the limit for upward (away from the valve) movement. For push-down-to-open valves, the actuator down-stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement. For Type 667 actuators, a down-stop (key 77, figure 7) is installed to limit actuator diaphragm downward movement when the actuator provides the limit.**

## Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 6). Each actuator spring has a fixed spring rate (force). You have verified that the right spring was installed in the actuator by completing the bench set spring adjustment steps.

Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

Deadband, psi

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn \%}$$

## Loading Connection

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted.

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary. For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT female connection in the side of the yoke (key 73).
2. For size 70 and 87 actuators, if necessary, remove the 1/4-inch NPT bushing if a 1/2-inch NPT female connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.
4. If valve stem travel appears to be incorrect, refer to the bench set spring adjustment procedures at the beginning of this section. Do not place the valve in service if it is not reacting correctly to diaphragm loading pressure changes.

## Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions. Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher Controls.

### WARNING

**Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring pre-compression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

The maintenance instructions are divided into several sections: Actuator, Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop), Side-Mounted Handwheel Assembly (Manual Actuator) for Size 34 through 60 Actuators, Side-Mounted Handwheel Assembly (Manual Actuator) for Size 70, 76 and 87 Actuators, and Casing-Mounted Travel Stops.

## Actuator Maintenance

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key are shown in figures 7, 8, or 9, unless otherwise noted. Figure 7 shows the size 30 through 60 actua-

tors, figure 8 shows the size 70 actuator, and figure 9 shows the size 87 actuator.

## Actuator Disassembly

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

1. Remove the tubing or piping from the connection in the top of the yoke (key 73). For a top-loaded construction, also remove the piping or tubing from the connection in the upper diaphragm casing (key 1).
2. Turn the spring adjuster (key 74) counterclockwise (**toward the valve body**) until all spring compression is relieved.

### WARNING

**To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector cap screws when the stem connector has spring force applied to it.**

3. If necessary, remove the actuator from the valve body by separating the stem connector (key 31). Loosen the stem locknuts for the size 87 actuator, and removing the stem connector nuts. For all other sizes, separate the stem connector by loosening the stem locknuts (keys 69 and 75) and unscrewing the two stem connector cap screws.
4. Unscrew the spring adjuster (key 74) from the actuator stem (key 144). Also lift the spring seat and spring (Key 19 and 18) out of the yoke.
5. Remove the diaphragm casing cap screws and nuts (keys 13 and 14), and lift off the upper diaphragm casing (key 1).
6. Remove the following connected parts: the diaphragm (key 3), upper diaphragm plate (key 4), spacer (key 2), cap screw (key 12), lower diaphragm plate (key 71), and actuator stem (key 144). Be careful when pulling the threads of the actuator stem through the seal bushing (key 7) to avoid damaging the O-rings (key 8).
7. Remove the cap screw (key 12) to separate the parts of this assembly.
8. To remove the seal bushing, remove the snap ring (key 72), and lift out the bushing. Inspect, and if necessary, replace O-rings (8 and 9).
9. Remove cap screws (key 30), and take off the lower diaphragm casing (key 64) and the gasket (key 70),

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size 30 through 60 and 76) or O-ring (key 70, size 70 or 87). If necessary, the down travel stops (key 77) can be removed.

## Actuator Assembly

1. Coat the O-rings (key 70, sizes 70 and 87) with lubricant (key 237 or equivalent). Or, coat the gasket with sealant (key 238 or equivalent). Place a new gasket or O-ring (key 70) on the yoke (key 73). Position the lower diaphragm casing (key 64) on the yoke, align the holes, and insert and tighten the cap screws (key 30). If down travel stops (key 77) were removed, insert and tighten them.
2. Coat the O-rings (keys 8 and 9) with lubricant (key 237 or equivalent) and place the O-rings in the seal bushing (key 7).
3. Fill the seal bushing with lubricant (key 237 or equivalent), slide the bushing into the yoke (key 73), and install the snap ring (key 72).
4. Assemble the actuator stem (key 144), lower diaphragm plate (key 71), diaphragm (key 3), upper diaphragm plate (key 4), and the travel stop cap screw and spacer (keys 12 and 2). Coat the cap screw threads with Lubriplate Mag-1 or equivalent (key 237). Tighten the cap screw (key 12) to 30 lbf•ft (41 N•m) torque for size 30 actuators, 70 lbf•ft (95 N•m) torque for size 34 and 40 actuators, or 190 lbf•ft (258 N•m) torque for size 45 to 70 and 87 actuators. Place this assembly in the actuator. Take care when pushing the actuator stem through the seal bushing so that the threads do not damage the O-rings.



## CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Install the upper diaphragm casing (key 1), and install the cap screws and nuts (keys 13 and 14). Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Install the actuator spring (key 18) and spring seat (key 19). Apply lubricant (key 239 or equivalent) to the threads of the actuator stem and to the surface of the spring adjuster (key 74) that contacts the spring seat. Thread the spring adjuster onto the actuator stem.
7. Mount the actuator onto the valve in accordance with the procedures in the Installation section.

## Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop)

Actuator key numbers are shown in figures 7, 8, and 9. And, top-mounted handwheels are shown in figures 10, 11, and 12.

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.**

A top-mounted handwheel assembly (figures 10, 11, and 12) is usually used as an adjustable down travel stop to limit full extension of the actuator stem. Turning the handwheel counterclockwise pulls the extension rod (key 150, figures 10, 11, and 12) up, retracting the actuator stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

## Disassembly for Top-Mounted Handwheel

1. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
2. Turn the handwheel (key 58) clockwise so that the handwheel assembly is not causing any spring compression.
3. Turn the actuator spring adjuster (key 74) to relieve all the compression from the spring (key 18).
4. If servicing just the thrust bearing, races, and handwheel screw (keys 180, 181, and 160) only, use the following steps:
  - Remove the cap and drive out the groove pin. Remove the castle nut, bearing retainer, thrust bearing, and races (keys 247, 167, 166, 180, and 181).
  - Use the handwheel to remove the handwheel screw (key 160) from the handwheel body (key 148).
  - It necessary, remove the extension rod (key 150) at this time. Most maintenance procedures do not require the rod to be removed.
  - Clean and inspect all parts or replace parts as necessary. Upon re-assembly, lubricate handwheel threads, bearings, and races with Never-Seez Nickel Special (key 239) or equivalent.



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- Lubricate and re-install the handwheel screw into handwheel body (key 148). Lubricate and replace the races, bearing, and retainer (keys 181, 180, and 182). Replace the castle nut (key 166), tighten it, and insert the groove pin (key 167). Replace the handwheel cap (key 247).

## 5. For size 30 through 60 and 76 actuator handwheels (figures 10 and 11):

- Remove the cap screws (key 161). Make sure that the guide plate can turn between the handwheel body and the mounting plate (keys 157, 148 and 158).

- Remove the cap (key 247) and drive out the groove pin (key 167). Remove the castle nut (key 166) and, if necessary, unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1) and the mounting plate (key 158).

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## 6. For size 70 and 87 actuator handwheels (figure 12):

- Remove the cap (key 247). Drive out the groove pin (key 167) and remove the castle nut, the bearing retainer, and thrust bearing (keys 166, 182, 181, and 180). It is not necessary to remove the extension rod (key 150) at this time.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1), handwheel body (key 148) and attached parts.

- If travel stops (key 152) are used, note and record their position relative to the cap screws (key 154) for use in assembly. Remove the travel stops and cap screws, and remove either the mounting plate (key 158, figure 12) or the handwheel body (key 148, figure 12) and attached parts.

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## Assembly for Top-Mounted Handwheel

### For size 30 through 60 and 76 actuator handwheels:

Refer to figures 10 and 11 for top-mounted handwheel assemblies.

1. If it was removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place. Also, install the guide post (key 150) if it was removed.

2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).

3. Install the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9) with the cap screws (key 154). Finger tighten the screws.

4. If travel stops were used, install the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

6. If necessary, screw the extension rod (key 150) into the connector (key 27). Slide the guide plate (key 157) onto the extension rod (key 150). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). If necessary, replace the extension rod (key 150). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

7. Lubricate and install the thrust bearings (keys 181 and 180), install the bearing retainer (key 182), install the castle nut (key 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

8. Refer to the Assembly portion of the Actuator maintenance section.

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## For size 70 and 87 actuators handwheels (figure 12):

Refer to figure 12 for top-mounted handwheel assemblies.

1. If removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place.
2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).
3. If necessary, install the extension rod (key 150) into the connector (key 27) and tighten it. Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Lubricate and install the thrust bearings (keys 180 and 181), install the bearing retainer (key 182), install the castle nut (keys 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).
7. Refer to the Assembly portion of the Actuator maintenance section.

## Side-Mounted Handwheel Assembly for Size 34 through 60 Actuators

A side-mounted handwheel assembly (figures 13 and 14) is usually used as a manual actuator. This design is frequently used to drive the valve open or closed under loading conditions. Turning the handwheel clockwise past the neutral position always closes a push-down-to-close valve. A pair of levers (key 146, figure 13) on a handwheel assembly close the valve by moving the valve stem.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

## Disassembly for Side-Mounted Handwheel (34-60)

1. If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the nuts (keys 147 and 170) from the U-bolts (keys 166 and 143) that hold the assembly to the yoke.
2. Remove retaining ring (key 154), and drive out the lever pivot pin (key 153).
3. There are two screws (key 156) that hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove screw (key 161) and pointer mounting bolt (key 159, not shown) located behind pointer (key 160).
5. Remove nut (key 54), lockwasher (key 150), and washer (key 149), and take off the handwheel (key 51). Be careful not to lose the small ball (key 55) and spring (key 56).
6. Unscrew the bearing retainer (key 136) after loosening the locking set screw (key 168, not shown).
7. Pull the screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also, remove the bushing (key 151) on sizes 34 and 40.
8. If required, remove the bearings (key 152), one from the bearing retainer and the other from the handwheel body.
9. **Size 34, 40, 45 and 76 actuator handwheels (figures 10 and 11)**, fasten the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9):
  - If travel stops were used, install the travel stops to their original positions as recorded in preceding disassembly steps.
  - Install the cap screws (key 154). Tighten the screws and travel stops.
10. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

11. **Size 60 and 76 actuator handwheels**, position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

- Slide the guide plate (key 157) onto the extension rod (key 150), and screw the extension rod into the connector (key 27). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the guide plate (key 157) or spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

12. **Size 70 or 87 actuator handwheel**, slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Insert and tighten the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9).

13. **Size 34 through 60, and 76 actuator handwheels**, re-lubricate the thrust bearings (key 180), install the washer and castle nut (keys 162 and 166) on the extension rod. Do not overtighten the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

- **Size 70 and 87 actuators handwheels**, screw the extension rod (key 150) into the connector (key 27). Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.

14. **Size 70 or 87 actuator handwheels**, re-lubricate the thrust bearing (key 180), install the thrust bearing and bearing retainer (keys 180 and 181) on the extension rod (key 150), and screw on the castle nut (key 166). Do not overtighten the bearing. Drive in the groove pin (key 167), and replace the cap (key 247).

15. Refer to the Assembly portion of the Actuator maintenance section.

## ***Assembly for Side-Mounted Handwheel (Sizes 34-60)***

1. Pack the bearings (key 152) with lubricant (key 239 or equivalent). Insert one bearing and the bushing (key 151) in the handwheel body (key 142) as shown in figure 13 or 14. The bushing is not used in a handwheel assembly for size 45 through 60 actuators.

2. Coat the screw threads with lubricant (key 239) or equivalent, and thread the operating nut onto the screw. Slide the second bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151) as shown in figure 13 or 14 or into the bearing.

3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, not shown) to hold the bearing retainer in place.

4. Coat the groove in the handwheel body (key 142) with lubricant (key 237 or equivalent). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51). Holding the ball and spring in the handwheel, put the handwheel (key 51), the washer (key 149), the lock-washer (key 150), and the hex nut (key 54) on the end of the screw (key 145). Tighten the hex nut.

5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160) as shown in figure 13 or 14. Insert and tighten the screw (key 161).

6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for size 45, 50, and 60 actuators or with the machine bolts (key 156) for handwheel assemblies on size 34 and 40 actuators.

7. If the handwheel assembly was removed from the yoke, remount the handjack assembly to the yoke using the dowel pins for alignment. Position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten nuts (key 144). Finish tightening the U-bolt nuts to 120 lbf•ft [163 N•m] (key 170) and 30 lbf•ft [41 N•m] (key 147). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

8. Position the levers (key 146) as shown in figure 13 or 14. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

## **Side-Mounted Handwheel Assembly (Sizes 70, 76, and 87)**

A side-mounted handwheel assembly (figure 15) is usually used as a manual actuator. Turning the handwheel clockwise past the neutral position always closes the valve body. A sleeve (key 123, figure 15) on a handwheel assembly for a size 70, 76 or 87 actuator opens the valve body by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

# Type 667 Size 30-76 & 87

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## **Disassembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

Bypass the control valve. Reduce the loading pressure to atmospheric. Disconnect the loading pressure tubing or piping at the yoke.

Remove cover band (key 87), and relieve spring compression by turning the spring adjuster (key 74) counterclockwise.

Remove the cap screws and nuts (keys 13 and 14) and lift off the upper diaphragm casing (key 1).

Remove the travel stop screw (key 12) and spacer (key 2), and take off the diaphragm plate (key 4), the diaphragm (key 3), and the lower diaphragm plate (key 71).

Unscrew the cap screws (key 90) and remove the following connected parts: the lower diaphragm casing (key 64), the O-ring (key 70), spring case adaptor (key 89), the seal bushing, O-rings, and snap ring (keys 7, 8, 9, and 72).

Remove the snap ring (key 72), and slide the seal bushing and O-rings (keys 7, 8, and 9) out of the spring case adaptor (key 89).

Take out the actuator spring (key 18).

Remove the stem connector (key 31) and stem connector cap screws.

Pull the actuator stem (key 144) up and out of the yoke. The spring seat (key 19), spring adjuster (key 74), thrust bearing (key 128), and the pinned adjusting screw (key 131) will come out with the actuator stem.

Turn the handwheel so that the lower sleeve (key 123) extends out of the bottom of the yoke. DO NOT move the neutral indicator scale (key 125).

Loosen two set screws (key 121), and unscrew the bearing retainer flange (key 45). Take out the worm gear and two thrust bearings (key 132), one on each side of the gear.

The worm shaft (key 51) and associated parts can be disassembled, if desired, by first removing handwheel nut (key 127) and the handwheel (key 58). Do not lose the small ball (key 141) and spring (key 142).

Loosen the set screw (key 52) for each worm shaft retainer (keys 48 and 49). Unscrew the two worm retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers.

## **Assembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

1. The front and back worm retainers (keys 48 and 49) each have a slot in their threads for a set screws (key 52). Pack the ball bearings (key 50) with lubricant (key 239) or equivalent, and insert one ball bearing in the back worm retainer (key 49) as shown in figure 15.

2. Thread the back bearing retainer and ball bearing (keys 49 and 50) into the yoke. Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 52), and tighten it.

3. Coat the worm shaft (key 51) threads with lubricant (key 239 or equivalent), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back bearing retainer.

4. Insert the bearing in the front bearing retainer (key 49), and thread the retainer and ball bearing into the yoke. Align the slot in the retainer with the hole in the yoke, insert the set screw (key 52), and tighten it.

5. Put the spring and ball (keys 141 and 142) in the handwheel (key 58). Slide the handwheel onto the worm shaft (key 51). Thread the hex nut (key 127) onto the worm shaft.

6. Pack the two needle bearings (key 132) and coat the worm gear (key 44) threads with lubricant (key 239) or equivalent. Insert the key (key 122), the bearings, and the worm gear in the yoke (key 73) as shown in figure 15.

7. Slots are cut in the threads of the bearing retainer flange (key 45). Thread the flange into the yoke so that the slots and the holes for the set screws (key 121) align. Insert the screws, and tighten them.

8. The lower sleeve (key 123) has a milled groove in one end. Coat the sleeve threads with lubricant (key 239 or equivalent), slide the end of the lower sleeve with the groove into the bearing retainer flange, turn the handwheel, and feed the sleeve through the worm gear so that the slot in the lower sleeve engages the key (key 122) in the yoke. Continue turning the handwheel until the lower sleeve protrudes 3.19 inches (81 mm) below the surface of the yoke. The bottom of the lower sleeve should be even with the bottom of the extension on the neutral indicator.

9. Pack the thrust bearing (key 128) with lubricant (key 239) or equivalent. Slide the actuator stem (key 144) and the attached adjusting screw (key 131), pin (key 130), thrust bearing (key 128), spring seat (key 19), and spring adjuster (key 74) into the yoke. The lower end of the stem slides through the lower sleeve (key 123) and the lower sleeve slides into the adjusting screw (key 131), as shown in figure 15.

10. Position the actuator stem (key 144) against the valve stem. Clamp both stems between the two halves of the stem connector (key 31), and be sure the threads are engaged properly on both stems. The stem connector should not be closer than 0.125 inches (3.2 mm) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 0.125 inches (3.2 mm) of free travel of the lower sleeve in either direction for manual operation. Fasten the halves together with the cap screws.

11. Put the actuator spring (key 18) in the yoke on the spring seat (key 19).

12. Coat the O-rings (keys 8 and 9) with lubricant (key 237) or equivalent, and insert them in the seal bushing (key 7). Slide the seal bushing and O-rings into the spring case adaptor (key 89).
13. Install the snap ring (key 72).
14. Slide the seal bushing and O-rings (keys 7, 8, and 9) over the actuator stem (key 144), and position the spring case adaptor (key 89), lower diaphragm casing (key 64), and O-ring (key 70) on the yoke.
15. Insert and tighten the cap screws (key 90).
16. Slide the lower diaphragm plate (key 71), the diaphragm (key 3) with the patterned side up, the diaphragm plate (key 4), the spacer (key 2), and the cap screw (key 12) on the actuator stem (key 144). Tighten the cap screw.
17. Put the diaphragm casing (key 1) on the diaphragm. Align the holes in the diaphragm (key 3) and the diaphragm casings (keys 1 and 64).



## CAUTION

**Over-tightening the cap screws and hex nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) of torque.**

18. Install the cap screws and hex nuts (keys 13 and 14) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a criss-cross pattern.
19. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

## Casing-Mounted Travel Stops

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as manual operator.**

Casing-mounted adjustable travel stops (shown in figures 16 through 20) are available to limit travel in the down direction (extending the actuator stem) or in the up direction (retracting the actuator stem). The travel stop in figure 16 is a down travel stop, the travel stop in figure 17 is an up and down travel stop, and the travel stops in figures 18, 19, and 20 are up travel stops.

Use the locknuts (key 151, figures 16 and 17), stem (key 150, figure 18), handwheel (key 58, figure 19) or cap screw (key 177, figure 20) to set the point at which the travel stop limits travel. Be sure to tighten the locknuts and replace the cap (key 149, figures 16 and 18; key 247, figure 17) after setting the travel stop.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 16 through 20.

1. Remove the cap (key 149 or 247) if the travel stop uses one. For down travel stops, loosen the locknuts (key 151, figures 16 and 17) so that the stop is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
3. For down travel stops, turn the spring adjuster (key 74, figures 7, 8, and 9) out of the yoke toward the stem connector (key 31) to relieve all the compression in the spring (key 18).
4. **For style 11 travel stops (figure 17)**, unscrew the cap screws (key 161), and make sure that the guide plate (key 157) can turn between the handwheel body (key 148) and the mounting plate (key 158).
5. Use a wrench on the nuts (key 151) to unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
6. Unscrew the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1, figures 7, 8, and 9) and, for the style 11 travel stop, the mounting plate (key 158). For styles 10, 12 and 13, the travel stop assembly will be removed with the casing.
7. Note and record the position of travel stops (key 152) relative to the cap screws (key 154) for use in assembly. Unscrew the travel stops and cap screws, and remove either the mounting plate (key 158) or the handwheel body (key 148) and attached parts.
8. Separate the stem (key 150) and screw (key 160, figure 17) from the handwheel body.
9. Before reassembling, lubricate parts indicated by key 239 in figures 16 through 20. Use lubricant (key 239 or equivalent).
10. Reassemble parts in the reverse order of removal.
11. When replacing the cap screws (key 154) and, if used, the travel stops (key 152), be sure to return them to their original position as recorded in step 6.

# Type 667 Size 30-76 & 87



## CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14), figures 7, 8, and 9 can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.

12. Install the cap screws and nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

13. Return the spring adjuster (key 74, figure 7, 8, and 9) to its original position. Re-adjust the travel stop.

## Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Fisher Controls sales office or sales representative regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts Kits and Parts List sections.

## Parts Kits

### Side-Mounted Handwheels Retrofit Kits

Key	Description	Part Number
	RETROFIT KIT INCLUDES PARTS TO ADD A SIDE-MOUNTED HANDWHEEL.	
	SIZE 34 PUSH-DOWN-TO-CLOSE	30A8778X0E2
	SIZE 34 PUSH-DOWN-TO-OPEN	30A8778X0F2
	SIZE 40 PUSH-DOWN-TO-CLOSE	30A8778X0G2
	SIZE 40 PUSH-DOWN-TO-OPEN	30A8778X0H2
	SIZE 45 & 46 PUSH-DOWN-TO-CLOSE	40A8779X0A2
	SIZE 45 & 46 PUSH-DOWN-TO-OPEN	40A8779X0B2
	SIZE 50 & 60 PUSH-DOWN-TO-CLOSE	40A8779X0C2
	SIZE 50 & 60 PUSH-DOWN-TO-OPEN	40A8779X0D2

### Top-Mounted Handwheels Retrofit Kits

RETROFIT KIT INCLUDES PARTS TO ADD A TOP-MOUNTED HANDWHEEL. KIT NUMBER 1 INCLUDES THE HANDWHEEL ASSEMBLY ONLY. KIT NUMBER 2 INCLUDES KIT NUMBER 1 AND A NEW DIAPHRAGM CASE THAT IS REQUIRED TO MOUNT THE HANDWHEEL ASSEMBLY.

Key	Description	Part Number
	KIT 1	
	SIZE 30	30B3940X102
	SIZES 34	39B3940X022
	SIZES 40	39B3940X042
	SIZES 45 & 50	33B9224X012
	SIZES 46, 60, AND 76	33B9224X012
	SIZES 70 & 87	CV8060X0012

Key	Description	Part Number
	KIT 2	
	SIZE 30	30B3940X052
	SIZES 34	30B3940X062
	SIZES 40	30B3940X092
	SIZES 45 & 50	33B9224X022
	SIZES 46, 60 AND 76	33B9224X032
	SIZES 70 & 87	CV8060X0022

## Actuator Repair Kits

PARTS KIT INCLUDES KEYS 8, 9, AND 70. O-RING MATERIAL IS NITRILE, AND GASKET MATERIAL IS COMPOSITION.

Key	Description	Part Number
	SIZE 30	R667X000302
	SIZE 34 & 40	R667X000402
	SIZE 45 THROUGH 60	R667X000502
	SIZE 70 & 87	R667X000702
	SIZE 76	R667X000762

## Parts List

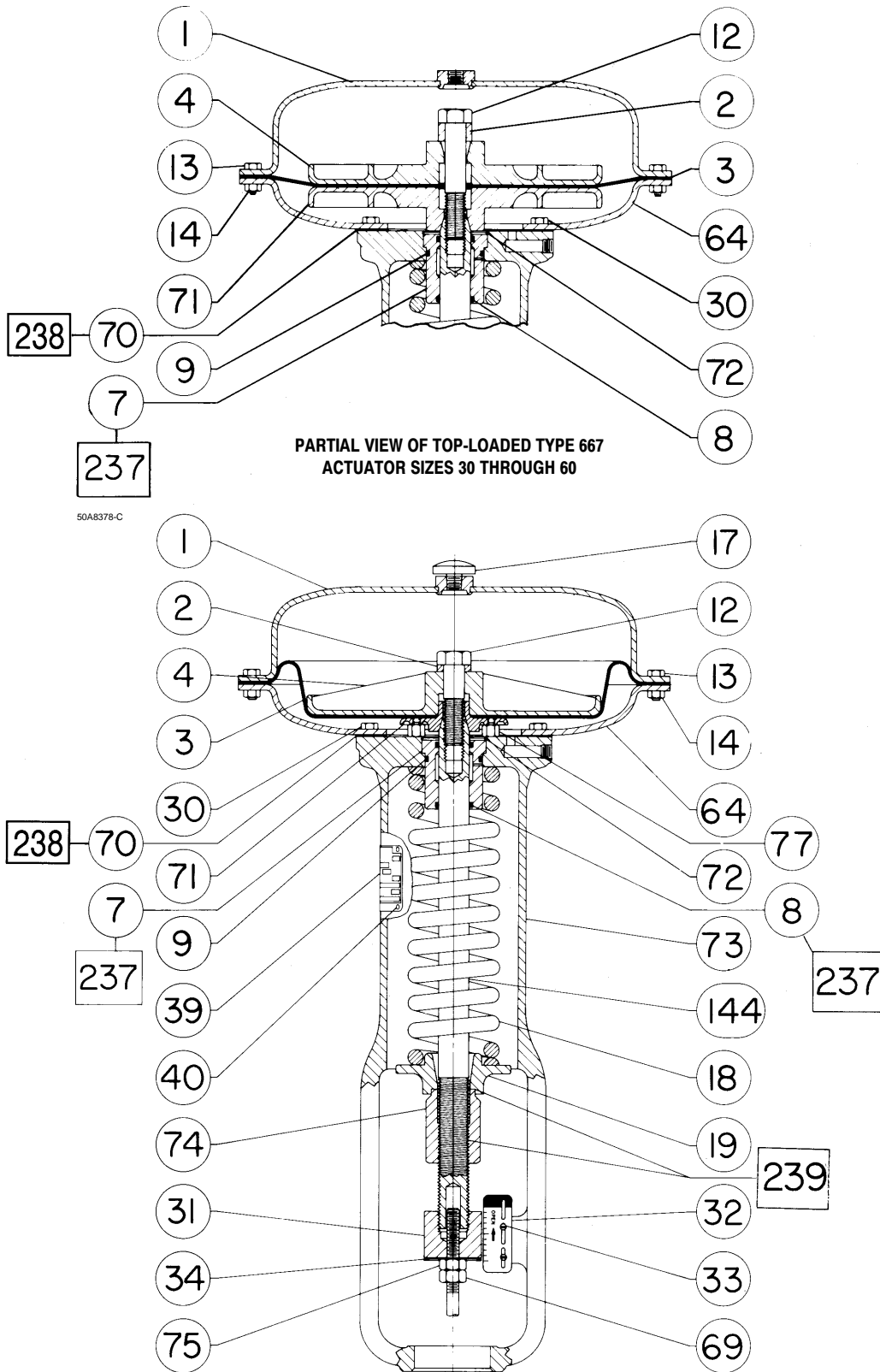
### Actuator Assembly

Key	Description	Part Number	Qty
1	UPPER DIAPHRAGM CASING [STEEL, ZINC PLATED (ZN PL)]		
	SIZE 30	2E800728992	1
	SIZE 34 & 40	2E681428992	1
	SIZE 45 & 50	3E844628992	1
	SIZE 46, 60 & 76	3E846728992	1
	SIZE 70 & 87	2N127828992	1
	W/TOP-MOUNTED HANDWHEEL		
	SIZE 30	2E792225062	1
	W/TOP-MTD HANDWHEEL OR STYLE 11 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	SIZE 46, 60 & 76	2E847425062	1
	SIZE 70 & 87	2N127125062	1
	W/STYLE 10 OR 13 TRAVEL STOP		
	SIZE 30	2E792225062	1
	W/STYLE 10 OR 12 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	W/STYLE 10, 12, OR 13 STOP		
	SIZE 46, 60 & 76	2E847425062	1
	W/STYLE 12 STOP OR REVERSE VALVE		
	SIZE 70 & 87	2N127125062	1
	W/STYLE 14 TRAVEL STOP		
	SIZE 30	2F486225062	1
	SIZE 34 & 40	2F753428992	1
	SIZE 45 & 50	3F860628992	1
	SIZE 46, 60 & 76	1K131025062	1
2	TRAVEL STOP SPACER	SEE FOLLOWING TABLE	
3*	DIAPHRAGM		
	MOLDED NITRILE/NYLON		
	SIZE 30	2E800002202	1
	SIZE 34 & 40	2E669902202	1
	SIZE 45 & 50	2E859602202	1
	SIZE 46, 60 & 76	2E859802202	1
	SIZE 70 & 87	2N130902202	1
	FLUOROELASTOMER/NOMEX		
	SIZE 30	1K7982X00A2	1
	SIZE 34 & 40	1F3620X00A2	1
	SIZE 45 & 50	1J381902402	1
	SIZE 46, 60 & 76	1R7728X00A2	1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
3*	DIAPHRAGM (Cont'd)		12	SCREW, CAP, HEX HD	
	MOLDED SILICONE/POLYESTER			STANDARD HANDWHEEL, TRAVEL STOP STYLE 13, ADJ.	
	SIZE 30	2E8000X0022 1		UP STOP STYLE 14, FOR:	
	SIZE 34 & 40	2E6699X0042 1		SIZE 30	
	SIZE 45 & 50	2E8596X0012 1		1/4, 5/16, & 11/16-INCH (6, 8, & 17 mm)	
	SIZE 46, 60 & 76	2E8598X0012 1		TRAVEL	1A8678X0012 1
	SIZE 70 & 87	2N1309X0012 1		7/16, 5/8, & 3/4-INCH (11, 16, & 19 mm)	
4	UPPER DIAPHRAGM PLATE			TRAVEL	1B227523052 1
	ALUMINUM [200°F (93°C) MAXIMUM]			3/8, 7/16, 1/2, 9/16, & 5/8-INCH (10, 11, 13,14, & 16 mm)	
	SIZE 30	31B2028X012 1		TRAVEL	1A8678X0032 1
	SIZE 34 & 40	31B2029X012 1		11/16 & 3/4-INCH (17 & 19 mm)	
	SIZE 45 & 50	41B2030X012 1		TRAVEL	1B2275X0022 1
	SIZE 46, 60 & 76	41B2031X012 1	13	HEX HD CAP SCREW (STEEL, ZN PL)	
	CAST IRON			SIZE 30	1E760324052 12
	SIZE 30	2E880419042 1		SIZE 34 & 40	1E760324052 16
	SIZE 34 AND 40	3E880519042 1		SIZE 45 & 50	1A675124052 20
	SIZE 45 & 50	2E831519042 1		SIZE 46, 60 & 76	1A675124052 24
	SIZE 46, 60, & 76	2E847519042 1		SIZE 70 & 87	1A582824052 28
	SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	2N127019042 1			
	SIZE 70 & 87 4 IN. (102 mm) TRAVEL	10A2421X012 1	14	HEX NUT (STEEL, ZN PL)	
	SIZE 70 & 87 TYPE 667-4	10A2421X012 1		SIZE 30	1A346524122 12
	WCB STEEL			SIZE 34 & 40	1A346524122 16
	SIZE 30	2H510922012 1		SIZE 45 & 50	1A346524122 20
	SIZE 34 & 40	3H511122012 1		SIZE 46, 60 & 76	1A346524122 24
	SIZE 45 & 50	2H511322012 1		SIZE 70 & 87	1A346524122 28
	SIZE 46, 60, & 76	2H511522012 1	17	VENT ASSEMBLY	
	SIZE 70 & 87	2N757522012 1		ALL SIZES	17A5515X012 1
7*	BUSHING, SEAL		18	SPRING	SEE FOLLOWING TABLE
	BRASS		19	SEAT, LOWER SPRING	
	SIZE 30	1E791214012 1		G10300 (STEEL, ZN PL)	
	SIZE 34 & 40	1E682814012 1		SIZE 30	1U425623122 1
	SIZE 45 THROUGH 60	1E845714012 1		SIZE 34 & 40	1R179923122 1
	SIZE 70, 76 & 87	1N1316X0052 1		SIZE 45 THROUGH 60	1R180023122 1
	S41600 [416 STAINLESS STEEL (SST)]			CAST IRON	
	SIZE 30	1E7912X0012 1		STANDARD	
	SIZE 34 & 40	1E6828X0012 1		SIZE 70, 76 & 87	1N129619052 1
	SIZE 45 THROUGH 60	1E8457X0012 1		WCB STEEL	
	PTFE W/25% GLASS			STANDARD	
	SIZE 70, 76 & 87	1N1316X0042 1		SIZE 70 & 87	1N757722012 1
8*	O-RING			CAST IRON	
	NITRILE			W/HANDWHEEL	
	SIZE 30	1E591406992 2		SIZE 70, 76 & 87	1N887119042 1
	SIZE 34 & 40	1D237506992 2	27	EXTENSION ROD CONN (STEEL, ZN PL)	
	SIZE 45 THROUGH 60	1C562206992 2		W/TOP-MOUNTED HANDWHEEL	
	SIZE 70, 76 & 87	1E736906992 2		SIZE 30	1F118824092 1
	FLUOROELASTOMER			W/TOP-MTD HANDWHEEL OR STYLE 11	
	SIZE 30	1E5914X0062 2		SIZE 34 & 40	1F135924092 1
	SIZE 34 & 40	1D237506382 2			
	SIZE 45 THROUGH 60	1N285406382 2	27	EXTENSION ROD CONN (STEEL, ZN PL) (CONT.)	
9*	O-RING			SIZE 45 THROUGH 60 & 76	1F119424092 1
	NITRILE			STEEL, ZN PL	
	SIZE 30 THROUGH 40	1C415706992 1		W/TOP-MOUNTED HANDWHEEL	
	SIZE 45 THROUGH 87	1E845806992 1		SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	1N838331012 1
	FLUOROELASTOMER			SIZE 70 & 87 W/4 IN. (102 mm) TRAVEL	11A8130X012 1
	SIZE 30 THROUGH 40	1C4157X0032 1	30	HEX HD CAP SCREW (STEEL, ZN PL)	
	SIZE 45 THROUGH 87	1E8458X0022 1		SIZE 30	1D529824052 6
12	SCREW, CAP, HEX HD	SEE FOLLOWING TABLE		SIZE 34 & 40	1A368424052 6
				SIZE 45 THROUGH 60 & 76	1A368424052 8
				SIZE 70 & 87	1N129328992 12

# Type 667 Size 30-76 & 87

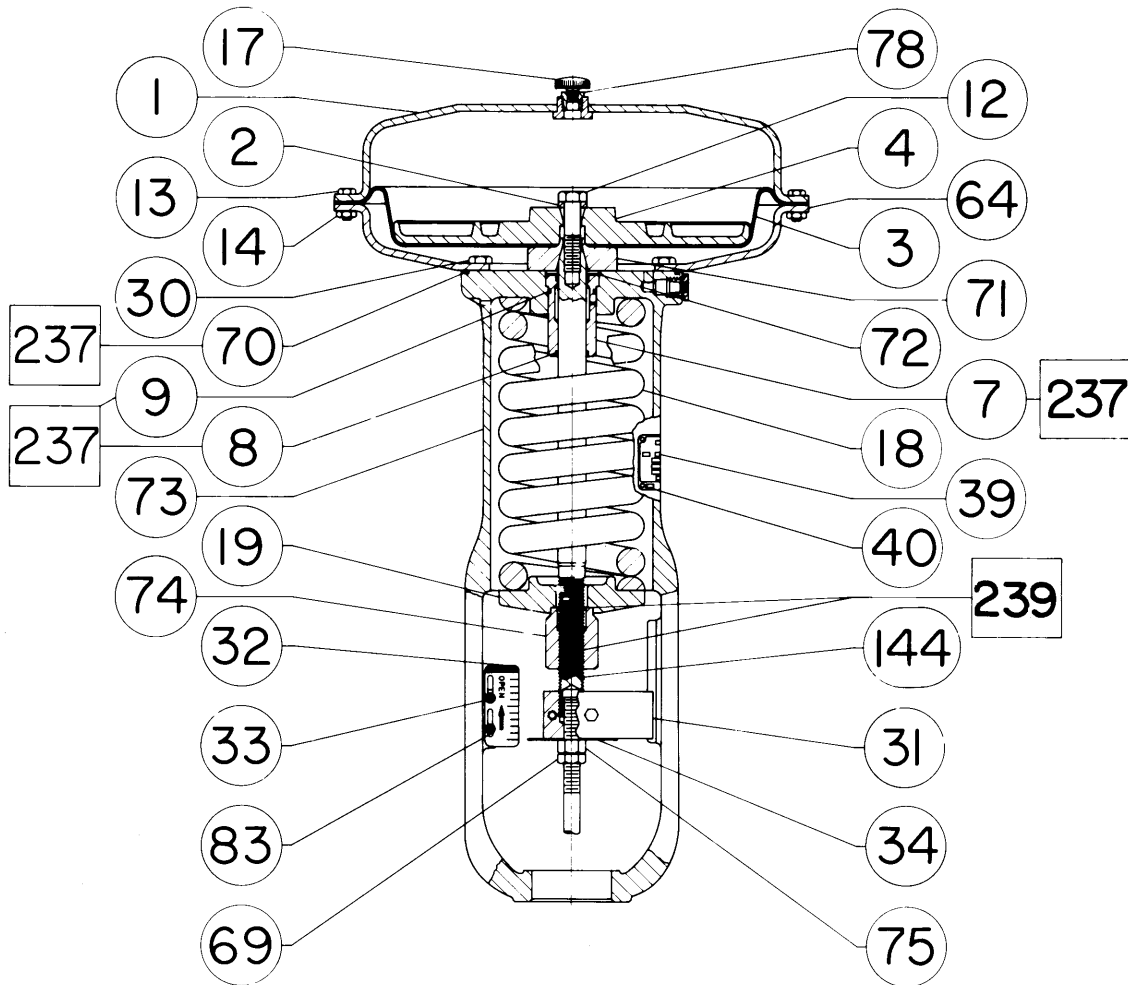


□ APPLY LUBRICANT OR SEALANT  
50A8379-C/IL

Figure 7. Type 667 Actuator Sizes 30 through 60



# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT  
50A8598-E / IL

Figure 8. Type 667 Size 70 Actuator

Key	Description	Part Number	Key	Description	Part Number
31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL)		31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL) (Con't.)	
	STANDARD			W/PMV POSITIONER	
	SIZE 30 & 34	18A1243X012 1		SIZE 70 3/4 TO 4 IN. (19 TO 102 mm)	
	SIZE 40	18A1668X012 1		TRAVEL	11B2000X012 1
	SIZE 45 & 46	18A1671X012 1			
	SIZE 50 & 60	18A1672X012 1	32	TRAVEL INDICATOR SCALE	SEE FOLLOWING TABLE
	SIZE 70 & 76	18A1675X012 1			
	SIZE 87	18A1825X012 1	33	SCREW, SELF TAPPING	
	W/SIDE-MOUNTED HANDWHEEL			STAINLESS STEEL	
	SIZE 34	1F659225142 1		STANDARD	
	SIZE 40	1F659125142 1		SIZE 30 THROUGH 46	1E793238992 2
	SIZE 45 & 46	2F1678000A2 1		SIZE 50 THROUGH 87	1E831338992 2
	SIZE 50 & 60	2F1672000A2 1			
	SIZE 70 3/4 THROUGH 3 IN. (19 TO 76 mm)		33	SCREW, MACH. FILL HD (STEEL, PLATED)	
	TRAVEL	18A1678X012 1		W/HANDWHEEL	
	SIZE 70 3/4 THROUGH 4 IN. (19 TO 102 mm)			SIZE 45 & 46	1B992528992 2
	TRAVEL	21A8254X012 1		SIZE 70, 76 & 87	1A340628982 2
	SIZE 76	18A1678X012 1			
	SIZE 87 1 IN. (25.4 mm) VALVE STEM	18A1825X012 1			
	SIZE 87 1-1/4 (31.8 mm) VALVE STEM	18A1833X012 1			

# Type 667 Size 30-76 & 87

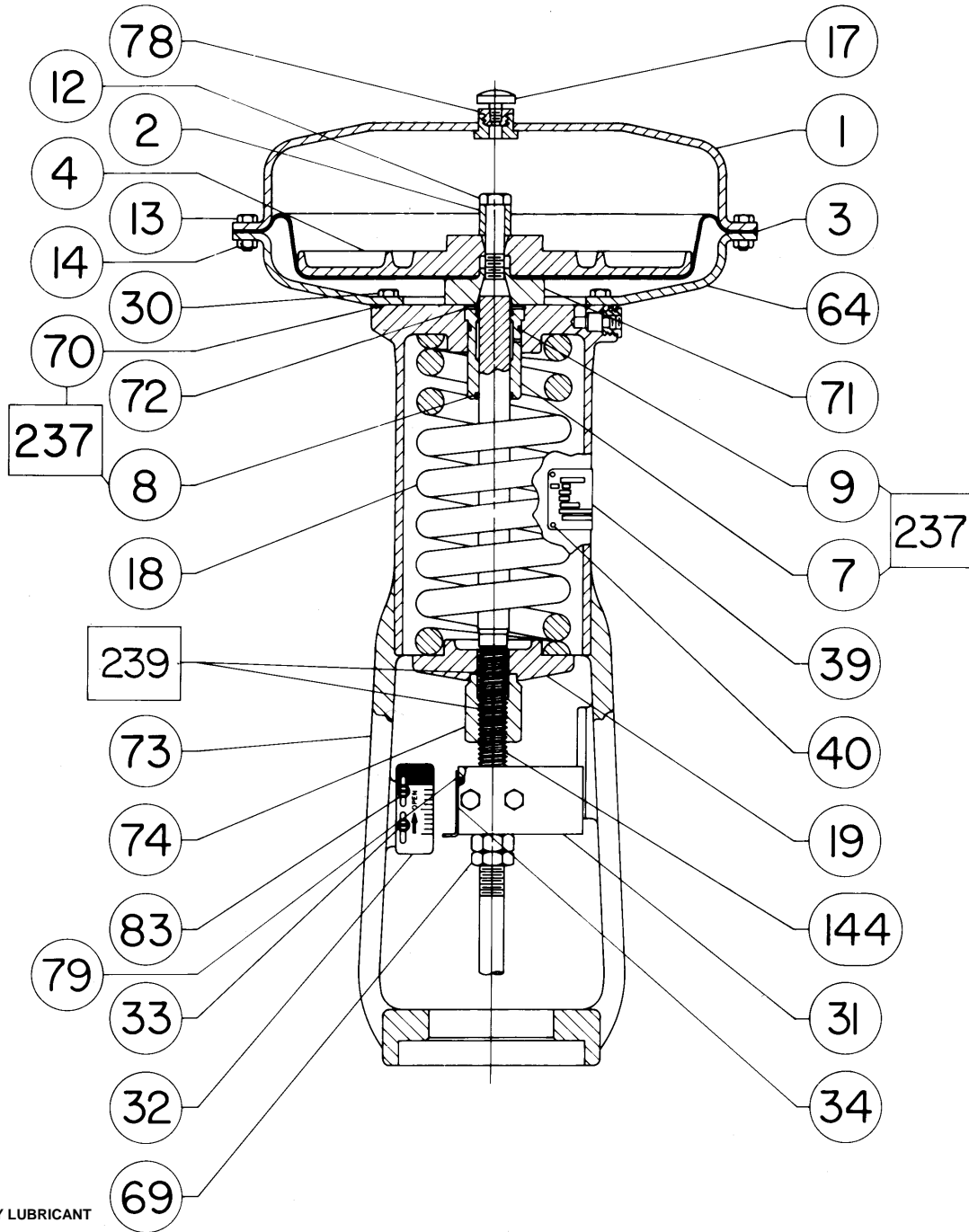


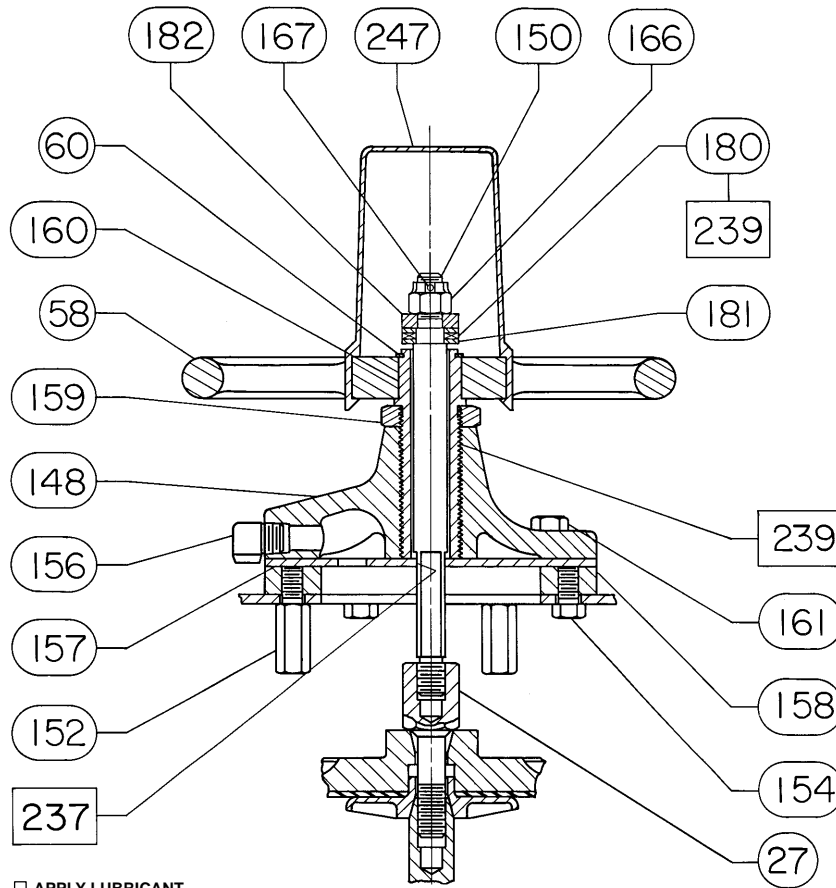
Figure 9. Type 667 Size 87 Actuator

Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) STANDARD		34	DISC, TRAVEL INDICATOR (SST) (Cont'd) W/SIDE-MOUNTED HANDWHEEL	
	SIZE 30 & 34	1E793138992 1		SIZE 34	1E793138992 1
	SIZE 40 THROUGH 46	1E807538992 1		SIZE 40	1E807538992 1
	SIZE 50 & 60	1E832838992 1		SIZE 46	11B7008X012 1
	SIZE 70 & 76	1B971838992 1		SIZE 60 & 70	1E832838992 1
	SIZE 87	10A8487X012 1		SIZE 76	1B971838992 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) (Cont'd)		73	YOKE	
	W/TYPE 304 SWITCH			CAST IRON	
	SIZE 30 & 34	10A0038X012 2		MOUNTING BOSS UNTAPPED	
	SIZE 40 THROUGH 46	1N253936012 2		SIZE 30	3E801419042 1
	SIZE 50 & 60	1N254036012 2		SIZE 34	3E884619042 1
39	NAMEPLATE			SIZE 40	3E820819042 1
	STAINLESS STEEL			SIZE 45 & 46	3E900819042 1
	ALL SIZES	12B6508X0A2 1		SIZE 50 & 60	3E845919042 1
40	SCREW, DRIVE			SIZE 70	3N130319042 1
	STAINLESS STEEL			SIZE 76	42B5909X012 1
	ALL SIZES	1A368228982 6		SIZE 87	3N664219042 1
64	LOWER DIAPHRAGM CASING (STEEL)			MOUNTING BOSS UNTAPPED W/HANDWHEEL	
	STANDARD			SIZE 70 & 76	4N890119042 1
	SIZE 30	2E801125062 1		SIZE 87 TO 3 IN. (76 mm) TRAVEL	4N886619042 1
	SIZE 34 & 40	2E682625062 1		MOUNTING BOSS TAPPED	
	SIZE 45 & 50	3E845325062 1		SIZE 30	3L921419042 1
	SIZE 46, 60 & 76	3E847725062 1		SIZE 34	3L9203X0012 1
	SIZE 70 & 87	2N131025062 1		SIZE 40	3L921619042 1
	W/ 1/2 NPT CONNECTION			SIZE 45 & 46	3L894219042 1
	SIZE 30	2H3822X00A2 1		SIZE 50 & 60	3L921919042 1
	SIZE 34 & 40	2K506725062 1		SIZE 70	3N130419042 1
	SIZE 45 & 50	2H3081X00A2 1		SIZE 76	42B6795X012 1
	SIZE 46 & 60	2F803325062 1		SIZE 70 TYPE 667-4	31A7392X012 1
69	NUT, HEX, JAM (STEEL ZN PL)			SIZE 87	3N664319042 1
	STANDARD			SIZE 87 TYPE 667-4	31A3813X012 1
	SIZE 45	1A353724122 2		MOUNTING BOSS TAPPED W/HANDWHEEL	
	SIZE 40 & 46	1A353724122 1		SIZE 70 & 76	4N890219042 1
	SIZE 50 THROUGH 70 & 76	1A351124122 1		SIZE 70 TYPE 667-4	4N890119042 1
	1 IN. (25.4 mm) VALVE STEM			SIZE 87	4N889019042 1
	SIZE 87	1C635224122 2		SIZE 87 TYPE 667-4	4N889019042 1
	1-1/4 (31.8 mm) VALVE STEM			WCB (STEEL)	
	SIZE 87	0W073524122 2		MOUNTING BOSS UNTAPPED	
70*	GASKET			SIZE 30	3K815622012 1
	COMPOSITION [UP TO 450°F (232°C)]			SIZE 34	3H787122012 1
	SIZE 30 THROUGH 40	1E801204022 1		SIZE 40	3H787322012 1
	SIZE 45 THROUGH 60 & 76	1E845404022 1		SIZE 45 & 46	3H787522012 1
				SIZE 50 & 60	3K830322012 1
				SIZE 70	3N130622012 1
				SIZE 87	3N758722012 1
70*	O-RING			MOUNTING BOSS TAPPED	
	NITRILE			SIZE 30	3L921522012 1
	SIZE 70 & 87	1D269106992 1		SIZE 34	3L9202X0012 1
				SIZE 40	3L921722012 1
				SIZE 45 & 46	3L921822012 1
71	LOWER DIAPHRAGM PLATE			SIZE 50 & 60	3L922022012 1
	ZINC			SIZE 70	3N130722012 1
	SIZE 30	1E791344022 1		SIZE 87	3N758822012 1
	SIZE 34 & 40	1E682744022 1			
	SIZE 45 THROUGH 60 & 76	1E845544022 1	74	SPRING ADJUSTER (STEEL, ZN PL)	
	STEEL			SIZE 30	1E801724102 1
	SIZE 34 & 40	1F885824092 1		SIZE 34 & 40	1E821024102 1
	SIZE 45 THROUGH 60	1F890924092 1		SIZE 45 THROUGH 60	1E846224102 1
	STANDARD CONSTRUCTION			SIZE 70 & 87 W/HANDWHEEL	1N886924392 1
	SIZE 70 & 87 TO 3-IN. (76 mm) TRAVEL	1N131524092 1		SIZE 70 & 87 TYPE 667-4	11A3811X012 1
	STANDARD OR W/SIDE-MTD HANDWHEEL			SIZE 70 & 87 TYPE 667-4 W/HANDWHEEL	1N886924392 1
	SIZE 70 & 87 W/4-IN. (102 mm) TRAVEL	1V7826X0012 1		SIZE 76	
				MAX SPRING ADJUSTMENT (ADJ)	
72	RING, SNAP			2-INCH (51 mm)	1N131824102 1
	S30200 (302 SST)			2.5-INCH (64 mm)	1N909524502 1
	STANDARD			3.5-INCH (89 mm)	1U1079X00A2 1
	SIZE 30 THROUGH 40	1E801337022 1		MAX SPRING ADJ W/SIDE-MOUNTED HANDWHEEL	
	SIZE 45 THROUGH 87	1E845638992 1		2.25-INCH (57 mm)	1N886924392 1
				2.75-INCH (70 mm)	1V176624092 1

# Type 667 Size 30-76 & 87



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NOTE:

THE TOP MOUNTED HANDWHEEL IS NOT DESIGNED FOR USE UNDER HEAVY LOAD OR FREQUENT USE.

30B3940-C / IL

Figure 10. Top-Mounted Handwheel Assembly for Size 30 through 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
75	NUT, HEX (STEEL, ZN PL) STANDARD SIZE 30 & 34	1P131224142 2	81	SCREW, MACH, RD HD (CARBON STEEL, PLATED) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1A331928982 2
	SIZE 40 & 46	1A413224122 1			
75	NUT, HEX (Cont.) SIZE 50 THROUGH 76	1A375424122 1	82	INDICATOR, TRAVEL, ADAPTOR (BRASS) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1F548214012 2
76	NUT, SPEED, TWIN STAINLESS STEEL STANDARD SIZE 30 & 34	1E793938992 1	83	WASHER, PLAIN CARBON STEEL-PLATED SIZE 70, 76 & 87 W/HANDWHEEL	1E873028992 2
	SIZE 40 THROUGH 46	1E808438992 1		BRASS SIZE 70, 76 & 87 W/HANDWHEEL	1F565618992 2
	SIZE 50 THROUGH 87	1E833538992 1			
77	STOP, TRAVEL (STEEL, ZN PL) (USE FOR PUSH-DOWN-TO-OPEN) SIZE 30 THROUGH 40	1H493524092 2	89	SPRING CASE ADAPTOR (CAST IRON) STANDARD SIZE 70 & 87 TYPE 667-4	2N889419042 1
	SIZE 45 THROUGH 60	1H494324092 2		W/HANDWHEEL SIZE 70 & 87 TYPE 667-4	3R675819042 1
78	BUSHING, PIPE, HEX (STEEL, PLATED ) SIZE 70 & 87	1C379026232 1	90	SCREW, CAP (STEEL, ZN PL) SIZE 70 & 87 TYPE 667-4	1N872428992 12
79	SCREW, MACH, FLAT HD (STEEL PLATED) SIZE 87	1H736528982 2	102	PLUG, PIPE, HEX HD (STEEL) W/ 1/2 NPT CONNECTION SIZE 30 THROUGH 60	1A767524662 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
144	ACTUATOR STEM (CHROMIUM PLATED STEEL)			<b>Top-Mounted Handwheel (Figures 10, 11, And 12)</b>	
	STANDARD		58	HANDWHEEL (CAST IRON)	
	SIZE 30	2E8016X0022 1		SIZE 30	1F119119042 1
	SIZE 34	3E8847X0012 1		SIZE 34 & 40	1F115819042 1
	SIZE 40	2E8209X0042 1		SIZE 45 TO 60 & 76	1F119819042 1
	SIZE 45 & 46	2J3328X0042 1		SIZE 70 & 87	2N837919042 1
	SIZE 50 & 60	2E8461X0042 1		STEEL	
	SIZE 70 & 76	2N131724222 1		SIZE 34 & 40	1H551922012 1
	SIZE 87	2N664724222 1		SIZE 45 TO 60 & 76	1H552122012 1
	W/SIDE-MOUNTED HANDWHEEL			SIZE 70 & 87	23B9744X012 1
	SIZE 34	2E8209X0042 1	60	RETAINER RING (STEEL, ZN PL)	
	SIZE 40	2F3259X0012 1		SIZE 34 & 40	1A911628992 1
	SIZE 70 3-IN. (76 mm) TRAVEL	2N890624222 1		Size 45 To 60 & 76	
	SIZE 70 TO 4-IN. (102 mm) TRAVEL	21A9816X012 1		8-INCH (203 mm) HANDWHEEL	1F120028992 1
	SIZE 76	23B7066X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	SIZE 87 3-IN. (76 mm) TRAVEL	2N889624222 1		SIZE 70 & 87	
	SIZE 87 TO 4-IN. (102 mm) TRAVEL	22A1501X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	TYPE 667-4 STANDARD		148	HANDWHEEL BODY	
	SIZE 70	21A3812X012 1		CAST IRON	
	SIZE 87	22A1963X012 1		SIZE 30 TO 40	27A9446X012 1
	TYPE 667-4 W/HANDWHEEL			SIZE 45 TO 60 & 76	27A9444X012 1
	SIZE 70	23A1793X012 1		SIZE 70 & 87	2N837719022 1
	SIZE 87	23A0125X012 1		STEEL	
	S31600 (316 SST)			SIZE 34 & 40	27A9636X012 1
	STANDARD			SIZE 45 TO 60 & 76	27A9445X012 1
	SIZE 30	1N429135162 1		SIZE 70 & 87	
	SIZE 34	1N429235162 1		EXTENSION ROD (416 SST)	
	SIZE 40	1N429335162 1		SIZE 30	29A9896X012 1
	SIZE 45	1N429535072 1		SIZE 34 & 40	29A9897X012 1
	SIZE 46 & 50	1N429435072 1		SIZE 45 TO 60 & 76	
	SIZE 60	1N429535072 1		UNDER 4000 LB (17,000 N·M)	23B9217X012 1
227	WASHER,PLAIN (STEEL, ZN PL)			4000 TO 6000 LB (17,000 TO 26,700 N·M)	23B9219X012 1
	W/TYPE 304 SWITCH			SIZE 45 TO 60 P-2	29A9900X012 1
	SIZE 40 THROUGH 46	1E658828982 2		SIZE 70 & 87	
	CARBON STEEL			3/4 IN. (19 mm) THROUGH	
	W/TOP-MOUNTED HANDWHEEL			3 IN. (76 mm) TRAVEL	24B0242X012 1
	SIZE 70 TO 3-IN. (76 mm) TRAVEL	1A521228992 1		4 IN. (102 mm) TRAVEL	24B0243X012 1
	W/TYPE 304 SWITCH		152	TRAVEL STOP (STEEL, ZN PL)	SEE FOLLOWING TABLE
	SIZE 60	1A375728992 2		154	CAP SCREW (PL STEEL)
	SIZE 70 & 76	1A375728992 1		SIZE 30 TO 40	1D529824052 3
228	STEM DISC SPACER [S41600 (416 SST)]			SIZE 45 TO 60 & 76	1A368424052 4
	W/TYPE 304 SWITCH			SIZE 70 & 87	1N129328992 9
	SIZE 70 TO 3-IN (76 mm) TRAVEL	1N952635132 1		156	VENT ASSEMBLY
	SIZE 76	1N952635132 1		SIZE 30 TO 60 & 76	27A5516X012 1
237	LUBRICANT, LUBRIPLATE MAG-1			SIZE 70 & 87	17A6572X022 1
	OR EQUIVALENT	---		157	GUIDE PLATE (STEEL)
	NOT FURNISHED WITH ACTUATOR	---		SIZE 30 TO 40	1F116428992 1
238	SEALANT, PERMATEx #2,			SIZE 45 TO 60 & 76	1F119528992 1
	FORM-A-GASKET			SIZE 70 & 87	1N837528982 1
	NOT FURNISHED WITH ACTUATOR	---		158	MOUNTING PLATE
239	LUBRICANT, ANTI-SIZE LUB-3			CAST IRON	
	NEVER-SEEZ OR EQUIVALENT			SIZE 30 TO 40	1F116519042 1
	NOT FURNISHED WITH ACTUATOR	---		SIZE 45 TO 60 & 76	1F119319042 1
254	WARNING NAMEPLATE	14B6769X0A2		STEEL, ZN PL	
				SIZE 34 & 40	1H552622012 1
				SIZE 45 TO 60 & 76	1H550922012 1

# Type 667 Size 30-76 & 87

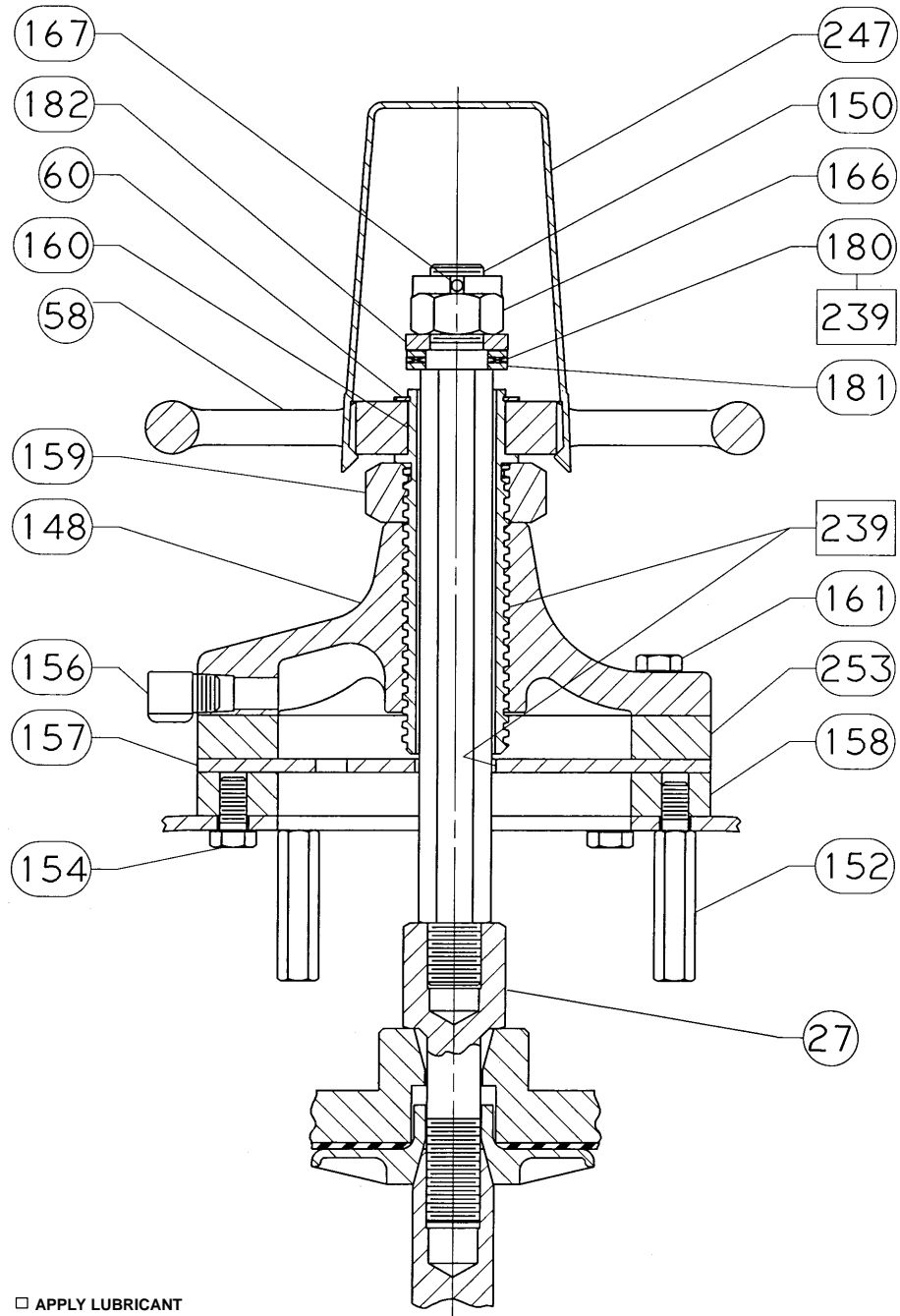


Figure 11. Top-Mounted Handwheel Assembly for Size 45-76 Actuators

# Type 667 Size 30-76 & 87

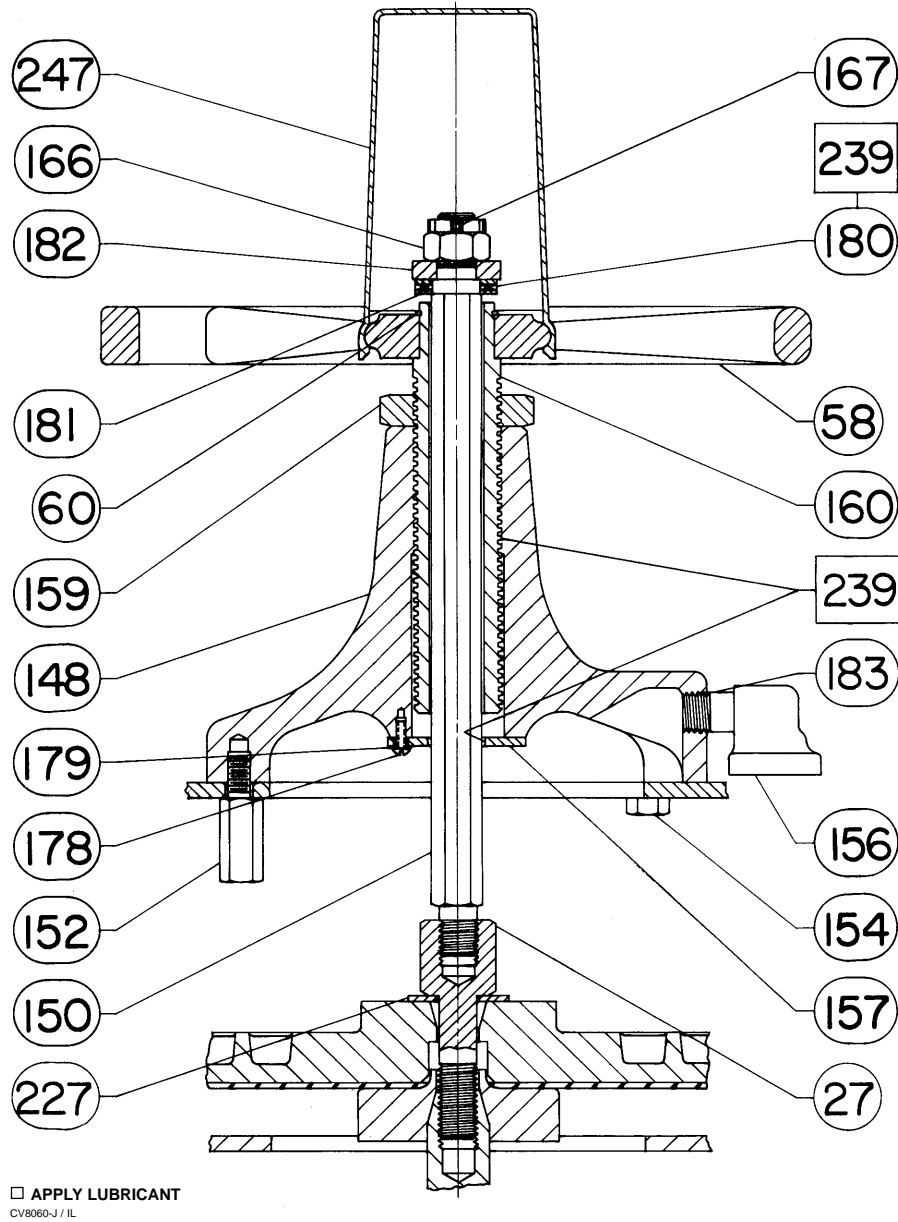


Figure 12. Top-Mounted Handwheel Assembly for Size 70 and 87 Actuators

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
159	LOCK NUT BRASS SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 STEEL, ZN PL SIZE 70 & 87	18A1271X012 1 18A2302X012 1 18A2302X012 1 1N837824102 1	247	HANDWHEEL CAP PLASTIC FOR CAST IRON HANDWHEEL SIZE 30 SIZE 34 TO 60 & 76 FOR STEEL HANDWHEEL SIZE 34 TO 60 & 76 FOR CAST IRON OR STEEL HANDWHEEL SIZE 70 & 87	27A8621X012 1 27A8622X012 1 28A1609X012 1 37A8623X012 1
160	HANDWHEEL SCREW (BRONZE) SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 SIZE 45 TO 60 P-2 SIZE 70 & 87	27A9639X012 1 27A9640X012 1 27A9637X012 1 27A9638X012 1 1N837414042 1	253	SPACER, HANDJACK CAST IRON SIZE 45 TO 76 STEEL SIZE 45 TO 76	23B9218X012 1 23B9221X012 1
161	CAP SCREW (PL STEEL) CAST IRON HANDWHEEL BODY SIZE 30 TO 40 STEEL HANDWHEEL BODY SIZE 34 & 40 CAST IRON & STEEL HANDWHEEL BODIES SIZE 45 TO 60 & 76	1A344924052 6 1N568232982 6 1A341824052 8	<b>Side-Mounted Handwheel (30-60, Figures 13 and 14)</b>		
166	CASTLE NUT (PL STEEL) SIZE 30 TO 40 SIZE 45 TO 87	1K193424122 1 1F120224122 1	51	HANDWHEEL CAST IRON SIZE 34 & 40 SIZE 45 TO 60	2D358519052 1 2D405019042 1
167	COTTER PIN SST SIZE 30 TO 40 SIZE 45 TO 87	1C5959X0012 1 1J340238992 1	54	HEX JAM NUT PL STEEL SIZE 34 & 40 SIZE 45 TO 60	1A352424112 1 1A352424122 1
178	MACHINE SCREW (PL STEEL) SIZE 70 & 87	1B877428992 4	55	BALL STEEL	1A342732992 1
179	LOCKWASHER (PL STEEL) SIZE 70 & 87	1A329128982 4	56	SPRING BRONZE	0D005916012 1
180	THRUST BEARING (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5444X012 1 1N838099012 1 13B9737X012 1	132	OPERATING NUT (STEEL) LEFT-HAND (DIRECT-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60 RIGHT-HAND (REVERSE-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60	1F659024092 1 2F548524092 1 1F658924092 1 2F548424092 1
181	THRUST RACE (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5446X012 2 1N838199012 2 13B9737X012 2	136	BEARING RETAINER STEEL SIZE 45 TO 60	1D385224092 1
182	BEARING RETAINER (STEEL, ZN PL) SIZE 30 TO 40 SIZE 45 THROUGH 60 & 76 SIZE 70 & 87	19A9895X012 1 19A9898X012 1 13B9741X012 1	142	HANDWHEEL BODY CAST IRON SIZE 34 & 40 SIZE 45 TO 60	3F6572000A2 1 3F1446000A2 1
183	PIPE NIPPLE (STEEL,GALV, ZN PL) SIZE 70 & 87	1K201526022 1	143	MOUNTING BOLTS STEEL SIZE 34 & 40 SIZE 45 & 46 SIZE 50 & 60	10A8522X012 2 18A9147X012 2 1F155624092 2
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	144	HEX NUT PL STEEL SIZE 34, 40, 50 & 60 SIZE 45 & 46	1A375324122 4 1A375324122 2
			145	HANDWHEEL SCREW BRONZE	



# Type 667 Size 30-76 & 87

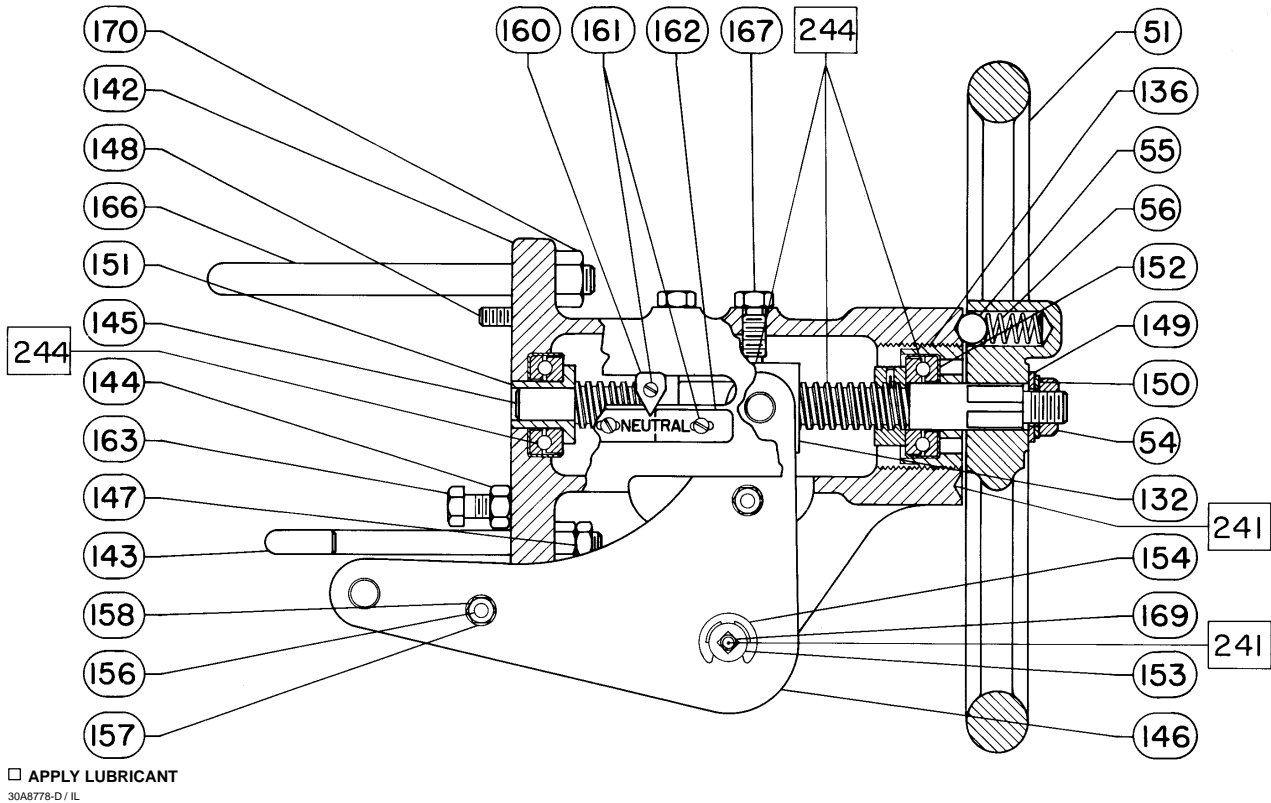
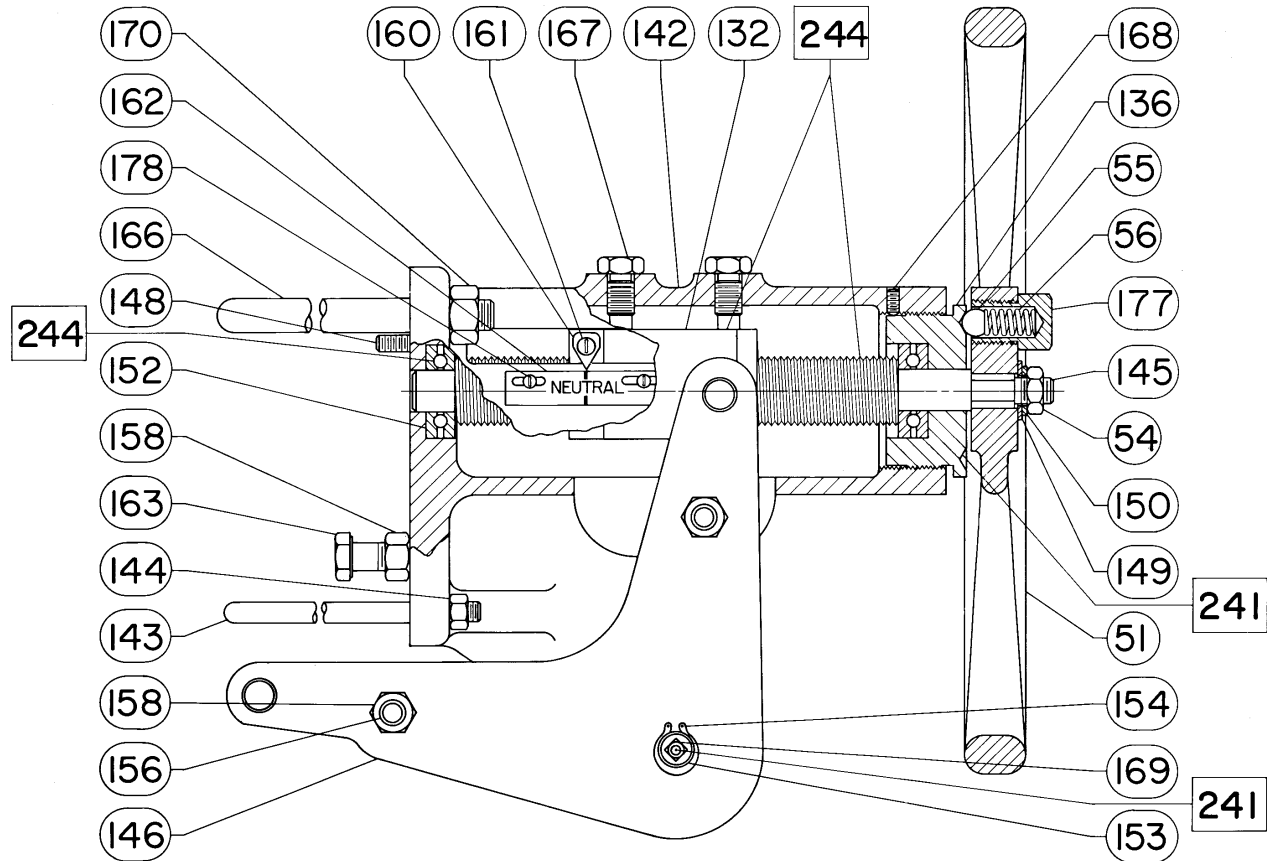


Figure 13. Side Mounted Handwheel Assembly for Size 34 and 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
	LEFT-HAND (DIRECT-ACTING VALVE)		153	LEVER PIVOT PIN (416 SST)	
	SIZE 34 & 40	1F6584000A2 1		SIZE 34 & 40	1F658135232 1
	SIZE 45 TO 60	1F548614052 1		SIZE 45 TO 60	1F156235232 1
	RIGHT-HAND (REVERSE-ACTING VALVE)		154	RETAINING RING (PL STEEL)	
	SIZE 34 & 40	1F6583000A2 1		SIZE 34 & 40	1F599428982 2
	SIZE 45 TO 60	1F548714052 1		SIZE 45 TO 60	1A903028992 2
146	LEVER & PIN ASSEMBLY		155	SPACER (STEEL)	
	STEEL			SIZE 34 & 40	1F658224092 2
	RIGHT-HAND SIDE			SIZE 45 TO 60	1F162524092 2
	SIZE 34 & 40	1F6614000A2 1	156	SCREW (PL STEEL)	
	SIZE 45 TO 60	1F1541000A2 1		SIZE 34 & 40	1D980628982 2
	LEFT-HAND SIDE			SIZE 45 TO 60	1F157624052 2
	SIZE 34 & 40	1F6613000A2 1	157	LOCKWASHER (PL STEEL) SIZE 34 & 40	1C225628982 2
	SIZE 45 TO 60	1F1539000A2 1	158	HEX NUT (PL STEEL) SIZE 34 & 40	1A345724122 2
147	HEX JAM NUT (PL STEEL)			SIZE 45 TO 60	1A341224122 4
	SIZE 34 & 40	1A352224122 2	159	POINTER MOUNTING BOLT (416 SST)	
148	DOWEL PIN (STEEL, ZN PL)			SIZE 34 & 40	1F657835132 1
	SIZE 34 TO 60	1D419828992 2		SIZE 45 TO 60	1F156535132 1
149	WASHER (PL STEEL)	1A518925072 1	160	POINTER (302 SST)	1F157536012 1
150	LOCKWASHER (PL STEEL)	1A353828982 1	161	MACHINE SCREW (PL STEEL)	
151	BUSHING (PL STEEL)			SIZE 34 & 40	1A344524052 8
	SIZE 34 & 40	1F657924092 1		SIZE 45 TO 60	1E175828982 1
152	BALL BEARING (STEEL)	1D361399012 2			

# Type 667 Size 30-76 & 87

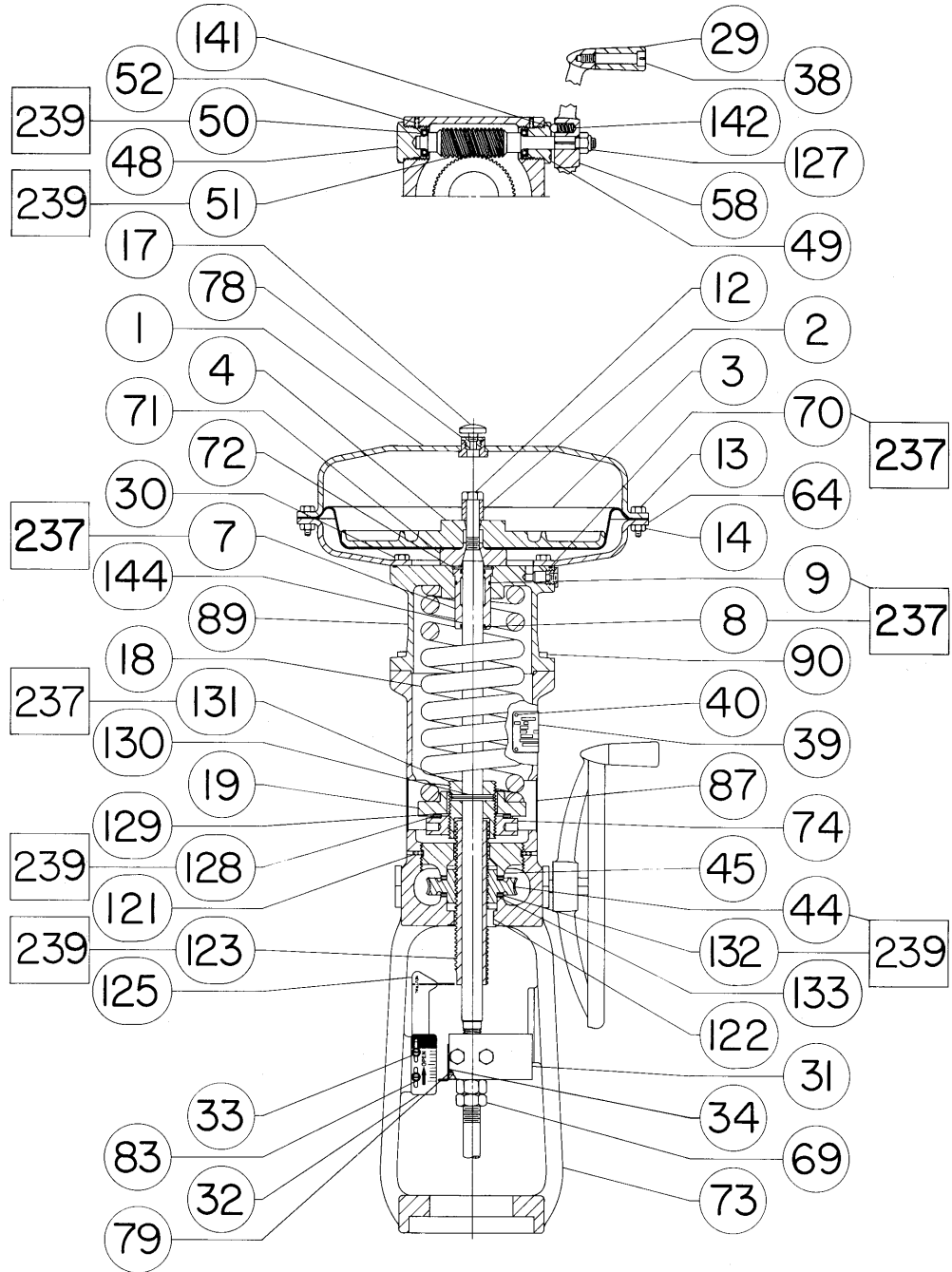


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Figure 14. Side-Mounted Handwheel Assembly for Size 45 and 60 Actuators

Key	Description	Part Number	Key	Description	Part Number
162	INDICATOR PLATE (ALUMINUM) SIZE 34 & 40 SIZE 45 TO 60	1F936411992 1 1D357411992 1	177	SPRING CAP (STEEL) SIZE 45 TO 60	1D385124092 1
163	CAP SCREW (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1C403824052 2 1A344424052 2	178	MACHINE SCREW (PL STEEL) SIZE 45 TO 60	1A331928982 2
166	U-BOLT (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1F657724092 1 1F155524092 1	241	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
167	GUIDE BOLT (416 SST) SIZE 34 & 40 SIZE 45 TO 60	1F657535132 2 1F155235132 2	244	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
168	SET SCREW (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A344724182 1 1A341528992 1	<b>Side-Mounted Handwheel, Size 70, 76 &amp; 87 (Figure 15)</b>		
169	GREASE FITTING	1H306199012 1	29	HANDGRIP (STEEL)	0U075624092 1
170	HEX NUT (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A341224112 2 1A343324122 2	38	HANDGRIP BOLT (STEEL)	0U077424092 1
			44	WORM GEAR (BRONZE)	2N886212052 1
			45	BEARING RETAINER FLANGE CAST IRON	1N889219042 1

# Type 667 Size 30-76 & 87



PART NOT SHOWN: 57  
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 50A8604-F / IL

Figure 15. Size 70, 76, and 87 Actuator with Side Mounted Handwheel Assembly

# Type 667 Size 30-76 & 87

Key	Description	Part Number	
48	BACK WORM RETAINER (STEEL, ZN PL)	1N888324492	1
49	FRONT WORM RETAINER (STEEL, ZN PL)	1N888424092	1
50	BALL BEARING (STEEL)	1A339228992	2
51	WORM SHAFT (STEEL)	2N886331092	1
52	SET SCREW (STEEL)	1A710328992	2
57	GREASE FITTING	1A926728982	2
58	HANDWHEEL (CAST IRON)	3H734319052	1
87	COVER BAND ASS'Y	1N8879X00A2	1
89	SPRING CASE ADAPTOR (CAST IRON)		
	SIZE 70 & 87	2N889419042	1
	SIZE 76	33B8000X012	1
90	CAP SCREW (STEEL, ZN PL)	1N872428992	12
121	SET SCREW (PL STEEL)	1A712228992	2
122	KEY (STEEL)	1N888025092	1
123	LOWER SLEEVE (STEEL)		
	SIZE 70 & 87		
	3 IN. (76 mm) TRAVEL	2N888224092	1
	4 IN. (102 mm) TRAVEL	21A8262X012	1
	SIZE 76	2N888224092	1
125	HANDWHEEL INDICATOR (SST)	10A2446X012	1
127	STOP NUT (STEEL, ZN PL)	1A780528992	1
128	NEEDLE BEARING (STEEL)	1N888599012	1
129	NEEDLE BEARING RACE (STEEL)	1N888699012	2
130	ROLL PIN (STEEL)	1N889828992	1
131	SPRING ADJUSTING SCREW (STEEL, ZN PL)		
	SIZE 70 & 87		
	3/4 TO 3 IN (19 TO 76 mm) TRAVEL	1N889724092	1
	4 IN. (102 mm) TRAVEL	11A9817X012	1
	SIZE 76	1N889724092	1
132	NEEDLE BEARING (STEEL)	1N888799012	2
133	NEEDLE BEARING RACE (STEEL)	1N888899012	4
141	BALL (STEEL)	1A342732992	1
142	SPRING (BRONZE)	0D005916012	1
237	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	

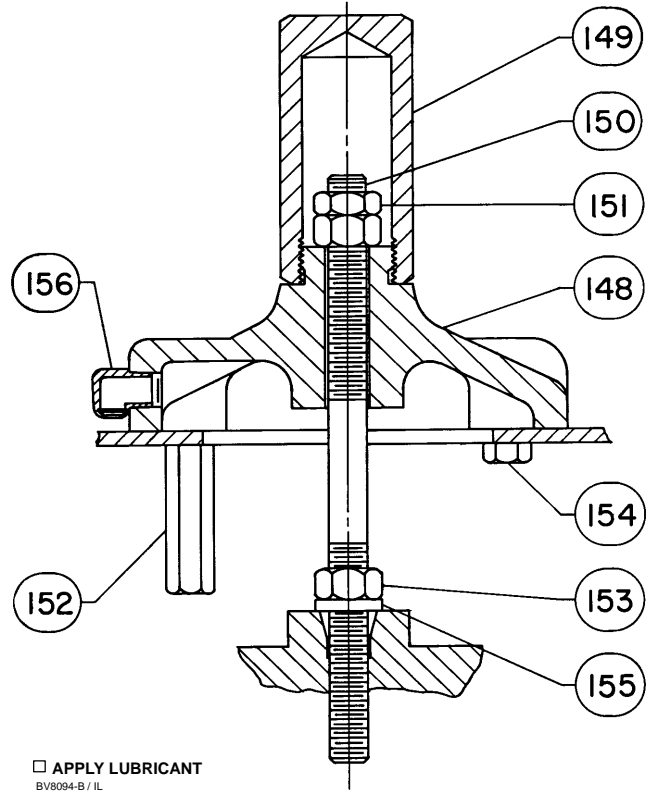
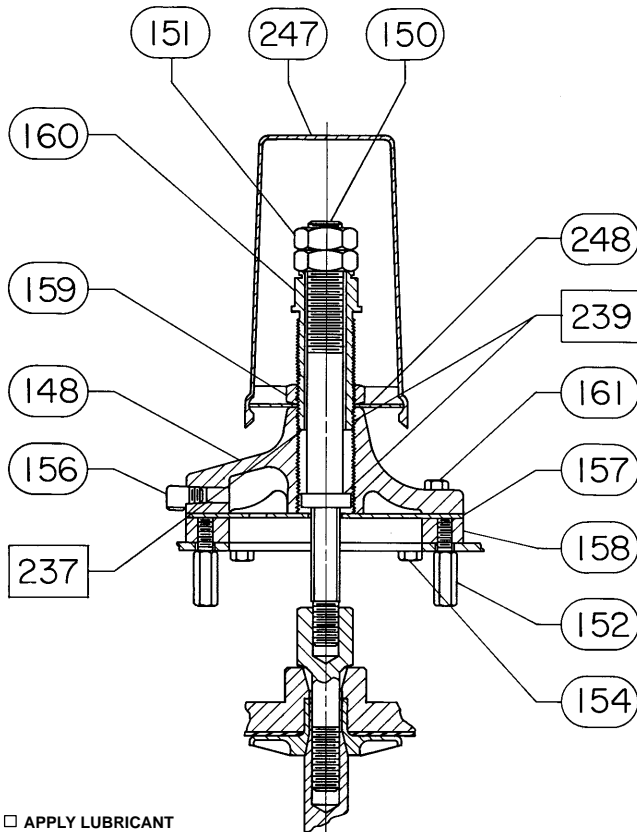


Figure 16. Style 10 Down Travel Stop (Casing Mounted)

Key	Description	Part Number
<b>Casing-Mounted Travel Stops (Figures 16 Through 20)</b>		
58	HANDWHEEL CAST IRON STYLE 13 UP TRAVEL STOP	
	SIZE 30	1F143819052 1
	SIZE 34 THROUGH 60	1F118119042 1
102	PLUG, PIPE STYLE 12 UP TRAVEL STOP	
	SIZE 70 & 87	1D754828982 1
127	HEX NUT (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A353724122 1
148	TRAVEL STOP BODY (CAST IRON)	
	STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 40	1K723519012 1
	SIZE 45 THROUGH 60	2K723019012 1
	SIZE 70 & 87	2U141819022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9446X012 1
	SIZE 45 THROUGH 60	27A9444X012 1
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	37A9437X012 1
	SIZE 45 THROUGH 60	37A9432X012 1
	SIZE 70 & 87	37A9661X012 1

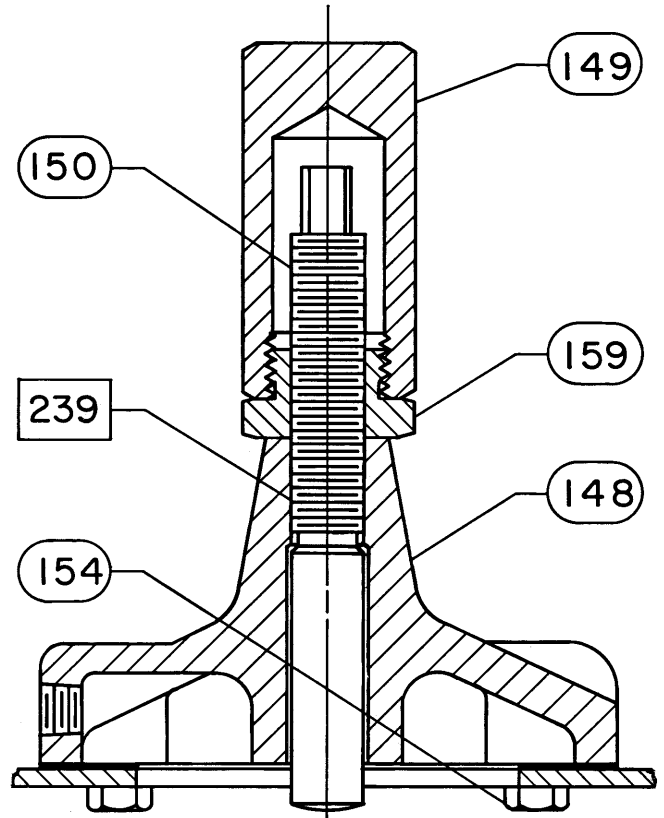
# Type 667 Size 30-76 & 87



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Figure 17. Style 11 Up Or Down Travel Stop (Casing Mounted)

Key	Description	Part Number	
148	TRAVEL STOP BODY (CAST IRON) (Cont'd)		
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 W/ 1/4 NPT CONNECTION	37A9437X012	1
	STYLE 13 UP TRAVEL STOP (CONT.)		
	SIZE 30 W/ 1/2 NPT CONNECTION	37A9438X012	1
	SIZE 34 & 40 W/ 1/4 NPT CONNECTION	37A9439X012	1
	SIZE 34 & 40 W/ 1/2 NPT CONNECTION	37A9440X012	1
	SIZE 45 THROUGH 60 W/ 1/4 NPT CONNECTION	37A9432X012	1
	SIZE 45 THROUGH 60 W/ 1/2 NPT CONNECTION	37A9434X012	1
149	TRAVEL STOP CAP (BRASS)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1H111114012	1
	SIZE 70 & 87	1R387614012	1
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1F839614012	1
	SIZE 70 & 87	1R387614012	1
	STEEL		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597824092	1
150	EXTENSION ROD		
	S41600 (416 SST)		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	28A1267X022	1
	STEEL, ZN PL		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 45 THROUGH 60	28A1266X012	1

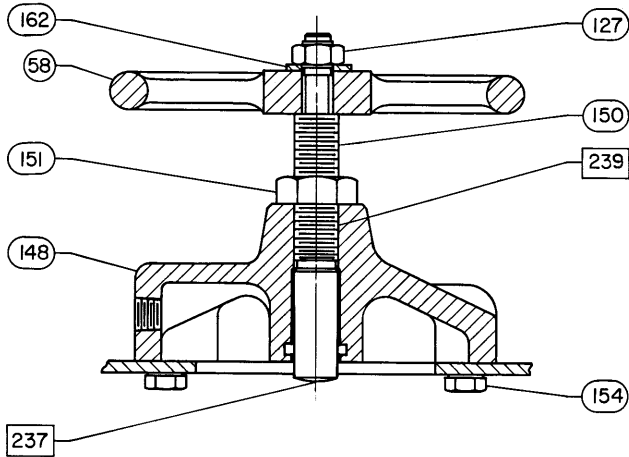


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Figure 18. Style 12 Up Travel Stop (Casing Mounted)

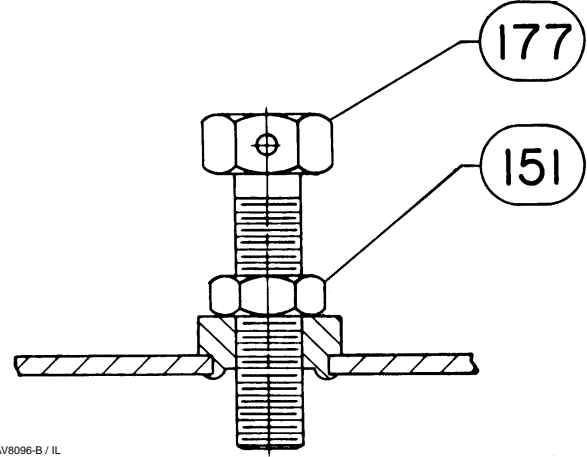
Key	Description	Part Number	
150	TRAVEL STOP STEM		
	S30300 (303 SST)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30	1H330735032	1
	SIZE 34 & 40	1F753635032	1
	SIZE 45 THROUGH 60	1J232735032	1
	SIZE 70 & 87	1V7764X00A2	1
	BRONZE		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	27A9655X012	1
	SIZE 45 THROUGH 60	27A9656X012	1
	SIZE 70 & 87	27A9763X012	1
	STYLE 13 UP TRAVEL STOP		
	SIZE 30	27A9652X012	1
	SIZE 34 & 40	27A9653X012	1
	SIZE 45 THROUGH 60	27A9654X012	1
151	HEX JAM NUT (STEEL, ZN PL)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1A353724122	1
	SIZE 45 THROUGH 87	1A351124122	1
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	1K130824122	2
	SIZE 45 THROUGH 60	1K130424122	2
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	18A2300X012	1
	STYLE 14 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	1A319224122	1
	SIZE 70, 87	1F118724122	1

# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT  
28A1204-B / IL

Figure 19. Style 13 Up Travel Stop  
(Casing Mounted), size 30 shown



AV8096-B / IL

Figure 20. Style 14 Up Travel Stop  
(Casing Mounted)

Key	Description	Part Number
152	TRAVEL STOP STYLE 10 AND 11 TRAVEL STOPS	SEE TABLE
153	NUT, HEX (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP (TOTAL OF 2 REQ'D FOR SIZE 30)	
	SIZE 30	1A413224122 1
	SIZE 30	1A346524122 1
	SIZE 34 & 40	1A413224122 2
	SIZE 45 THROUGH 87	1A375424122 2
154	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	1A368424052 4
	SIZE 70 & 87	1N129328992 9
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1D529824052 3
	SIZE 45 THROUGH 60	1A368424052 4
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
	SIZE 70 & 87	1N129328992 12
	STYLE 13 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
155	WASHER, LOCK, SPLIT (STEEL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30	1D716228982 1
	SIZE 34 & 40	1A487828992 1
	SIZE 45 THROUGH 60	1A873228992 1
	SIZE 70 & 87	1A549328982 1
156	VENT STYLE 10 & 12 TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	SIZE 70 & 87	17A6572X022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	STYLE 13 UP TRAVEL STOP	
	1/4 NPT CONNECTION	27A5516X012 1
	1/2 NPT CONNECTION	17A6572X022 1

Key	Description	Part Number
157	GUIDE PLATE (STEEL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116428992 1
	SIZE 45 THROUGH 60	1F119528992 1
158	MOUNTING PLATE (CAST IRON) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116519042 1
	SIZE 45 THROUGH 60	1F119319042 1
159	NUT, TRAVEL STOP BRONZE	
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	18A2301X012 1
	SIZE 45 THROUGH 60	18A2302X012 1
	BRASS	
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	18A2303X012 1
	STEEL	
	SIZE 30 THROUGH 40	18A2303X022 1
159	TRAVEL STOP NUT (BRASS) STYLE 12 UP TRAVEL STOP	
	SIZE 45 THROUGH 60	18A1272X012 1
160	SCREW, HANDWHEEL (BRONZE) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9640X012 1
	SIZE 45 THROUGH 60	27A9638X012 1
161	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1A336924052 6
	SIZE 45 THROUGH 60	1A341824052 8
162	WASHER (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A518925072 1
177	TRAVEL STOP SCREW S41600 (416 SST) STYLE 14 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1F753735132 1
	SIZE 45 THROUGH 60	1K131135132 1
	SIZE 70 & 87	13A2133X012 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
184	NIPPLE, PIPE, NPT (STEEL ZN PL)		239	LUBRICANT, ANTI-SEIZE LUB-3	
	STYLE 10 & 12 TRAVEL STOP			NEVER-SEEZ OR EQUIVALENT	
	SIZE 70 & 87	1K201526022 1		NOT FURNISHED WITH HANDWHEEL	---
	STYLE 13 UP TRAVEL STOP		247	TRAVEL STOP CAP, PLASTIC	
	W/ 1/2-IN NPT CONNECTION			STYLE 11	
	SIZE 30	1A473526012 1		SIZE 34 THROUGH 60	37A8623X012 1
	SIZE 34 & 40	1C782526012 1			
	SIZE 45 THROUGH 60	1H392826012 1	284	MOUNTING PLATE (STEEL, ZN PL)	
237	LUBRICANT, LUBRIPLATE MAG-1			STYLE 11 UP & DOWN TRAVEL STOP	
	OR EQUIVALENT			SIZE 34 & 40	17A9360X012 1
	NOT FURNISHED WITH TRAVEL STOP	---		SIZE 45 THROUGH 60	17A9361X012 1

# Type 667 Size 30-76 & 87

Key 2. Spacer, Steel, and Key 12 Travel Stop Cap Screw, Steel

TRAVEL		KEY	ACTUATOR SIZE					
Inches	mm		30	34	40	45 Through 60	76	70 & 87
3/16	5	2	---	1U721324092	1U721324092	---	---	---
		12	---	1R4088X0022	1R4088X0022	---	---	---
1/4	6	2	1R737024092	1U145024092	1U145024092	1U417824092	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	1R4098X0022	---	---
5/16	8	2	1R773024092	1U569824092	1U569824092	---	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	---	---	---
11/32	9	2	1U437224052	---	---	---	---	---
		12	1A8678X0012	---	---	---	---	---
3/8	10	2	1R767724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
7/16	11	2	1R408724092	1R409324092	1R409324092	1R410324092	---	---
		12	1A6857X0032	1R4088X0022	1R4088X0022	1R4098X0022	---	---
1/2	13	2	1U328924092	1R782324092	1R782324092	1R411424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
9/16	14	2	1J830724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
5/8	16	2	1R408624092	1R409424092	1R409424092	1R410424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
11/16	17	2	1U726324092	1U726224092	1U726224092	---	---	---
		12	1B2275X0022	1R4089X0042	1R4089X0042	---	---	---
3/4	19	2	1R408524092	1R409524092	1R409524092	1R410524092	1R410524092	1R411624092
		12	1B2275X0022	1R4089X0042	1R4089X0042	1R4098X0022	1R4110X0012	1R411624092
7/8	22	2	---	---	1R927624092	17A4720X012	17A4720X012	---
		12	---	---	1U8659X0022	1R4099X0022	1R4099X0022	---
1	25	2	---	1U866024092	1U866024092	1R411324092	1R411324092	1U803124092
		12	---	1U8659X0022	1U8659X0022	1R4099X0022	1R4099X0022	1R4111X0012
1-1/8	29	2	---	1R409624092	1R409624092	1R410824092	1R410824092	1R411524092
		12	---	1R4091X0032	1R4091X0032	1R4099X0022	1R4099X0022	1R4111X0012
1-3/16	30	2	---	---	1U137724092	1U164824092	---	---
		12	---	---	1R4092X0022	1R4099X0022	---	---
1-1/4	32	2	---	---	11A2680X012	1U143224092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-3/8	35	2	---	---	1U176124092	1U276824092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-1/2	38	2	---	---	1R409724092	1R410624092	1R410624092	1R411424092
		12	---	---	1R4092X0022	1R4101X0022	1R4101X0022	1R4098X0022
1-5/8	41	2	---	---	---	1R712924092	---	1R410424092
		12	---	---	---	1R4101X0022	---	1R4098X0022
1-7/8	48	2	---	---	---	1U256124092	---	---
		12	---	---	---	1R4102X0012	---	---
2	51	2	---	---	---	1R410724092	1R410724092	1R411324092
		12	---	---	---	1R4102X0012	1R4102X0012	1R4099X0022
2-1/8	54	2	---	---	---	---	---	1R410824092
		12	---	---	---	---	---	1R4099X0022
2-1/2	64	2	---	---	---	---	---	1R410624092
		12	---	---	---	---	---	1R4101X0022
3	76	2	---	---	---	---	---	1R410724092 <sup>(1)</sup>
		12	---	---	---	---	---	1R4102X0012
4	102	2	---	---	---	---	---	10A2426X012
		12	---	---	---	---	---	1E7246X0022

1. For Type 667-4, part number is 17A2270X012.



# Type 667 Size 30-76 & 87

Key 18. Actuator Spring, Steel<sup>(1)</sup>

ACTUATOR SIZE	DIAPHRAGM PRESSURE RANGE		TRAVEL, INCHES (mm)					
			7/16 (11)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (38)	2 (51)
	Psig	Bar						
30	3-15	0.2-1.0	1E795327082 Light Blue	1E795527092 Brown	1E792327092 Dark Gray	---	---	---
	6-30	0.4-2.0	1E795627082 White	1E795427082 Light Gray	1E792427082 Light Green	---	---	---
34 <sup>(2)</sup> & 40	3-15	0.2-1.0	1E805127082 Aluminum	1E804927082 Yellow	1E805827082 Light Gray	1E805327092 Dark Gray	1E805627092 <sup>(3)</sup> Dark Green	---
	6-30	0.4-2.0	1E805027082 Purple	1E804827082 Light Blue	1E805227082 Orange	1E805527082 Dark Blue	1E805827082 <sup>(3)</sup> Light Gray	---
45 & 50	3-15	0.2-1.0	---	1E826727082 Purple	1E826227082 Light Green	1E826127082 Dark Gray	1E826627082 Orange	1E826927082 Dark Green
	6-30	0.4-2.0	---	1E825627082 Light Blue	1E825527082 Aluminum & Red	1E826427082 Light Gray	1E826227082 Light Green	1E826527082 Red
46 & 60	3-15	0.2-1.0	---	1E825827082 Yellow	1E825727082 Brown	1E826227082 Light Green	1E826527082 Red	1E827027082 Aluminum & Dark Blue
	6-30	0.4-2.0	---	---	1E826027082 Bronze	1E825527082 Aluminum & Red	1E825727082 Brown	1E826327082 Aluminum & Dark Green
			<b>3/4 (19)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102)</b>
70 & 87	3-15	0.2-1.0	1N127927082 Red	1N719327082 White	1N128727082 Yellow	1N128427082 Light Green	1N128627082 Dark Gray	---
	6-30	0.4-2.0	---	1N128127082 Brown	1N127927082 Red	1N128527082 Light Blue	1N128727082 Yellow	1R67607082 <sup>(4)</sup> Black

1. Other spring selections are available by contacting your Fisher Controls sales office or sales representative.  
2. 1-1/8 inch travel is available for size 34, and 1-1/2 inch travel is available for size 40 only.  
3. For size 40 only.  
4. Diaphragm pressure range for this spring and travel combination is 3-30 psig (0.2-2.0 bar).

Key 32. Travel Indicator Scale, Stainless Steel

SIZE	TRAVEL, INCHES (mm) <sup>(1)</sup>								
	7/16 (11)	1/2 (12)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (28)	2 (51)	3 (76)	4 (102)
30	1E793438992	1E793538992	1E793538992	1E793638992	---	---	---	---	---
34	1E793438992	1E807738982	1E807738982	1E793638992	17A9814X012	---	---	---	---
40	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(2)</sup>	1E808238992	1E808338992	---	---	---
45	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(3)</sup>	1E808238992	1E808338992	1R444538982	---	---
46	1E807638992	1E807738982	1E807738982	1E808138992	1E808238992	1E808338992	1R444538982	---	---
50	1E833038982	1E833038982	1E833038982	1E833138992 <sup>(4)</sup>	1E833238992	1E833338992	1E833438992	---	---
60	1F535238982	1E833038982	1E833138992	1E833138992	1E833238992	1E833338992	1E833428992	---	---
70	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012
76	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	---	---
87	---	---	---	1H745738992 <sup>(5)</sup>	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012

1. 2-inch maximum travel for size 76 actuator.  
2. 1U356138982 is for 1-inch (25 mm) travel.  
3. 1H147938992 is for 7/8-inch (22 mm) travel.  
4. 1U356238982 is for 1-inch (25 mm) travel.  
5. 1H745838992 is for 7/8-inch (22 mm) travel.

# Type 667 Size 30-76 & 87

Key 152. Travel Stop for Top-Mounted Handwheels and Style 10 and 11 Adjustable Travel Stops, Steel

ACTUATOR SIZE	TRAVEL INCHES (mm)							
	7/16 (11)	5/8 (16)	3/4 (19)	7/8 (22)	1 (25)	1-1/8 (29)	1-1/2 (38)	2 (51)
30 (3 req'd)	1F393224092 <sup>(1)</sup>	1E797924092 <sup>(1)</sup>	1E792524092 <sup>(1)</sup>	---	---	---	---	---
34 & 40 (4 req'd)	1E806424092 <sup>(2)</sup>	1E806524092	1E806624092	1F424624092	1H797624092	1E806724092	1E806824092	---
45 thru 60 & 76 (4 req'd)	---	1E827324092	1E831924092	1H1912X0012	1H355824092	1E831924092	1E806424092	1E832124092 <sup>(1)</sup>
	<b>3/4 (19)</b>	<b>7/8(22)</b>	<b>1 (25)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102) (3)</b>
70 & 87 <sup>(1)</sup> (3 req'd)	1N128824092	18A0351X012	---	1N128924092	1N129024092	1N12914092	1N129224092	11A8131X012

1. For top-mounted handwheels and style 10 travel stops.  
 2. For style 11 travel stops.  
 3. Type 667-4.

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# Design D and DA Valves

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## Introduction

### Scope of Manual

This instruction manual includes installation, maintenance, and parts information for the Design D and DA valves. Refer to separate manuals for instructions covering the actuator, positioner, and accessories.



W0232- / IL

Figure 1. Design D Valve with Type 657 Actuator

Only persons qualified through training or experience should install, operate, and maintain this valve. If you have any questions about these instructions, contact your Fisher sales office before proceeding.



FISHER-ROSEMOUNT™

# Design D & DA

Table 1. Specifications

<p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b>          If the valve nameplate shows an ANSI pressure-temperature class, maximum inlet pressure and temperature is consistent with applicable ANSI class per ASME B16.34. If the nameplate does not show an ANSI class, it will show a maximum cold working pressure at 38°C (100°F) (for example, 3600, 6000, 9000, or 10,000 psi)</p> <p><b>Maximum Allowable Pressure Drops<sup>(2)</sup></b>  <b>Flow up:</b> Capable of full rated pressure drops  <b>Flow down:</b> See table 2 for pressure drop limits for ceramic trim</p> <p><b>Shutoff Classification Per ANSI/FCI 70-2 and IEC 60534-4</b>  <b>Standard:</b> Class IV  <b>Optional:</b> Class V</p>	<p><b>Maximum Service Temperature</b>          232°C (450°F)</p> <p><b>Flow Characteristic</b>          Equal Percentage</p> <p><b>Flow Direction</b>  <b>Design D Valve:</b> Flow up through the seat ring and out past the valve plug  <b>Design DA Valve:</b> Flow in either direction</p> <p><b>Approximate Weight</b>  <b>Design D:</b> 34 kg (75 lbs)  <b>Design DA:</b> 46 kg (100 lbs)</p>
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1. Do not exceed the pressure or temperature limits in this manual and any applicable standard limitations.  
 2. The pressure-temperature limits in this manual and in any applicable standard limitations should not be exceeded.

Table 2. Flow Down Pressure Drop Limits - Ceramic Trim Only

VALVE SIZE INCHES	SEAT RING DIAMETER, mm (INCHES)					
	6.4 (1/4)	9.5 (3/8)	12.7 (1/2)	19.1 (3/4)	25.4 (1)	31.8 (1-1/4)
	Pressure Drop, bar					
1	414	414	414	193	---	---
2	689	689	689	462	262	165
	Pressure Drop, psi					
1	6000	6000	6000	2800	---	---
2	10,000	10,000	10,000	6700	3800	2400

## Description

The Design D globe-style (figure 1) and Design DA angle-style (figure 4) valves are single-port, metal-seated valves for high-pressure applications.

## Specifications

Specifications for these valves are in table 1. Some of the specifications for a given valve appear on a nameplate, which is attached to the valve actuator or wired to the valve assembly if the valve was purchased without an actuator.

## Ceramic Trim

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

## WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

## Installation

## WARNING

**To avoid personal injury or property damage resulting from the sudden release of process pressure or bursting of parts, do not install the valve**

assembly where service conditions could exceed the limits given in this manual or on the appropriate nameplates. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

## CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Some body/trim material combinations are limited in their pressure drop and temperature ranges. Do not apply any other conditions to the valve without first contacting your Fisher sales office.

1. Before installing the valve, inspect it to be certain that the valve body cavity is free of foreign material. Clean out all pipelines to remove scale, welding slag, and other foreign materials.
2. Install the valve so that flow through the valve is in the direction shown by the arrow cast on the valve body. The control valve assembly may be installed in any position unless limited by seismic considerations. However, the normal method is with the actuator vertical above the valve. With some valves, the actuator may need support when it is not vertical. For more information, consult your Fisher sales office.
3. Use accepted piping and welding practices when installing the valve in the line. For flanged valve bodies, use suitable gaskets between the body flanges and pipeline flanges.

### Note

Depending on valve body materials used, post-weld heat treating might be needed. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrink-fit pieces and threaded connections may also loosen. In general, if post-weld heat treating is needed, remove all trim parts. Contact your Fisher sales office for additional information.

For screwed end connections, apply pipe compound to pipeline threads.

4. To allow continuous operation during inspection or maintenance, install a three-valve bypass around the control valve assembly.
5. If you received the actuator and valve body shipped separately, refer to the appropriate actuator instruction manual for the actuator mounting procedure.

## WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however the packing might require some readjustment to meet specific service conditions.

## Maintenance

### WARNING

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

# Design D & DA

Table 3. Bolting Torque for Packing Box Nuts (Key 15)

VALVE RATING	STEM DIAMETER		MINIMUM RECOMMENDED TORQUE		MAXIMUM RECOMMENDED TORQUE	
	mm	Inches	N•m	Lbf•in	N•m	Lbf•in
3600 or to Class 1500	9.5	3/8	4	36	5	48
	12.7	1/2	7	66	11	96
	19.1	3/4	16	144	24	216
6000 or Class 2500	9.5	3/8	5	42	7	60
	2.7	1/2	9	78	12	108
	19.1	3/4	20	180	30	264
9000 psi	12.7	1/2	6	54	8	72
	19.1	3/4	20	180	30	264
10,000 psi	12.7	1/2	6	54	8	72
	19.1	3/4	20	180	30	264

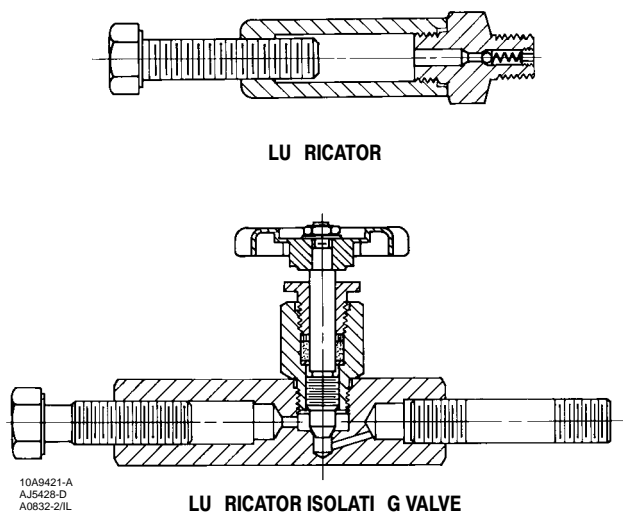


Figure 2. Lubricator and Lubricator/Isolating Valve (optional)

Valve body parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and lapping seating surfaces. All maintenance operations can be performed with the valve in the line.

Because of the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher.

### Note

**Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket upon reassembly. This is necessary to ensure a good gasket seal because the used gasket might not seal properly.**

## Packing Lubrication

The valve might have an optional lubricator or lubricator/isolating valve (figure 2) in the tapped bonnet. Use the lubricator or lubricator/isolating valve for PTFE/composition or other packings that need lubrication. Use a silicon-base lubricant. Do not lubricate packing used in oxygen service. To operate the lubricator, turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except open the isolating valve before turning the cap screw. Close the isolating valve after lubrication is completed.

## Packing Maintenance

Refer to figures 3, 4, and 5 for key number locations.

For spring-loaded single PTFE V-ring packing, the packing spring (key 9) maintains a sealing force on the packing. If you find leakage around the packing follower (key 10), check to be sure the packing follower is touching the bonnet (key 5). If the packing follower is not touching the bonnet, tighten the packing flange nuts (key 15) until the packing follower touches the bonnet. If you cannot stop leakage in this way, proceed to the *Replacing Packing* procedure.

If there is unwanted packing leakage with other than spring-loaded packing, first try to limit the leakage and seal the stem. To limit the leakage, tighten the packing flange nuts (key 15) to at least the minimum recommended torque in table 3. However, do not exceed the maximum recommended torque in table 3, or excessive friction might result. If the packing (key 8) is relatively new and tight on the stem, and tightening the packing flange nuts does not stop the leakage, a worn or nicked valve stem might prevent a seal. If the leakage comes from the outside diameter of the packing, nicks or scratches around the packing box wall might cause the leakage. While replacing the packing per the numbered steps below, inspect the valve stem and packing box wall for nicks and scratches.

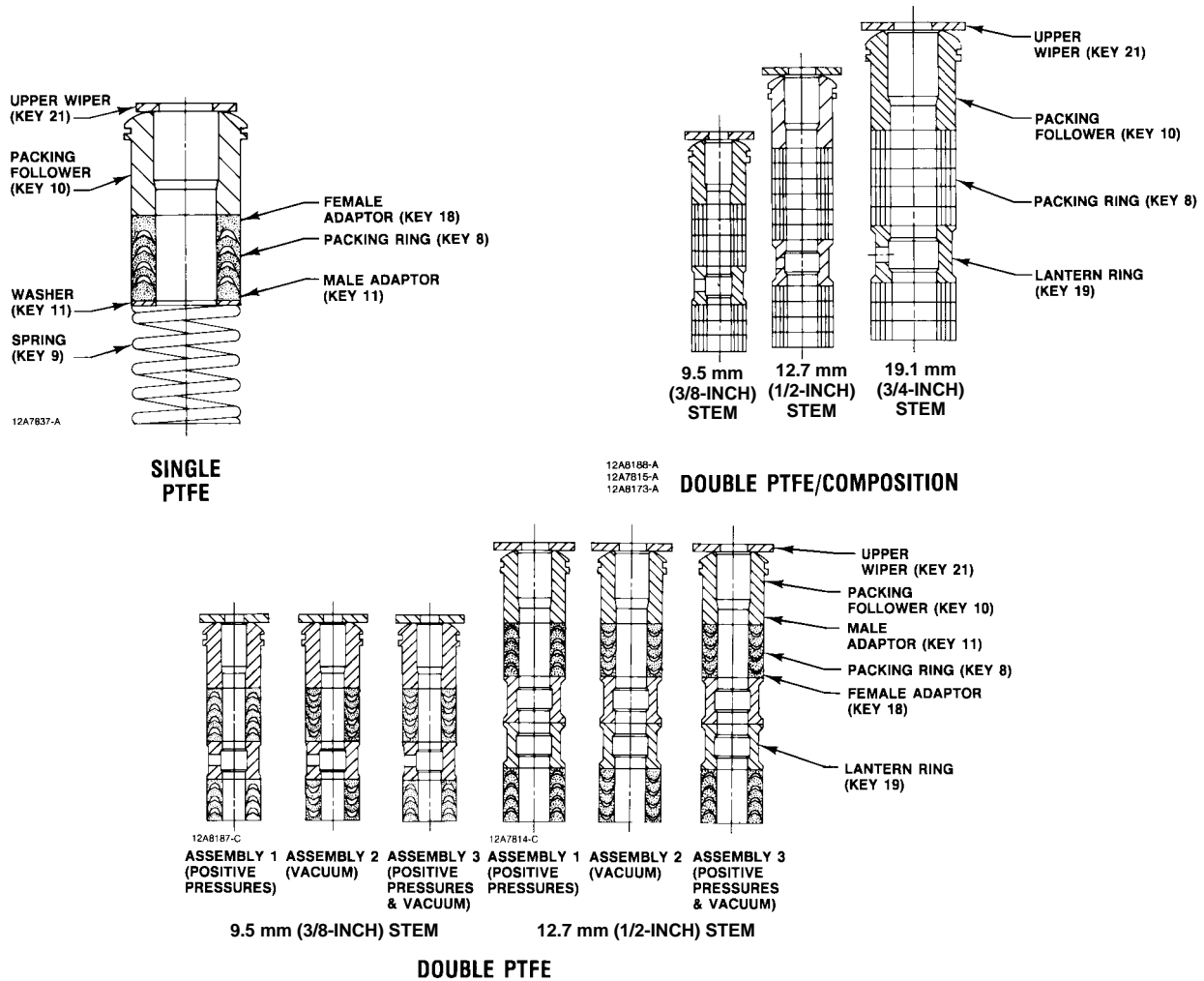


Figure 3. Packing Arrangements.

## Replacing Packing

Except where indicated, refer to figures 3, 4, and 5 for key number locations.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut-off all pressure lines to the power actuator and any leak-off piping from the bonnet. Release all pressure from the actuator and relieve spring precompression. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

Disconnect the stem connector, and then remove the actuator from the valve body by unscrewing the actuator yoke locknut (key 14).

2. Loosen the packing flange nuts (key 15) so the packing is not tight on the valve stem. Remove any

travel indicator parts and stem locknuts from the valve stem threads.

3. Unscrew the bonnet (key 5) from the valve body (key 1). Carefully lift off the bonnet and valve plug/stem assembly (key 4) as a unit. Set the bonnet on a protective surface to prevent damage to the bonnet threads and gasket surface.

4. Remove the valve plug/stem assembly from the bonnet. If you plan to re-use the valve plug, tape or otherwise protect the valve plug seating surface and the stem threads to prevent damage.

5. Remove the bonnet gasket (key 7). Cover the opening in the valve body to protect the gasket surface and prevent foreign material from getting into the body cavity.

6. Remove the packing flange nuts, packing flange, upper wiper, and follower (keys 15, 12, 21, and 10). Carefully push out all the remaining packing box parts from the bonnet using a rounded rod or other tool that will not scratch the packing box wall or bottom guide

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bushing. Clean the packing box and the metal packing box parts.

7. Inspect the valve stem threads and packing box surfaces for any sharp edges that might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If you cannot improve the surface condition by light sanding, replace the damaged parts.

8. Install a new bonnet gasket (key 7), making sure the gasket seating surfaces are clean and smooth. Carefully install the valve plug/stem assembly into the valve body. Then slide the bonnet over the stem and thread it tightly into the valve body, per the torque values in table 4.

9. Install new packing and the metal packing box parts according to the correct arrangement in figure 3. Place a smooth-edged pipe over the valve stem, and gently tap each soft packing part into the packing box.

10. Slide the packing follower, upper wiper, and packing flange (keys 10, 21, and 12) into position. Lubricate the packing flange studs (key 13) and the faces of the packing flange nuts (key 15). Install the packing flange nuts.

11. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts (key 15) until the packing follower (key 10) contacts the bonnet. For other packing arrangements, tighten the packing flange nuts (key 15) alternately in small equal increments. Continue until one of the nuts reaches the minimum recommended torque shown in table 3. Then tighten the remaining packing flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

12. Mount the actuator on the bonnet (key 5) and connect the actuator and valve plug stem according to the procedure in the appropriate actuator instruction manual. Check for leakage around the packing follower when you put the control valve assembly into service. Retighten the packing flange nuts as required.

## Trim Maintenance

Refer to figure 4 and 5 for key number locations.

## Disassembly

1. Remove the actuator and the bonnet as described in steps 1 through 3 of the *Replacing Packing* procedure.

## CAUTION

**Use care to avoid damaging the gasket sealing surfaces.**

Table 4. Torque for Body-to-Bonnet Joint

VALVE SIZE, INCHES	RECOMMENDED TORQUE	
	N•m	Lbf•ft
1	1060	780
2 - 6000 <sup>(1)</sup>	2030	1500
2 - 10,000 <sup>(1)</sup>	9080	6700

1. Valve rating.

Table 5. Torque for Seat Ring (Key 2)

VALVE SIZE		RECOMMENDED TORQUE	
mm	Inches	N•m	Lbf•ft
25.4	1	407	300
50.8	2	698	515

**The stem surface finish of the valve plug/stem assembly (key 4) is critical for making a good packing seal. The seating surfaces of the seat ring (key 2) and the plug of the valve plug/stem assembly (key 4) are critical for tight shutoff. Protect these parts from damage if you plan to re-use them in the valve.**

2. If you wish, remove the valve plug/stem assembly (key 4) and the packing parts from the bonnet. If you plan to re-use the valve plug, tape or otherwise protect the valve plug seating surface and the stem threads to prevent damage. Remove the packing parts as described in the *Packing Maintenance* procedure.
3. Use a socket wrench to remove the seat ring (key 2).
4. Remove the seat ring (key 2) and seat ring gasket (key 3) from the valve body.
5. Inspect parts for wear or damage that would prevent proper operation of the valve body. Clean the gasket surfaces.
6. Replace trim parts as necessary or use the *Lapping Metal Seats* procedure.

## Lapping Metal Seats

A certain amount of leakage should be expected with metal-to-metal seating in any valve body. If the leakage becomes excessive, however, the condition of the seating surfaces of the valve plug and seat ring (keys 4 and 2, figures 4 and 5) can be improved by lapping. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Partially assemble the valve so the seat ring and valve plug are in place and the bonnet (with bushing installed) is screwed hand-tight into the body. Make a simple handle from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction with light downward pressure to lap the seats. If you think there is not



enough lubrication (for example, if you hear a squeaking noise or feel vibration), stop the procedure, and apply more lapping compound before continuing. After lapping, remove the bonnet and valve plug/stem assembly as a unit, and clean the seating surfaces. Completely assemble as described in the *Assembly* portion of the *Trim Maintenance* procedure.

Test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

## Assembly

1. Thoroughly clean the seat ring and bonnet threads in the valve body (key 1). Also clean the valve body seat ring gasket surfaces.
2. Apply Never-Seez Nickel Special lubricant or equivalent to the threads of the seat ring (key 2), bonnet (key 5), and their mating threads in the body.
3. Put the seat ring gasket (key 3) into the body.
4. Screw the seat ring into the body. Use a socket wrench to tighten the seat ring to the torque values shown in table 4. Remove all excess lubricant after tightening.
5. Clean the bonnet gasket seating surfaces, and install a new bonnet gasket (key 7).
6. If you had not removed the valve plug/stem assembly and packing from the bonnet, then install the bonnet (key 5) and valve plug/stem assembly (key 4) as a unit, into the valve body. Keeping the valve plug/stem assembly in an “up” position, thread the bonnet tightly into the valve body, per torque values in table 4.
7. If you had previously chosen to remove the valve plug/stem assembly and packing from the bonnet, then remove any protective tape or covering from the valve plug/stem assembly (key 4) and carefully install it into the valve body. Slide the bonnet (key 5) over the stem and thread it tightly into the valve body. Install new

packing and the metal packing box parts according to the correct arrangement in figure 3. Place a smooth-edged pipe over the valve stem, and gently tap each soft packing part into the packing box.

8. Slide the packing follower, upper wiper, and packing flange (keys 10, 21, and 12) into position. Lubricate the packing flange studs (key 13) and the washer surfaces of the packing flange nuts (key 15). Install the packing flange nuts.
9. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts (key 15) until the packing follower (key 10) contacts the bonnet. For other packing arrangements, tighten the packing flange nuts (key 15) alternately in small equal increments. Continue until one of the nuts reaches the minimum recommended torque shown in table 3. Then tighten the remaining packing flange nut until the packing flange is level and at a 90-degree angle to the valve stem.
10. Mount the actuator on the bonnet (key 5) and connect the actuator and valve plug stem according to the procedure in the appropriate actuator instruction manual. Check for leakage around the packing follower (key 10) when you put the control valve assembly into service. Retighten the packing flange nuts as required.

## Parts Ordering

Each body-bonnet assembly is assigned a serial number, which is on the body or nameplate. The serial number also appears on the actuator nameplate if you bought a valve and actuator assembly. Refer to this serial number when contacting your Fisher sales office for technical advice. When ordering replacement parts, mention the serial number. Also specify key number, part description, material, and part number from the following lists of *Parts Kits* and part numbers.

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## Parts Kits

Key	Description	Part Number
---	Packing Box Parts for Double PTFE V-Ring Packing (Includes keys 3, 7, 8, 11, 18, 19, and 21)	
	9.5 mm (3/8-Inch) Stem	RDX0000CN12
	12.7 mm (1/2-Inch) Stem	RDX0000CN22
---	Trim Package (31600) [Includes Equal Percentage S31600 (316 SST) W/R30006 (alloy 6) tip valve plug/stem (key 4), S316000 w/alloy 6 seat ring (key 2), stainless steel gaskets (keys 3 & 7), and single PTFE packing parts (keys 8, 9, 11, 17, 18, and 21) or double PTFE packing parts (keys 8, 11, 18, 19, and 21)]	
	Double PTFE V-Ring Packing	
	1 In. Valve w/ 9.5 mm (3/8-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXCNTRM112
	9.5 mm (3/8-Inch) port dia.	RDXCNTRM122
	12.7 mm (1/2-Inch) port dia.	RDXCNTRM132
	19.1 mm (3/4-Inch) port dia.	RDXCNTRM142
	2 In. Valve w/ 12.7 mm (1/2-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXCNTRM212
	9.5 mm (3/8-Inch) port dia.	RDXCNTRM222
	12.7 mm (1/2-Inch) port dia.	RDXCNTRM232
	19.1 mm (3/4-Inch) port dia.	RDXCNTRM242
	25.4 mm (1-Inch) port dia.	RDXCNTRM252
	31.8 mm (1-1/4-Inch) port dia.	RDXCNTRM262
---	Trim Package (Ceramic) Includes seat ring and valve plug/stem assembly (keys 2 and 4)	
	1-In. Valve w/ 9.5 mm (3/8-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXVTC00012
	9.5 mm (3/8-Inch) port dia.	RDXVTC00022
	12.7 mm (1/2-Inch) port dia.	RDXVTC00032
	19.1 mm (3/4-Inch) port dia.	RDXVTC00042
	2-In. Valve w/ 12.7 mm (1/2-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXVTC00052
	9.5 mm (3/8-Inch) port dia.	RDXVTC00062
	12.7 mm (1/2-Inch) port dia.	RDXVTC00072
	19.1 mm (3/4-Inch) port dia.	RDXVTC00082
	25.4 mm (1-Inch) port dia.	RDXVTC00092
	31.8 mm (1-1/4 In) port dia.	RDXVTC00102

## Parts List

### Note

**Abbreviations used in this parts list are: SST (stainless steel), RTJ (ring-type joint), RF (raised face), SCH (schedule), BWE (butt welding end), dia. (diameter), in. (inches), mm (millimeters), psi (pounds per square inch), and zn pl (zinc plated).**

**Sizes shown in inches are valve sizes unless otherwise stated.**

**Select parts titled 3600 PSI if your valve has a Class 1500 or lower rating and select parts titled 6000 PSI if your valve has a Class 2500 rating.**

Key	Description	Part Number
001	Valve Body If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
002*	Seat Ring CF8M or S31600 (316 SST) w/COCR-A seat	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	2B5097X0012
	9.5 mm (3/8-inch) port dia.	2B5098X0012
	12.7 mm (1/2-inch) port dia.	2B5099X0012
	19.1 mm (3/4-inch) port dia.	2B5100X0012
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	2B5106X0012
	9.5 mm (3/8-inch) port dia.	2B5107X0012
	12.7 mm (1/2-inch) port dia.	2B5108X0012
	19.1 mm (3/4-inch) port dia.	2B5109X0012
	25.4 mm (1-inch) port dia.	2B5110X0012
	31.8 mm (1-1/4 inch) port dia.	2K1801X0012
	316 SST w/tungsten carbide insert	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	1J6886000A2
	9.5 mm (3/8-inch) port dia.	1J6887000A2
	12.7 mm (1/2-inch) port dia.	1J6888000A2
	19.1 mm (3/4-inch) port dia.	1J6889000A2
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	1J6899000A2
	9.5 mm (3/8-inch) port dia.	1J8154000A2
	12.7 mm (1/2-inch) port dia.	1J8156000A2
	25.4 mm (1-inch) port dia.	1J8160000A2
	Ceramic	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	22B8996X012
	9.5 mm (3/8-inch) port dia.	22B8997X012
	12.7 mm (1/2-inch) port dia.	22B8998X012
	19.1 mm (3/4-inch) port dia.	22B8999X012
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	22B9000X012
	9.5 mm (3/8-inch) port dia.	22B9001X012
	12.7 mm (1/2-inch) port dia.	22B9002X012
	19.1 mm (3/4-inch) port dia.	22B9003X012
	25.4 mm (1-inch) port dia.	22B9004X012
	31.8 mm (1-1/4 inch) port dia.	22B9005X012
003*	Gasket S31600 (316 SST)	
	For 1 In. valves and NACE MR0175 <sup>(1)</sup>	1B198636042
	For 2 In. valves and NACE MR0175 <sup>(1)</sup>	1B198836042
004*	Micro-Flute™ valve plug/stem assembly NACE MR0175 <sup>(1)</sup> S31600, COCR-A seat - S20910	
	1-In. valve, 9.5 mm (3/8-in.) stem	
	1 flute	
	6.4 mm (1/4-inch) port dia.	2N7147X0032
	3 flutes	
	6.4 mm (1/4-inch) port dia.	2F3280X0022
	9.5 mm (3/8-inch) port dia.	2N7389X0022
	12.7 mm (1/2-inch) port dia.	2N7338X0022
	19.1 mm (3/4-inch) port dia.	2N7393X0022

\*Recommended spare parts

1. These materials are listed in NACE standard MR0175 as being acceptable for direct exposure to sour environment when used under conditions stated in that standard.

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Key	Description	Part Number	Key	Description	Part Number
004*	Equal percentage valve plug/stem assembly		005	Bonnet/Bushing Assy	
	S31600 (316 SST) w/S20910 (22-13-5) & Alloy 6 for NACE MR0175 <sup>(1)</sup>			If you need a bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
	1 in. valve, 9.5 mm (3/8-in.) stem		007*	Gasket	
	6.4 mm (1/4-inch) port dia.	2F1388X0042		S31600 (316 SST)	
	9.5 mm (3/8-inch) port dia.	2F1389X0032		For 1 in. valves and NACE MR0175 <sup>(1)</sup>	1B198236042
	12.7 mm (1/2-inch) port dia.	2F1390X0032		For 2 in. valves and NACE MR0175 <sup>(1)</sup>	1B198436042
	19.1 mm (3/4-inch) port dia.	2F1391X0032	008*	Packing Ring	
	2 in. valve, 12.7 mm (1/2-in.) stem			Double PTFE/Composition packing	
	6.4 mm (1/4-inch) port dia.	2F1427X0022		9.5 mm (3/8-in.) stem (7 req'd)	1F3370X0012
	9.5 mm (3/8-inch) port dia.	2F1428X0022		12.7 mm (1/2-in.) stem (10 req'd)	1E319001042
	12.7 mm (1/2-inch) port dia.	2F1429X0022		19.1 mm (3/4-in.) stem (8 req'd)	1E319101042
	19.1 mm (3/4-inch) port dia.	2F1430X0022		Double PTFE V-Ring	
	25.4 mm (1-inch) port dia.	2F1431X0022		9.5 mm (3/8-in.) stem (6 req'd)	1C752601012
	31.8 mm (1-1/4 inch) port dia.	2L5331X0032		12.7 mm (1/2-in.) stem (6 req'd)	1C752701012
	S31600 (316 SST) w/tungsten carbide tip for NACE MR0175 <sup>(1)</sup>			19.1 mm (3/4-in.) stem (6 req'd)	1C752801012
	1 in. valve, 9.5 mm (3/8-in.) stem		010	Packing Follower	
	6.4 mm (1/4-inch) port dia.	2J6894X0022	011*	Packing Adaptor, male	
	9.5 mm (3/8-inch) port dia.	2J6895X0022		Double PTFE V-Ring packing	
	12.7 mm (1/2-inch) port dia.	2J6896X0022		9.5 mm (3/8-in.) stem (2 req'd)	1F124801012
	19.1 mm (3/4-inch) port dia.	2J6897X0022		12.7 mm (1/2-in.) stem (2 req'd)	1F124701012
	2 in. valve, 12.7 mm (1/2-in.) stem			19.1 mm (3/4-in.) stem (2 req'd)	1F124601012
	6.4 mm (1/4-inch) port dia.	2J8189X0022	012	Packing Flange	
	9.5 mm (3/8-inch) port dia.	2J8191X0022	013	Packing Box Stud	
	12.7 mm (1/2-inch) port dia.	2J8193X0022	014	Yoke Locknut, steel	
	19.1 mm (3/4-inch) port dia.	2J8195X0022	015	Hex Nut	
	25.4 mm (1-inch) port dia.	2J8197X0052	016	Pipe Plug	
	31.8 mm (1-1/4 inch) port dia.	2V2234X0022	016	Stem Lubricator/Isolating Valve	
	Ceramic		016	Pipe Nipple, for lubricator/isolating valve	
	1-in. valve, 9.5 mm (3/8-in) stem		016	Stem Lubricator	
	6.4 mm (1/4-inch) port dia.	22B8956X012	018*	Packing Adaptor, female	
	9.5 mm (3/8-inch) port dia.	22B8957X012		Double PTFE V-Ring	
	12.7 mm (1/2-inch) port dia.	22B8958X012		9.5 mm (3/8-in.) stem (2 req'd)	1F124401012
	19.1 mm (3/4-inch) port dia.	22B8959X012		12.7 mm (1/2-in.) stem (2 req'd)	1F124301022
	1-in. valve, 12.7 mm (1/2-inch) stem			19.1 mm (3/4-in.) stem (2 req'd)	1F124201012
	6.4 mm (1/4-inch) port dia.	22B8960X012	019	Lantern Ring	
	9.5 mm (3/8-inch) port dia.	22B8961X012	021*	Upper Wiper, felt	
	12.7 mm (1/2-inch) port dia.	22B8962X012		9.5 mm (3/8-in.) stem	1J872606332
	19.1 mm (3/4-inch) port dia.	22B8963X012		12.7 mm (1/2-in.) stem	1J872706332
	1-in. valve, 19.1 mm (3/4-in) stem			19.1 mm (3/4-in.) stem	1J872806332
	6.4 mm (1/4-inch) port dia.	22B8964X012	025	Seal & Wire (not shown), lead	
	9.5 mm (3/8-inch) port dia.	22B8965X012		Required only if actuator is not furnished	
	12.7 mm (1/2-inch) port dia.	22B8966X012	---	Tag,warning (not shown)	
	19.1 mm (3/4-inch) port dia.	22B8967X012			
	2-in. valve, 12.7 mm (1/2-in) stem				
	6.4 mm (1/4-inch) port dia.	22B8968X012			
	9.5 mm (3/8-inch) port dia.	22B8969X012			
	12.7 mm (1/2-inch) port dia.	22B8970X012			
	19.1 mm (3/4-inch) port dia.	22B8971X012			
	25.4 mm (1-inch) port dia.	22B8972X012			
	31.8 mm (1-1/4 inch) port dia.	22B8973X012			
	2-in. valve, 19.1 mm (3/4-inch) stem				
	6.4 mm (1/4-inch) port dia.	22B8974X012			
	9.5 mm (3/8-inch) port dia.	22B8975X012			
	12.7 mm (1/2-inch) port dia.	22B8976X012			
	19.1 mm (3/4-inch) port dia.	22B8977X012			
	25.4 mm (1-inch) port dia.	22B8978X012			
	31.8 mm (1-1/4 inch) port dia.	22B8979X012			

\*Recommended spare parts

1. These materials are listed in NACE standard MR0175 as being acceptable for direct exposure to sour environment when used under conditions stated in that standard.

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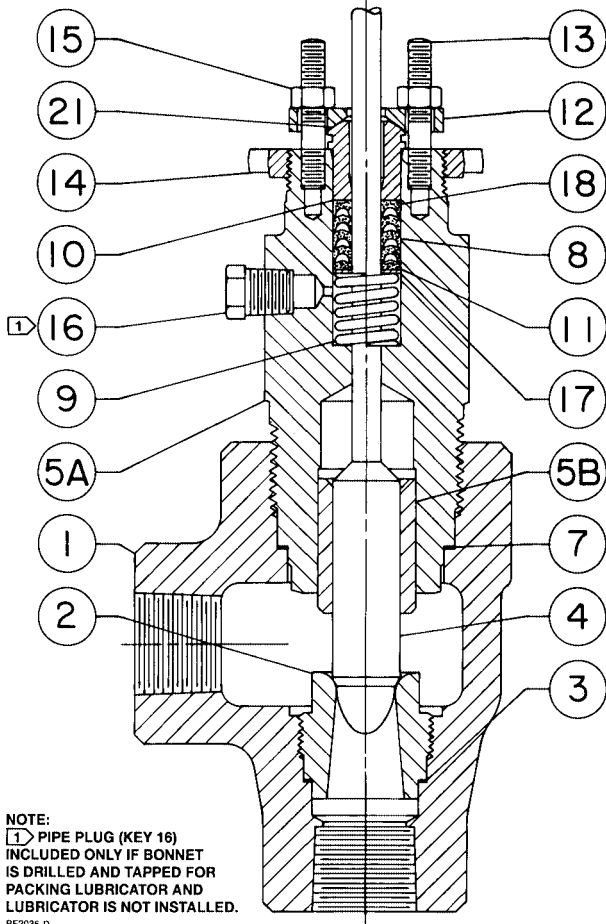


Figure 4. Design DA Angle-Style Valve

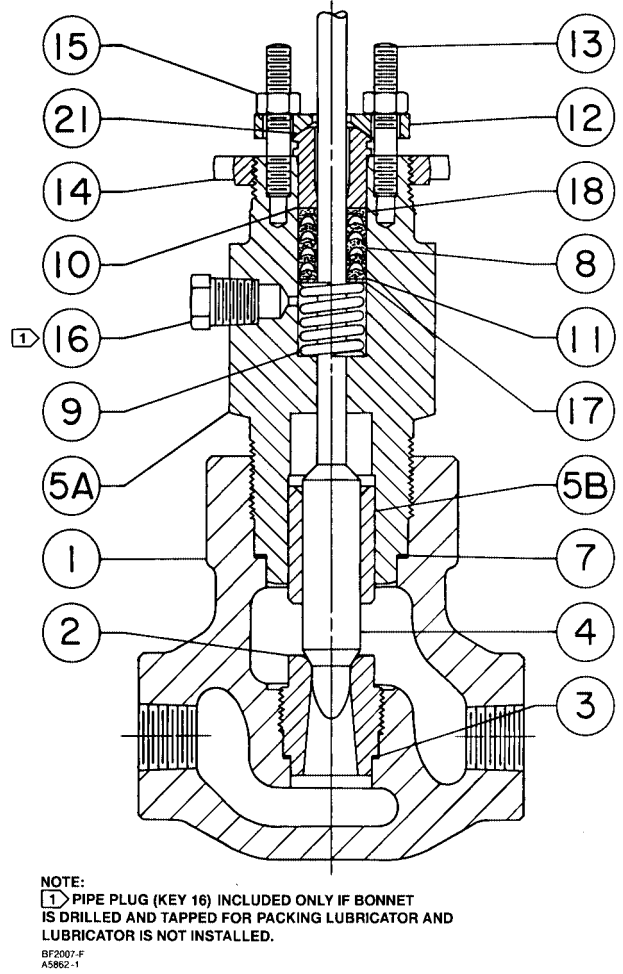


Figure 5. Design D Globe-Style Valve



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PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 2	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : FLOW CONTROL VALVES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
				BY	CHK'D	APPR.			
G 1	TAG NO.	LCV-640		LCV-690					
E 2	SERVICE	V-640 LEVEL		FUEL GAS SCRUBBER					
N 3	LINE NO. / VESSEL NO.	V-640		V-690					
E 4	LINE SIZE / SCHED. NO.	33mm SCH.80		33mm SCH.80					
B O D Y	5	TYPE OF BODY		GLOBE (FLOW UP)		GLOBE			
	6	BODY SIZE	PORT SIZE	33 mm	6.4 mm	33 mm	6.4 mm	mm	mm
	7	GUIDING	NO. OF PORTS	STD	ONE	STD	ONE		
	8	END CONN. & RATING		33mm NPT		33mm NPT			
	9	BODY MATERIAL		CS		CS			
	10	PACKING MATERIAL		STD		STD			
	11	LUBRICATOR	ISOLAT. VALVE	---	---	---	---	---	---
	12	BONNET TYPE		STD BONNET		STD BONNET			
	13	TRIM FORM		MICROFORM		TAPER			
	14	TRIM MATERIAL	SEAT / PLUG	STD		STD			
			SHAFT / MAT'L	STD		STD			
	15	REQUIRED SEAT TIGHTNESS							
	16	MAX. ALLOW SOUND LEV. dBA							
	A 17	MODEL NO. & SIZE		20					
	C 18	TYPE OF ACTUATOR		DIAPHRAGM		DIAPHRAGM			
	T 19	CLOSE AT	OPEN AT	20 kPa	100 kPa	20 kPa	100 kPa	kPa	kPa
U 20	FLOW ACTION TO		OPEN		OPEN				
A 21	FAIL POSITION		CLOSED		CLOSED				
T 22	HANDWHEEL & LOCATION		---		---				
P 23	MFR. & MODEL NO.		---		---				
O 24	FILT REG   GAGES   BYPASS								
S 25	INPUT SIGNAL								
I 26	OUTPUT SIGNAL								
T 27	AIR SUPPLY PRESS		kPa		kPa		kPa	kPa	
T 28	MFR. & MODEL NO.								
R 29	INPUT SIGNAL								
N 30	OUTPUT SIGNAL								
O 31									
P 32									
T 33									
S E R V I C E	34	FLOW UNITS		L/M		L/M			
	35	FLUID		70% E.GLYCOL LIQUID		H.C.LIQUID			
	36	QUANT. MAX.	MAX. Cv						
	37	QUANT. OPER.	OPER Cv	5.70	0.248	12	0.23		
	38	VALVE Cv	VALVE FL	1.45		1.6			
	39	NORM IN PRES	NORM DELTA P	480 kPa(g)	280 kPa	770 kPa(g)	720 kPa	kPa(g)	kPa
	40	MAX. INLET PRESS.		1724 kPa		1724 kPa		kPa	kPa
	41	MAX.SHUT OFF	MAX.DELTA P	1724 kPa(g)	1724 kPa	1724 kPa(g)	1724 kPa	kPa(g)	kPa
	42	TEMP. MAX.	OPER. TEMP	93 ° C	57 ° C	66 ° C	24 ° C	° C	° C
	43	OPER. SP. GR.	MOL. WT.	1.11		0.55			
	44	OPER. VISC.	% FLASH						
	45	% SUPERHEAT	% SOLIDS						
	46	VAPOR PRESS	CRIT PRESS	kPa(g)	kPa(g)	kPa(g)	8260 kPa(g)	kPa(g)	kPa(g)
	47	PREDICTED SOUND LEVEL dBA							
	48	MANUFACTURER		FISHER		FISHER			
	49	MODEL NO.		357-20		128 PQC			
	50	P. O. NUMBER							

NOTES:

AREA. UNIT # :

# 357 Series Control Valves

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W5810/IL

Figure 1. 357 Series Control Valve

## Introduction

### Scope of Manual

This instruction manual provides installation, maintenance, and parts information for 357 Series control valves. Refer to separate manuals for instruction covering accessories used with the control valve.

### Description

The 357 Series control valves (figure 1) are designed for high-pressure on-off and throttling applications and are used as dump valves on oil and gas separators, scrubbers, and other field process equipment. They are also used for well-head applications where rugged

steel construction and easy maintenance are necessary. (The bonnet/body connection is covered by patent.)

Only personnel qualified through training or experience should install, operate, and maintain this control valve. If you have any questions concerning these instructions, contact your Fisher sales office before proceeding.

### Specifications

Table 1 lists specifications for the 357 Series control valves. Some of the specifications for the control valve, as it originally comes from the factory, are stamped on nameplates.





# 357 Series

Table 1. Specifications

<p><b>Available Configurations</b> See table 2</p> <p><b>Valve Body Sizes and End Connection Styles</b> See table 3</p> <p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b> 276 bar from –29 to 93°C (4000 psig from –20 to 200°F), 276 bar at –45°C (4000 psig at –50°F), and 268 bar at 149°C (3880 psig at 300°F) unless limited by end connection rating</p> <p><b>Maximum Pressure Drops<sup>(1)</sup></b> <b>Metal Seats:</b> See tables 4 and 5</p> <p><b>Input Signal to Actuator</b> See tables 4 and 5</p> <p><b>Actuator Maximum Casing Pressure</b> Size 20: 3.4 bar (50 psig) Size 40: 3.4 bar (50 psig)</p> <p><b>Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4</b> <b>Metal Seats:</b> ANSI Class IV <b>Soft Seats:</b> ANSI Class VI</p> <p><b>Material Temperature Capabilities<sup>(1)(2)</sup></b> <b>With Nitrile O-Rings, Nylon Bushings, and WCC Valve Bodies:</b> –29 to 93°C (–20 to 200°F) <b>With Fluoroelastomer O-Rings, Ryton Bushings, and WCC Valve Bodies:</b> –23 to 149°C (–10 to 300°F)</p>	<p><b>With Nitrile<sup>(3)</sup> O-Rings, Nylon Bushings, and LCC Valve Bodies:</b> –45 to 82°C (–50 to 180°F)</p> <p><b>Flow Characteristic</b> <b>Metal or Ceramic Seats:</b> Equal percentage <b>Soft Seats:</b> Quick opening</p> <p><b>Flow Direction</b> May be in either direction as suits the application</p> <p><b>Port Diameters</b> ■ 6.4, ■ 9.5, ■ 12.7, ■ 19.1, ■ 25.4, or ■ 38.1 mm (1/4, 3/8, 1/2, 3/4, 1, or 1-1/2 inch) port diameters for both 1-inch and 2-inch valve bodies. See tables 4 and 5 for more information.</p> <p><b>Maximum Rated Valve Plug Travel</b> 19 mm (3/4 inch)</p> <p><b>Valve Plug Style</b> Micro-Form™ valve plug<sup>(4)</sup></p> <p><b>Actuator Diaphragm Effective Area</b> Size 20: 213 cm<sup>2</sup> (33 inches<sup>2</sup>) Size 40: 452 cm<sup>2</sup> (70 inches<sup>2</sup>)</p> <p><b>Actuator Spring Information</b> See table 6</p> <p><b>Actuator Pressure Connection Size</b> 1/4 inch NPT female</p> <p><b>Approximate Weight</b> See table 7</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ANSI code limitations should not be exceeded.
2. Process temperature should not go below –29°C (–20°F).
3. Low temperature material.
4. Contact your Fisher sales office for other valve plug requirements.

Table 2. Available Configurations

VALVE TYPE NUMBER AND FAIL ACTION	357, FAIL DOWN (SPRING CLOSES—AIR OPENS)				357, FAIL UP (SPRING OPENS—AIR CLOSES)			
	20		40		20		40	
Actuator Sizes	20		40		20		40	
Valve Configurations	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Valve Size, Inches	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2

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Table 3. Valve Sizes and Connection Styles

VALVE SIZE, INCHES	SCREWED <sup>(1)</sup>	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		Class 150	Class 300	Class 600	Class 1500	Class 600	Class 1500
1	X	X	X	X	---	X	---
2	X	X	X	X	X	X	X

X = Available construction.  
 1. The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

Table 4. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Down, Spring Closes—Air Opens Configuration)

ACTUATOR SIZE	FLOW DIRECTION	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR, SPRING PART NUMBER											
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
		mm	Inches	16A9594X012		16A9595X012		16A9656X012		16A9929X012		16A9656X012		16A9656X012	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open	6.4	1/4	117	1700	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	42	610	166	2400	104	1510	104	1510	276	4000	276	4000
		12.7	1/2	18	260	88	1270	53	770	53	770	157	2280	169	2450
		19.1	3/4	3	40	34	490	19	270	19	270	65	940	70	1010
		25.4	1	---	---	17	240	8	110	8	110	34	490	37	530
		38.1	1-1/2	---	---	5	70	1	10	1	10	12	180	14	200
	Down to Close	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	16A9929X012		16A9656X012		16A9656X012		16A9929X012		16A9656X012		16A9656X012	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				66	960	111	1620	111	1620	111	1620	186	2700	232	3360
				76	1100	178	2590	178	2590	178	2590	276	4000	276	4000
				87	1270	236	3420	247	3580	121	1760	276	4000	276	4000
				31	450	76	1100	103	1490	76	1100	141	2050	195	2830
				12	180	32	460	43	620	32	460	54	850	81	1180
				---	---	12	170	16	230	12	170	22	320	30	440
40	Up to Open	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
				1F176827092		1E792427082		1E795627082		1F176827092		1E792427082		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
				201	2920	276	4000	276	4000	276	4000	276	4000	276	4000
				108	1560	157	2270	157	2270	181	2630	276	4000	276	4000
	43	620	65	940	65	940	76	1100	30	1890	174	2520			
	21	310	34	490	34	490	39	570	70	1020	95	1380			
	7	100	12	180	12	180	15	220	29	420	39	570			
	Down to Close	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	1J258127092		1E793327082		1E795627082		1J258127092		1E793327082		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				159	2300	276	4000	257	3720	257	3720	276	4000	276	4000
				259	3750	276	4000	276	4000	276	4000	276	4000	276	4000
				276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
83				1210	182	2640	248	3860	182	2640	276	4000	276	4000	
34				500	76	1100	117	1690	76	1100	141	2050	190	2760	
13				190	28	410	44	630	28	410	52	760	71	1030	

1. For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.

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Table 5. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Up, Spring Opens—Air Closes Configuration)

ACTUATOR SIZE	FLOW DIRECTION <sup>(3)</sup>	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR <sup>(2)</sup> , SPRING PART NUMBER					
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
		mm	Inches	16A9594X012		16A9929X012		16A9595X012	
				Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open <sup>(2)</sup>	6.4	1/4	276	4000	276	4000	276	4000
		9.5	3/8	152	2210	276	4000	276	4000
		12.7	1/2	80	1160	173	2510	273	3960
		19.1	3/4	30	440	72	1040	117	1690
		25.4	1	14	210	37	540	63	910
		38.1	1-1/2	3	50	14	200	26	370
40	Up to Open <sup>(2)</sup>	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
				1F176727032		1F714327092		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi
				276	4000	276	4000	276	4000
				276	4000	276	4000	276	4000
				194	2810	276	4000	276	4000
86	1250	175	2540	119	1730				
48	700	96	1390	64	930				
21	300	40	580	26	380				

- For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.
- Actual operating pressure includes an additional 0.2 bar (3 psig) input supply to the controller.
- Consult your Fisher sales office for maximum allowable shutoff pressure drops of flow down to close valve configuration.

Table 6. Spring Part Number, Color Code, Spring Rate and Free Length

ACTUATOR SIZE	SPRING PART NUMBER	COLOR CODE	SPRING RATE		FREE LENGTH	
			N/mm	Lb/in	mm	Inch
20	16A9594X012	Aluminum	36	205	140	5.5
	16A9595X012	Light Green	100	571		
	16A9656X012	Yellow	160	912		
	16A9929X012	Black	67	380		
40	1E792427082	Light Green	257	1470	165	6.5
	1E793327082	Yellow	367	2100		
	1E795627082	White	441	2520		
	1F176727032	Dark Green	64	368		
	1F176827092	Aluminum	86	490		
	1F714327092	Aluminum/Dark Blue	145	830		
	1J258127092	Aluminum/Brown	175	1000		

Table 7. 357 Series Approximate Weights

Actuator Size		20				40			
Valve Size, Inches		1		2		1		2	
Valve Configuration		Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Screwed	kg	21 <sup>(1)</sup>	21 <sup>(1)</sup>	28	23	29 <sup>(1)</sup>	29 <sup>(1)</sup>	35	31
	Pounds	47 <sup>(1)</sup>	47 <sup>(1)</sup>	61	51	64 <sup>(1)</sup>	64 <sup>(1)</sup>	78	68
Class 150	kg	23	22	27	27	30	29	35	35
	Pounds	50	48	60	60	67	65	77	77
Class 300 & 600	kg	26	26	37	35	34	34	45	43
	Pounds	57	57	82	77	74	74	99	94
Class 1500	kg	---	---	55	57	---	---	63	65
	Pounds	---	---	122	126	---	---	139	143

- The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

## Installation

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.



### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**



### WARNING

**To avoid personal injury or property damage caused by bursting of pressure-retaining parts or by uncontrolled process fluid, be certain the service conditions do not exceed the limits shown on the valve nameplate and in tables 1, 4, and 5.**

1. Before installing the control valve assembly, inspect it for any damage and for any foreign material that may have collected in the valve body.
2. Remove any pipe scale, welding slag, and other foreign material from the pipeline.
3. The control valve can be installed in any position, but normally the actuator is vertical above the valve. Install the valve so the flow direction arrow on the side of the valve indicates the direction of the process flow.
4. Install the valve following local and national piping codes when they apply to the application. For screwed connections, treat the male pipe threads with a good grade pipe compound. For flanged valves, use suitable gaskets between valve and pipeline flanges.
5. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the valve.
6. Connect loading pressure for the fail-up configuration to the 1/4-18 NPT connection in the spring case. The fail-down configuration loading pressure connection is in the lower casing assembly as shown in figure 3.

## CAUTION

**If a fail-up configuration is used, do not plug the 1/4-18 NPT connection in the lower casing. It acts as a vent for the lower casing, permitting air to move in and out of the lower casing cavity as the diaphragm moves up and down. If the vent is plugged, the actuator will not respond properly to loading pressure changes and may be incapable of completely opening or shutting off the valve.**

## Spring Adjustment

The spring supplied with the actuator has been selected to meet the requirements of the application as specified on the order. This pressure condition is stamped on the actuator nameplate.

The spring has a fixed pressure span over which loading pressure will stroke the valve. Adjustment of the spring compression shifts the span so that more or less loading pressure is required to start travel. Since the span does not change, there will be a corresponding increase or decrease in the pressure requirements at the end of the valve stroke.

If the actuator has been disassembled or pressure conditions have changed, the spring may need adjustment to make the valve travel coincide with the diaphragm pressure range. Make the adjustment in the following manner.

1. Loosen the adjusting screw nut (key 35, figure 3) on the fail-down configuration, or unscrew the spring case assembly (key 46, figure 2) on the fail-up configuration.
2. Turn the fail-down adjusting screw (key 34, figure 3) or the fail-up adjusting stem nut (key 35, figure 2) clockwise to compress the spring or counterclockwise to decrease spring compression.

Increased spring compression results in increased loading pressure necessary to start travel. Decreased spring compression results in less loading pressure required to start travel. With the fail-down configuration flow-to-open, increased spring compression will balance a higher line pressure or provide additional seating load. With the fail-up configuration flow-to-open, decreased spring compression may be necessary if the line pressure is increased or if more valve plug seating load is required from the input signal.

3. After adjustment, tighten the adjusting screw nut (fail-down configuration), or replace the spring case assembly (fail-up configuration).

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The maximum pressure drop conditions are shown in tables 4 and 5. Note that the springs can be identified by the color code. Depending on how much conditions are changed, it may be necessary to change the actuator spring. If so, check the *Parts List* section to see if a different adjusting screw or adjusting stem assembly (key 34) is required.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

Due to the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher.

### WARNING

**Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- Vent the power actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or

### **when loosening the packing box pipe plug.**

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

The following describes the procedure for complete disassembly and assembly of the actuator-valve combination. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. Key numbers refer to figure 2 for the fail-up configuration and figure 3 for the fail-down configuration.

## Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Unscrew the hammer nut (key 3). If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 58) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

If the bonnet is stuck on the valve, insert a large screwdriver or steel rod into the pry hole in the bonnet. Push down on the screwdriver or rod to loosen the bonnet.

### Note

**The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.**

3. Remove the cage (key 60) and seat ring (key 61). Inspect the cage and bonnet O-rings (keys 6 and 11) for wear or damage.

If the seat ring cannot be easily removed, perform one of the following procedures.

- If the end connections are accessible, reach in through one of the end connections and pry out the seat ring.
  - If the end connections are not accessible or if the valve is installed in a pipeline, use a blind-hole puller similar to CG 2545AB, which is made by Snap-On Tools.
4. To remove the valve plug (key 7), drive out the roll pin (key 9) and unscrew the valve plug from the stem (key 8).

If the valve plug cannot be easily unscrewed from the stem, disassemble the actuator in accordance with steps 7 through 9. Hold a wrench on the hex nut (key 29) to prevent the stem and diaphragm from rotating.

## CAUTION

**Be careful to avoid damaging the seating surface on the valve plug or the cage as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.**

5. If packing parts (keys 12, 13, 14, 15 for PTFE V-ring and nitrile/cotton; keys 12, 13, 14, and 16 for PTFE/composition) are to be replaced with new parts, remove the washer (key 10) and pull out the old parts using a formed wire hook.

### Note

**Save three flat washers (key 13) when removing packing.**

6. No further disassembly is necessary if only the trim and/or packing is being serviced. To reassemble the unit, proceed to the *Assembly* section step 1 and steps 7 through 15.



## WARNING

**To avoid personal injury caused by sudden release of spring force, relieve all spring compression before continuing disassembly. Use step 7 to relieve spring compression.**

7. To relieve all spring compression,

**For fail-down configuration**, loosen the adjusting screw nut (key 35, figure 3) and turn the adjusting screw (key 34, figure 3) counterclockwise to remove all spring compression.

**For fail-up configuration**, unscrew the spring case assembly (key 46, figure 2) and turn the adjusting stem nut (key 35, figure 2) counterclockwise to remove all spring compression. Remove the adjusting stem nut, spring seat, and spring.

8. Unscrew the casing cap screws and hex nuts (keys 36 and 37), and remove the upper casing assembly (key 23) from the lower casing (key 22).
9. For fail-up configuration, remove the cotter pin (key 50, figure 2) and unscrew the adjusting stem (key 34, figure 2) from the stem.
10. Lift out the diaphragm, diaphragm plate, and stem assembly.
11. To replace the diaphragm (key 26), separate the diaphragm assembly by using a wrench on the hex nuts (key 29) to unscrew the assembly.
12. Separate the parts—diaphragm washer, actuator O-ring (keys 27 and 28), diaphragm, and diaphragm plate, (keys 26 and 24).
13. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.
14. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 21) and lift off the lower casing (key 22). Replace the O-ring if necessary.

### Note

**The stem O-ring and bonnet bushing (keys 19 and 20), when used in fail-down, seal against loading pressure. The stem O-ring and bonnet bushing in fail-up have atmospheric pressure on the actuator side.**

15. If the hammer nut needs to be removed from the bonnet, the spring pins (key 58) can be removed with locking pliers.
16. The travel indicator assembly on the fail-up configuration has an O-ring (key 44, figure 2) that may become worn and leak loading pressure. If this happens, replace with a new assembly (key 43).
17. The fail-up configuration has an adjusting stem bushing and actuator stem O-ring (keys 48 and 49, figure 2) that seals against loading pressure around the adjusting stem.

## Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might

# 357 Series

cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant, lubricate all O-rings and bushings and the threads of parts that have to pass through the O-rings and bushings.

## CAUTION

**The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.**

2. If the actuator being reassembled is a fail-up configuration, replace the O-ring and bushing (keys 49 and 48, figure 2).
3. Assemble the diaphragm and diaphragm plate assembly. Place the patterned side of the diaphragm (key 26) (size 40 only) against the diaphragm plate (key 24). Be sure to turn the diaphragm washer (key 27) so that the side that is beveled on the inside diameter is against the O-ring (key 28). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 30) and lower spring seat (key 31), if used, are on the spring side.
4. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20); then bolt the lower casing to the bonnet.

## Note

**Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.**

5. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 29). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet.

6. For a fail-up configuration, screw the adjusting stem (key 34) onto the stem (key 8) and secure with a cotter pin (key 50). Make sure the bushing (key 48) and O-ring (key 49) are in place in the upper casing.
7. Install packing parts (keys 12, 13, 14, 15, or 16). Install the washer (key 10). Screw the valve plug onto the stem. Drive in the roll pin.
8. Make sure the O-ring (key 6) is in the seat ring. Install the seat ring and cage into the valve.
9. Make sure the bonnet O-ring (key 11) is on the bonnet.
10. Lubricate the threads on the valve body and hammer nut and on the contact surfaces of the bonnet and hammer nut flange. Install the bonnet with the attached diaphragm and valve plug onto the valve body. Tighten the hammer nut using a hammer until the nut stops turning. A few extra hammer blows will be required to ensure that the assembly is tight. To avoid overloading of the cage, do not use excessive force, which can be seen by deformation of the nut.

## CAUTION

**Over-tightening the diaphragm casing cap screws and nuts (keys 36 and 37) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.**

11. If the valve is a fail-up, position the upper casing (key 23) on the lower casing (key 22). Insert the cap screws (key 36) and tighten the hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern. Replace the spring, spring seat, (keys 32 and 33) and adjusting stem nut (key 35) over the adjusting stem (key 34). Replace the spring case assembly (key 46).
12. If the valve is fail-down, replace the spring (key 32) on the diaphragm plate (key 24). Replace the upper spring seat (key 33). Position the upper casing (key 23) on the lower casing (key 22). Insert the cap screws (key 36) and tighten the hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
13. Install the travel indicator assembly.
14. Refer to the *Spring Adjustment* section.
15. Adjust the travel indicator nut (key 42).

## Parts Ordering

Each 357 Series control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting your Fisher representative for assistance or when ordering replacement parts. When ordering replacement parts, also be sure to include the complete 11-character part number from the following parts list.

## Parts Kits

### Repair kits for the valve portion only.

PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, and 15) Nitrile seal Fluoroelastomer seal	R357XPTFE12 R357XPTFE22
Nitrile/Cotton Packing Repair Kit (includes keys 6, 11, 12, and 15) Nitrile seal Fluoroelastomer seal	R357X00NC12 R357X00NC22
Ceramic Trim Package (includes keys 7, 9, 60, and 61) 6.4 mm (1/4-inch) port diameter 9.5 mm (3/8-inch) port diameter 12.7 mm (1/2-inch) port diameter 19.1 mm (3/4-inch) port diameter 25.4 mm (1-inch) port diameter 38.1 mm (1-1/2 inch) port diameter	R357XVTC012 R357XVTC022 R357XVTC032 R357XVTC042 R357XVTC052 R357XVTC062

### Repair kits for the valve and actuator assembly.

Diaphragm is not included and must be ordered separately by appropriate part number. PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49) Nitrile seal Fluoroelastomer seal	R357X000012 R357X000032
Nitrile/Cotton Packing Repair Kit (includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49) Nitrile seal Fluoroelastomer seal	R357X000022 R357X000042

## Parts List

### Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number
2	Bonnet	
3	Hammer Nut	
4	Pipe Plug	
6*	Cage O-Ring	See following table
7*	Valve Plug	
	Taper Plug (all port diameters)	
	416 stainless steel	22B3498X012
	17-4PH stainless steel DH1150 (NACE)	22B3498X022
	Micro-Form Plug	
	416 stainless steel	
	6.4 mm (1/4-inch) port diameter	22B3492X012
	9.5 mm (3/8-inch) port diameter	22B3493X012
	12.7 mm (1/2-inch) port diameter	22B3494X012
	19.1 mm (3/4-inch) port diameter	22B3495X012
	25.4 mm (1-inch) port diameter	22B3496X012
	38.1 mm (1-1/2 inch) port diameter	22B3497X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	22B3492X022
	9.5 mm (3/8-inch) port diameter	22B3493X022
	12.7 mm (1/2-inch) port diameter	22B3494X022
	19.1 mm (3/4-inch) port diameter	22B3495X022
	25.4 mm (1-inch) port diameter	22B3496X022
	38.1 mm (1-1/2 inch) port diameter	22B3497X022
	VTC (ceramic) (standard or NACE)	
	6.4 mm (1/4-inch) port diameter	22B8922X012
	9.5 mm (3/8-inch) port diameter	22B8923X012
	12.7 mm (1/2-inch) port diameter	22B8924X012
	19.1 mm (3/4-inch) port diameter	22B8925X012
	25.4 mm (1-inch) port diameter	22B8926X012
	38.1 mm (1-1/2 inch) port diameter	22B8927X012
8*	Valve Stem	
	S31600 (316 stainless steel)	22B3516X012
	S20910 (Nitronic 50) (NACE)	22B3516X032
9*	Roll Pin, 18-8 stainless steel	1U5972X0012
9*	Pin, 17-4PH SST (DH1150) (NACE)	12B3507X022
10	Cage/Packing Washer	
11*	Bonnet O-Ring	See following table
12*	Packing Wiper, PTFE	15A9637X012
13	Packing Washer	
14	Packing Spring	

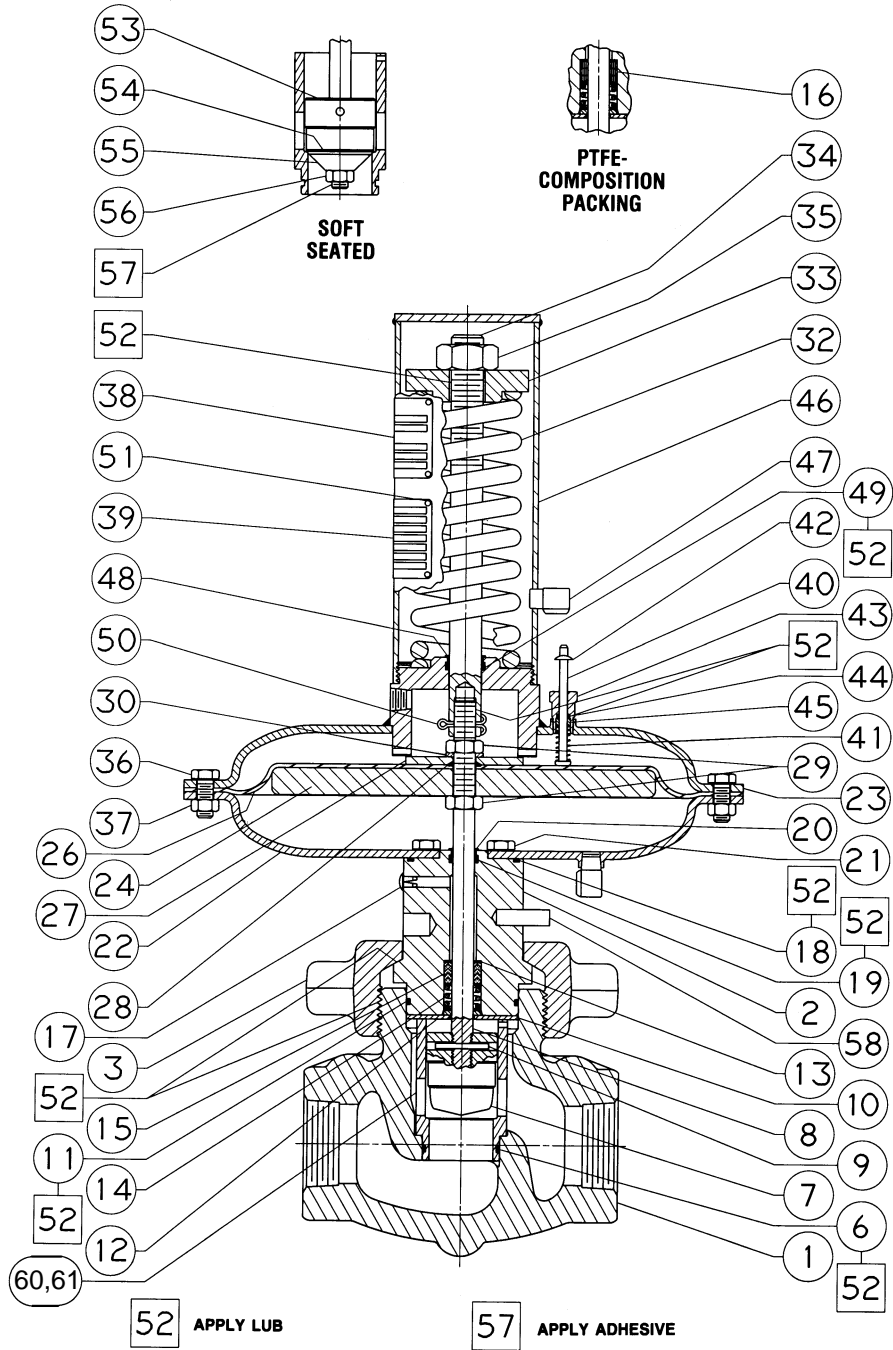


# 357 Series

Key	Description	Part Number	Key	Description	Part Number
15*	Packing Set		48*	Adjusting Stem Bushing, nylon (for fail up)	17A4059X012
	PTFE V-ring	12A9016X012	49*	Actuator Stem O-Ring (for fail up)	See following table
	Nitrile/cotton	19A5772X012	50*	Cotter Pin, S30200 (302 stainless steel) (for fail up)	1C608035022
16*	Packing Ring, PTFE comp (3 req'd)	1P390501042	51	Drive Screw	
17	Leak-off Plug		52	Lubricant, Lubriplate Mag-1	- - -
18*	Casing O-Ring	See following table		Not included with control valve	
19*	Stem O-Ring	See following table	53*	Plug, Disk Holder, S17400 D1150	
20*	Bonnet Bearing	See following table		12.7 mm (1/2-inch) port diameter	22B3533X012
21	Cap Screw			19.1 mm (3/4-inch) port diameter	22B3532X012
22	Lower Casing			25.4 mm (1-inch) port diameter	22B3531X012
23	Upper Casing Assy			38.1 mm (1-1/2 inch) port diameter	22B3530X012
24	Diaphragm Plate		54*	Disk, Plug Seat, UHMWPE <sup>(1)</sup>	
26*	Diaphragm (O-Ring, key 28 should be ordered with diaphragm)			12.7 mm (1/2-inch) port diameter	15A3584X012
	Size 20			19.1 mm (3/4-inch) port diameter	13A7446X012
	Nitrile/nylon	32B3520X012		25.4 mm (1-inch) port diameter	13A7450X012
	Fluoroelastomer	32B3520X022		38.1 mm (1-1/2 inch) port diameter	13A7463X012
	Size 40		55*	Disk Retainer, S31600	
	Neoprene/nylon	22B3521X012		12.7 mm (1/2-inch) port diameter	15A3583X022
	Fluoroelastomer	22B3521X032		19.1 mm (3/4-inch) port diameter	13A7447X012
27	Diaphragm Washer			25.4 mm (1-inch) port diameter	13A7451X012
28*	Actuator O-Ring	See following table		38.1 mm (1-1/2 inch) port diameter	12B3529X012
29	Hex Nut		56	Hex Nut	
30	Lockwasher		57	Adhesive, Loctite No. 262	
31	Lower Spring Seat		58	Spring Pin	
32	Actuator Spring	See tables 4, 5, and 6	60*	Cage for Metal Seats, Soft Seats, and Ceramic Trim	
33	Upper Spring Seat			S17400 D1150 (std or NACE) all port dia	22B8912X012
34	Adjusting Screw		61*	Seat Ring, 17-4PH stainless steel DH1150 (NACE)	
34	Adjusting Stem			Metal Seat Only,	
35	Adjusting screw nut			6.4 mm (1/4-inch) port diameter	39B2046X012
35	Adjusting stem nut			9.5 mm (3/8-inch) port diameter	39B2846X012
36	Cap Screw			Metal Seat and Soft Seat	
37	Hex Nut			12.7 mm (1/2-inch) port diameter	39B2047X012
38	Actuator Nameplate			19.1 mm (3/4-inch) port diameter	39B2048X012
40	Indicator Rod (included in key 43 assembly)			25.4 mm (1-inch) port diameter	39B2843X012
41	Indicator Spring (included in key 43 assembly)			38.1 mm (1-1/2 inch) port diameter	39B2844X012
42	Indicator Nut (included in key 43 assembly)		61*	Seat Ring for Ceramic Trim	
43	Indicator Assembly			S17400/Ceramic D1150 (std or NACE)	
	Fail up (includes keys 40, 41, 42, 43, 44, and 45)			6.4 mm (1/4 inch) port diameter	17B1949X012
	Fail down (includes keys 40, 41, 42, and 43)			9.5 mm (3/8 inch) port diameter	17B1950X012
44	Indicator O-Ring (included in key 43 assembly)			12.7 mm (1/2 inch) port diameter	17B1951X012
45	Indicator Bushing (included in key 43 assembly)			19.1 mm (3/4 inch) port diameter	17B9680X012
46	Spring Case Assembly			25.4 mm (1-inch) port diameter	17B9681X012
47	Vent Assy			Ceramic (std or NACE)	
				38.1 mm (1-1/2 inch) port diameter	32B8918X012

\*Recommended spare parts

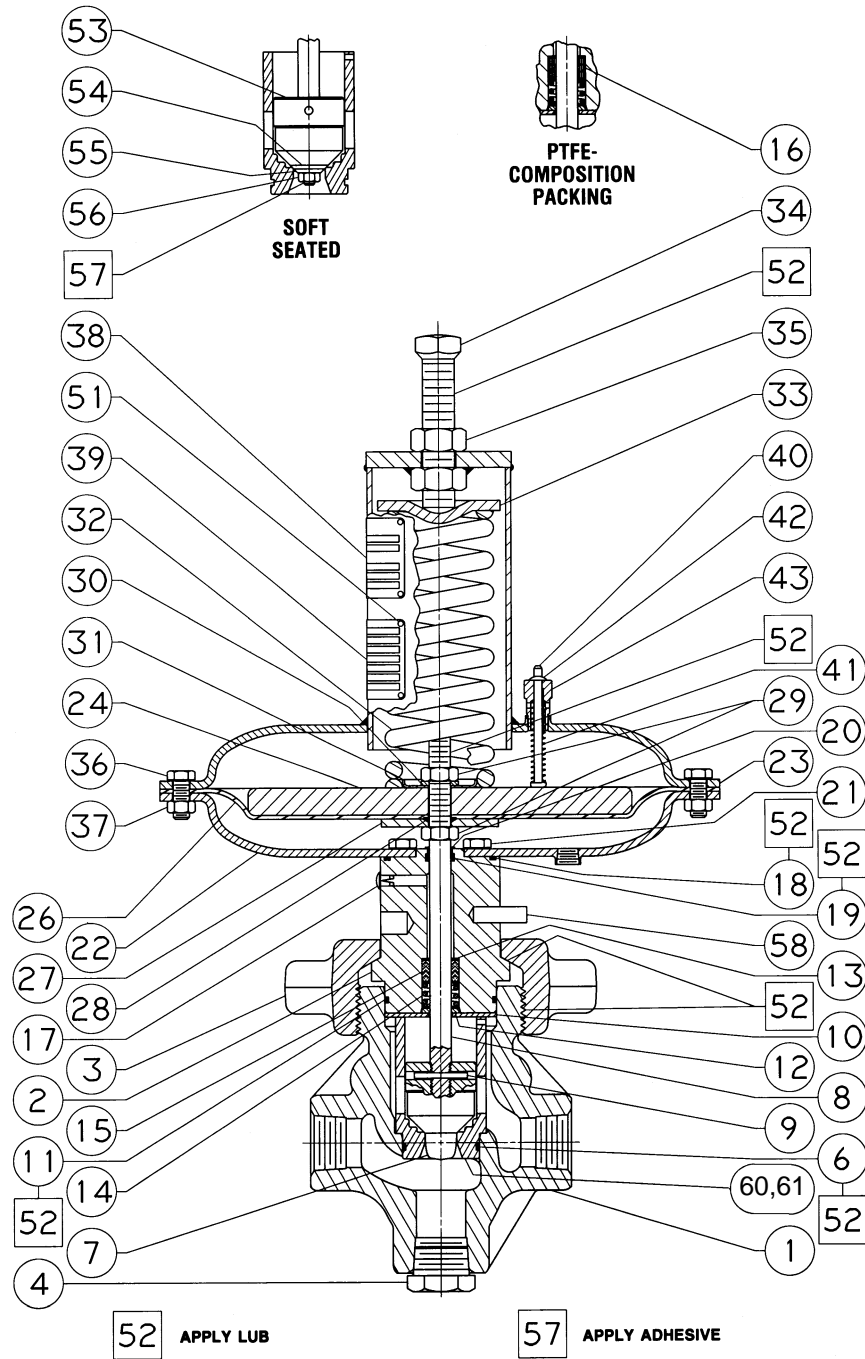
1. Ultra High Molecular Weight Polyethylene



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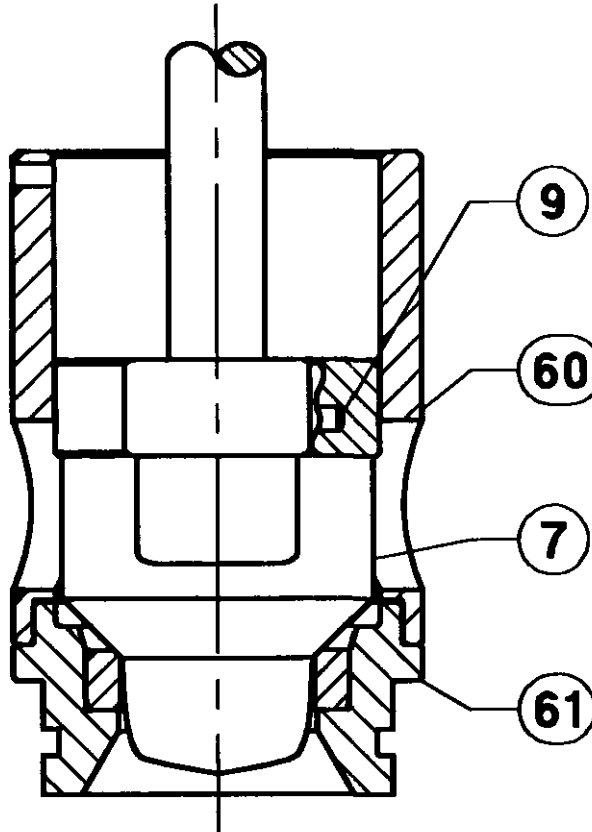
Figure 2. 2-Inch 357 Series Valve—Fail-Up

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Figure 3. 1-Inch 357 Series Valve—Fail-Down



17B9686-A / DOC

Figure 4. Ceramic Trim Assembly

Keys 6\*, 11\*, 18\*, 19\*, 28\*, and 49\* O-Rings and Key 20\* Bushing

KEY NUMBER	PART NAME	WCC VALVE BODY MATERIAL		LCC VALVE BODY MATERIAL
		Temperature Capabilities		
		-29 to 93°C (-20 to 200°F)	-23 to 149°C (-10 to 300°F)	-45 to 82°C (-50 to 180°F)
		O-Ring Materials		
		Nitrile	Fluoroelastomer	Nitrile <sup>(1)</sup>
6*	Cage O-Ring	12B3522X012	12B3522X022	12B3522X042
11*	Bonnet O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
18*	Casing O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
19*	Stem O-Ring	1K7561X0012	1K756106382	1K7561X0022
28*	Actuator O-Ring	1K7561X0012	1K756106382	1K7561X0022
49* <sup>(2)</sup>	Actuator Stem O-Ring	1C7812X0012	1C7821X0012	1C782106992
		Bushing Materials		
		Nylon	Ryton	Nylon
20*	Bonnet Bushing	17A7112X012	17A7112X032	17A7112X012

1. Low-temperature material.  
2. For fail-up configuration.





# 357 Series

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# Type 128-PQC Control Valves

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## Introduction

### Scope of Manual

This manual provides installation, maintenance, and parts information for the Type 128-PQC control valve. Instructions and parts lists for Fisher pneumatic instrumentation and other equipment used with this control valve are found in separate manuals.

Only personnel qualified through training or experience should install, operate, or maintain the Type 128-PQC control valve. If you have any questions concerning the instructions in this manual, please contact your Fisher sales office before proceeding.

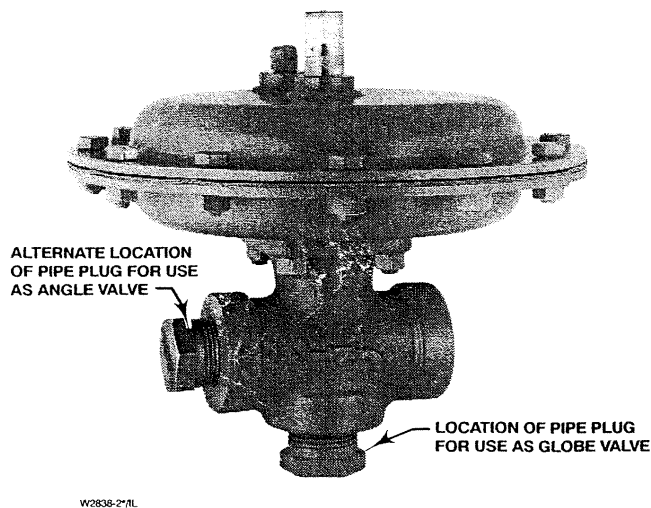


Figure 1. Type 128-PQC Control Valve

## Description

The Type 128-PQC control valve provides on-off dump valve service for such oil production applications as separators, scrubbers, and treaters, even under sour gas conditions. It also may be used in general on-off high-pressure control of a wide variety of liquids and gases, including those which are sticky or gritty and erosive. The Type 128-PQC valve is a 1-inch combination control valve with a pipe plug in the bottom connection for straight-through globe valve flow as shown in figure 1. However, the pipe plug may be field-changed to the left-hand end connection as shown in figure 3 for angle flow.

## Specifications

Table 1 lists specifications for the Type 128-PQC control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate, shown in figure 2, located on the upper diaphragm casing flange.





# Type 128-PQC

Table J. Specifications

## Available Configurations

**Type 128 Actuator:** Yokeless, on-off spring-and-diaphragm actuator with action field-reversible between

- spring-open and
- spring-close

**Design PQC Valve:** See table 2

## Valve Sizes and End Connection Styles

See table 2

## Maximum Inlet Pressures and Temperatures<sup>(1)</sup>

248 bar from -29 to 38°C, 245 bar at 66°C, and 243 bar at 82°C (3600 psig from -20 to 100°F, 3550 psig at 150°F, and 3520 psig at 180°F)

## Maximum Pressure Drops<sup>(1)</sup>

See table 3

## Actuator Input Signal

- 0 or 1.4 bar (0 or 20 psig) or
- 0 or 2.4 bar (0 or 35 psig)

## Maximum Actuator Casing Pressure

6.9 bar (100 psig)

## Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

- Metal Seats:** ANSI Class IV
- Soft Seats:** ANSI Class VI

## Material Temperature Capabilities<sup>(1)</sup>

**Metal Seat:** -29 to 82°C (-20 to 180°F)

**Soft Seat:** -29 to 66°C (-20 to 150°F)

**LCC Valve Body:** -46 to 82°C (-50 to 180°F)

## Flow Characteristic

Quick-opening with 45-degree taper valve plug

## Flow Direction

Either way

## Port Diameters

See table 2

## Maximum Travel

10 mm (3/8-inch)

## Actuator Diaphragm Effective Area

213 cm<sup>2</sup> (33 inches<sup>2</sup>)

## Actuator Pressure Connections

1/4 inch NPT female

## Valve Travel Indication

Scale divisions for each 25% of travel are provided on the plastic travel indicator cover

## Approximate Weight

7.7 kg (17 lb)

1. The pressure and temperature limitations in this manual, and any applicable code limitation, should not be exceeded.

Table 2. End Connections and Port Diameters

DESIGN		PQC	
VALVE STYLE		Combination globe and angle valve body; common end and bottom connections and pipe plug allow conversion between globe and angle styles	
END CONNECTIONS <sup>(1)</sup>		1 inch NPT female	
SEATING		Metal	Soft
PORT DIAMETERS	mm	6.4, 9.5, 12.7	19.1 <sup>(2)</sup>
	Inch	1/4, 3/8, 1/2	3/4 <sup>(2)</sup>
C <sub>v</sub> AT MAX TRAVEL FOR LARGEST PORT WITH FLOW TENDING TO CLOSE VALVE		8.32 (angle-style valve body)	
<p>1. End connection threaded to various national or international thread standards can usually be supplied. Contact your Fisher sales office.                  2. Cageless construction with seat cut into valve body for soft seat only.</p>			

# Type 128-PQC

Table 3. Maximum Allowable Shutoff Pressure Drops

SEATING	ACTUATOR ACTION	FLOWING PRESSURE DROP TENDS TO:	PORT DIAMETER		CADMIUM COLORED MAIN SPRING 14A8831X012				RED MAIN SPRING 14A9077X012			
					0 or 1.4 Bar (0 to 20 Psig) Actuator Input Signal (2 Springs Required)		0 or 2.4 Bar (0 to 35 Psig) Actuator Input Signal (4 Springs Required)		0 or 1.4 Bar (0 to 20 Psig) Actuator Input Signal (2 Springs Required)		0 or 2.4 Bar (0 to 35 Psig) Actuator Input Signal (4 Springs Required)	
			mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
			Metal	Spring closes valve	Open valve	6.4	1/4	104	1510	232	3370	233
9.5	3/8	36				520	92	1340	92	1340	215	3120
12.7	1/2	15				220	47	690	48	700	118	1720
19.1	3/4	2.1				30	16	240	16	240	49	710
Close valve	6.4	1/4		65	940	128	1860	94	1370	201	2920	
	9.5	3/8		78	1130	169	2450	106	1540	227	3300	
	12.7	1/2		92	1330	201	2920	118	1710	248	3600	
	19.1	3/4		140	2030	248	3600	160	2320	248	3600	
Spring opens valve	Close valve	6.4	1/4	12	170	24	350	Valve will not shut off with this combination of spring and application				
		9.5	3/8	36	530	42	610					
		12.7	1/2	37	540	79	1150					
		19.1	3/4	96	1400	200	2910					
Soft	Spring closes valve	Open valve	6.4	1/4	69	1000	69	1000	69	1000	69	1000
			9.5	3/8	49	710	69	1000	69	1000	69	1000
			12.7	1/2	28	400	57	830	57	830	69	1000
			19.1	3/4	11	160	24	350	25	360	54	790
	Close valve	6.4	1/4	65	940	69	1000	69	1000	69	1000	
		9.5	3/8	69	1000	69	1000	69	1000	69	1000	
		12.7	1/2	69	1000	69	1000	69	1000	69	1000	
		19.1	3/4	69	1000	69	1000	69	1000	69	1000	
	Spring opens valve	Close valve	6.4	1/4	39	560	45	660	Valve will not shut off with this combination of spring and application			
			9.5	3/8	33	480	66	960				
			12.7	1/2	37	540	69	1000				
			19.1	3/4	69	1000	69	1000				

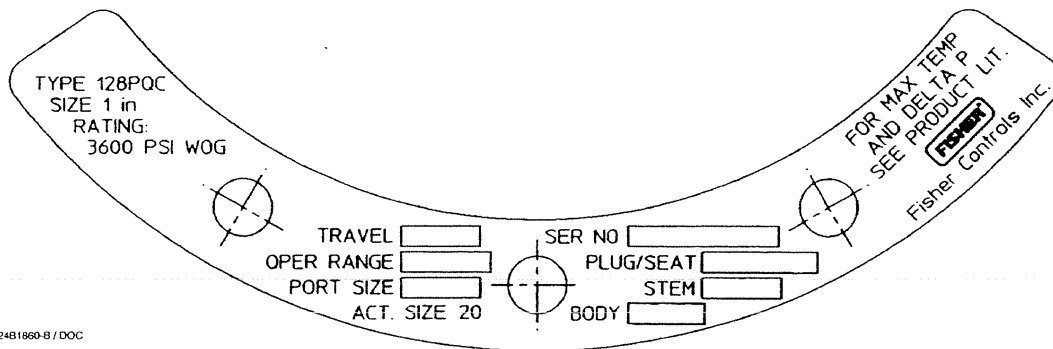


Figure 2. Typical Nameplate

## Installation

### **WARNING**

To avoid personal injury or property damage resulting from the sudden release of pressure, do not install the valve assembly where service conditions could exceed the limits given in this manual or on the appropriate nameplates. The leakoff and spring case vents must be kept open. Avoid danger

of fire or explosion from venting of flammable or otherwise hazardous fluid into a closed or poorly vented location by providing adequate ventilation.

1. Before installing the valve, inspect the valve body and associated equipment for any damage and for any foreign material.
2. The control valve may be installed in any orientation. However, the normal method is with the actuator above the valve, especially for an angle configuration.

# Type 128-PQC

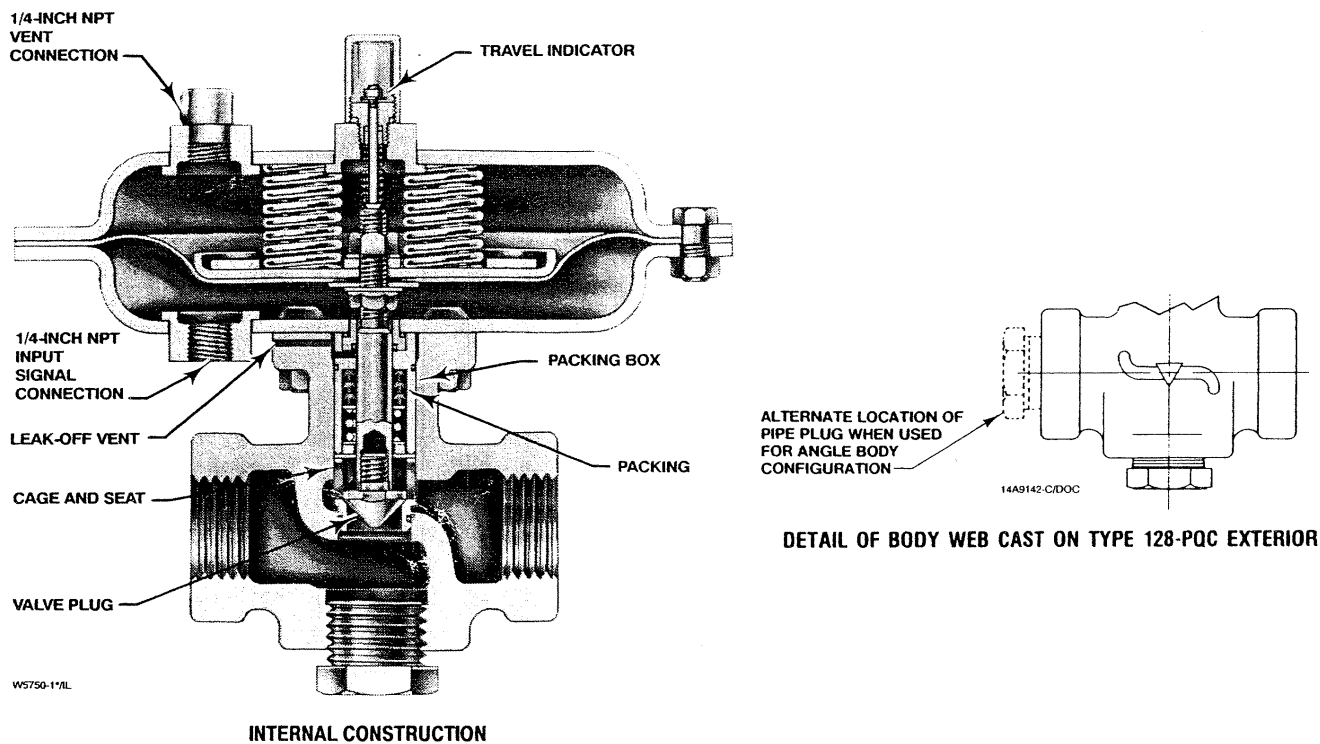


Figure 3. Type 128-PQC Control Valve with Spring-Close Action

3. Make sure that the valve is oriented so that flow is in the desired direction. If angle flow is desired, switch the pipe plug to the left-hand end connection as shown in figure 3.
4. Install the valve following local and national piping codes when they apply to the application. Use a good grade pipe compound on all male threads. If continuous operation is required during inspection and maintenance, install a three-valve bypass around the control valve.
5. Refer to figure 3. Connect the input signal line to the 1/4-inch NPT connection in the lower diaphragm casing of a spring-close control valve or in the upper diaphragm casing of a spring-open control valve.

## Principle of Operation

The Type 128-PQC control valve has push-down-to-close valve plug action, as shown in figure 3. With a metal seat, the valve uses a caged construction and the valve plug shuts off against the integral seat ring in the cage. In the cageless soft-seat construction, the valve plug shuts off against the seat cut into the web of the valve body.

A nylon insert in the valve plug thread is used to help keep the valve plug from rotating.

A leakoff vent passes through the packing box and out the valve body. This permits any process leakage through the packing to escape before passing along the stem into the actuator. It also permits loading pressure leakage from the lower diaphragm case to escape before passing along the stem into the valve body.

## Maintenance

### WARNING

**Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:**

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve

from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.

- Vent the actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, even when the valve has been removed from the pipeline. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing and trim maintenance, changing the main spring range, reversing the action, and replacing actuator parts.

Because of the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher.

All maintenance operations can be performed with the valve in the line.

## Replacing Packing and Trim

Perform these procedures either when using a complete replacement packing and trim assembly or when replacing individual packing and trim parts. Replacement packing and trim assembly part numbers are listed in the *Parts List*. Packing and trim assembly key numbers are referenced in figure 5. Control valve assembly key numbers are shown in figure 7 for the valve body and in figure 8 for the actuator except where indicated. Most packing and trim assembly key numbers are duplicated in both figure 5 and figure 7.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut-off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

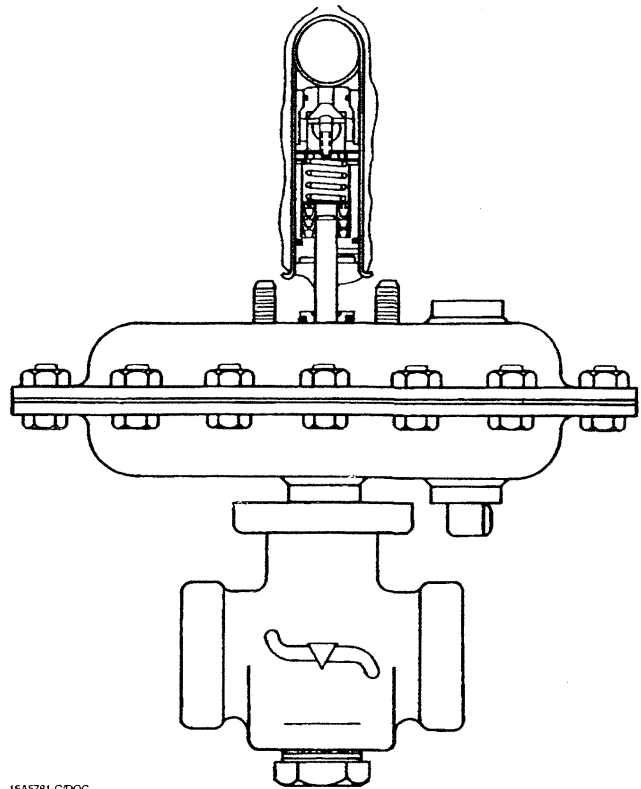


Figure 4. Installing Replacement Packing and Trim Assembly on Valve Stem

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve.

2. Remove the four nuts (key 14) from the integral screws of the lower diaphragm casing. Disconnect the input signal line, and lift the actuator and attached trim parts out of the valve body. Cleaning or other necessary maintenance may be performed on any accessible areas. The actuator and attached trim parts may be turned over and the valve body used to hold them as an aid in further maintenance.
3. To disassemble trim and gain access to packing parts or seal O-rings, unscrew the valve plug (key 3A) and remove the packing box washer (key 4).
4. Pull the packing box (key 9), O-ring retainer (key 39), O-ring (key 11), and diaphragm casing O-ring (key 35) off the stem.
5. Install the packing and trim assembly or individual parts over the stem as shown in figure 4. With a packing and trim assembly, remove the assembly from the tube (key 42), but do not remove the web sleeve (key 43) from the assembly. The sleeve helps to keep the assembly parts in place during installation; roll

# Type 128-PQC

back the sleeve as necessary during installation of the assembly.

If installing nitrile/cotton packing, lubricate the packing rings (key 8) with Dow-Corning No. 3 silicon-base lubricant or equivalent.

6. If installing a packing and trim assembly, continue pushing the assembly onto the stem until the stem pushes the valve plug and cage (key 2) away from the packing box washer (key 4). Roll the sleeve back just past the packing box (key 9).

7. Push the packing box all the way onto the stem until the packing box, the O-ring (key 11), the O-ring retainer (key 39), and the diaphragm casing O-ring (key 35) are sealed against the diaphragm casing. Make sure the O-rings are positioned properly so that they will not be cut when the other parts are compressed against them. Then, push the packing spring washer (key 6), packing spring (key 7), other packing spring washer, wiper ring, and packing box washer (key 4) down on the stem.

8. If installing a packing and trim assembly, remove the sleeve, cage puller (key 44, if included in the assembly), cage, and spring clip (key 38, if included in the assembly) from the valve plug.

9. Install the valve plug into the stem.

## Note

**Rotate the valve plug until the shoulder on the plug contacts the stem snugly. Further tightening is not needed.**

To replace the cage (if used) or to gain access to the O-ring (key 12), use the cage puller (key 44) or a wire hook to remove the cage from the valve body (key 1). Then, install replacement parts as necessary.

## CAUTION

**Use care performing the installation in the next step to avoid damaging the O-ring.**

10. Install the actuator and attached trim parts back into the valve body (key 1), and secure with the four nuts (key 14) attached to the lower diaphragm casing assembly screws. Tighten the nuts to 20 N•m (15 lbf•ft).

11. Connect the input signal line to the 1/4-inch NPT connection of the appropriate diaphragm casing.

## Changing Main Spring Range

Key numbers used in this procedure are shown in figure 8 unless otherwise indicated.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut-off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve. Unscrew the handles or pipe plugs and remove the indicator cover (key 41 in figure 9). Drive out the groove pin (key 50 in figure 9) and remove the stem nut and thrust washer (keys 49 and 51 in figure 9).

2. Disconnect the input signal line, if necessary, and remove the diaphragm casing nuts (key 14), cap screws (key 21), and upper diaphragm casing (key 20).

3. With spring-close action, remove the existing main springs (key 19) and install replacement springs of the correct quantity and description as listed in table 3. Make sure that the springs rest in the spring plate holes and will not ride on the upper diaphragm casing vent boss.

## Note

**Do not loosen the stem nut (key 14). Disturbing its position in the following step may keep the valve either from shutting off or from opening completely at the correct input signal pressure, thus requiring complete reassembly of the stem and diaphragm assembly.**

4. With spring-open action, remove the locknut (key 46), flat washer (key 15), diaphragm (key 16), diaphragm plate (key 17), spring plate (key 18), and main springs (key 19). Install replacement springs of the correct quantity and description as listed in table 3. Re-install the removed parts (keys 18, 17, 16, 15, and 46) so that the lower ends of the main springs rest over the weld stud heads of the lower diaphragm casing and the spring plate holes fit over the upper ends of the springs. Tighten the locknut (key 46) to 20 N•m (12 lbf•ft).

5. Install the upper diaphragm casing cap screws and casing nuts. To avoid crushing the diaphragm, tighten the cap screws and nuts evenly in a crisscross pattern to 20 N•m (15 lbf•ft).

6. Connect the input signal line to the 1/4-inch NPT connection of the upper diaphragm casing.
7. If an optional handjack is used, reinstall the handjack parts. Be sure to secure the stem nut (key 49 in figure 9) with the groove pin (key 50 in figure 9).

## Reversing Action or Replacing Actuator Parts

Key numbers used in this procedure are shown in figure 8 unless otherwise indicated.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve. Unscrew the handles or pipe plugs and remove the indicator cover (key 41 in figure 9). Drive out the groove pin (key 50 in figure 9) and remove the stem nut and thrust washer (keys 49 and 51 in figure 9).

The optional handjack is used only with spring-close valves. If changing the action of a spring-close valve with a handjack to spring-open action, the only function the handjack performs is to restrict the valve from closing.

2. Disconnect the input signal line and remove the diaphragm casing nuts (key 14), cap screws (key 21), and upper diaphragm casing (key 20).
3. Remove the main springs (key 19), stem nut (key 14), locknut (key 46), lock washer (key 29), spring plate (key 18), diaphragm plate (key 17), diaphragm (key 16), and flat washer (key 15).
4. Remove the four nuts (key 14) from the integral screws of the lower diaphragm casing. Lift the casing and attached trim parts off of the valve body.
5. Unscrew the valve plug (key 3A) and remove the packing box washer (key 4).
6. Pull the packing box (key 9), O-ring retainer (key 39), O-ring (key 11), and diaphragm casing O-ring (key 35) off the stem.
7. Remove the stem (key 3B), and replace it, the bottom stem nut (key 14), or the locknut (key 46) as necessary.

8. When reinstalling the stem nut (key 14) or locknut (key 46), make sure the distance between the bottom shoulder of the nut and the plug end of the stem is equal to dimension A in figure 6.
9. Begin the following procedure as appropriate, depending on whether the desired control valve action is spring-close or spring-open.

**For spring-close action**, install the flat washer (key 15), diaphragm (key 16), diaphragm plate (key 17), spring plate (key 18), lock washer (key 29), and stem nut (key 14). Tighten the stem nut to 16 N•m (12 lbf•ft).

**For spring-open action**, install the lock washer (key 29), spring plate (key 18), diaphragm plate (key 17), diaphragm (key 16), flat washer (key 15), and locknut (key 46). Tighten the locknut to 16 N•m (12 lbf•ft).

10. For spring-open action only, install the main springs (key 19) into the lower diaphragm casing so that the lower ends of the springs rest over the weld stud heads of the lower diaphragm casing.
11. Install the stem and diaphragm assembly into the lower diaphragm casing. For spring-open action, make sure that the assembly is oriented so that the spring plate holes fit over the upper ends of the springs.
12. Secure the stem by installing the packing and trim parts according to steps 5 through 9 of the *Replacing Packing and Trim* section.
13. If reversing action from what it was previously, remove the vent assembly (key 31), and install it in the 1/4-inch NPT connection of the lower diaphragm casing for spring-open action or the upper diaphragm casing for spring-close action.
14. For spring-close action only, install the main springs, making sure they rest in the spring plate holes and will not ride on the upper diaphragm casing vent boss.
15. Install the upper diaphragm casing, cap screws, and casing nuts. To avoid crushing the diaphragm, tighten the cap screws and nuts evenly in a crisscross pattern to 20 N•m (15 lbf•ft).
16. Install the actuator and attached trim parts back into the valve body (key 1), and secure with the four nuts (key 14) attached to the lower diaphragm casing assembly screws. Tighten the nuts to 20 N•m (15 lbf•ft).
17. Connect the input signal line to the 1/4-inch NPT connection of the appropriate diaphragm casing.
18. If an optional handjack is used, reinstall the handjack parts. Be sure to secure the stem nut (key 49 in figure 9) with the groove pin (key 50 in figure 9).

# Type 128-PQC

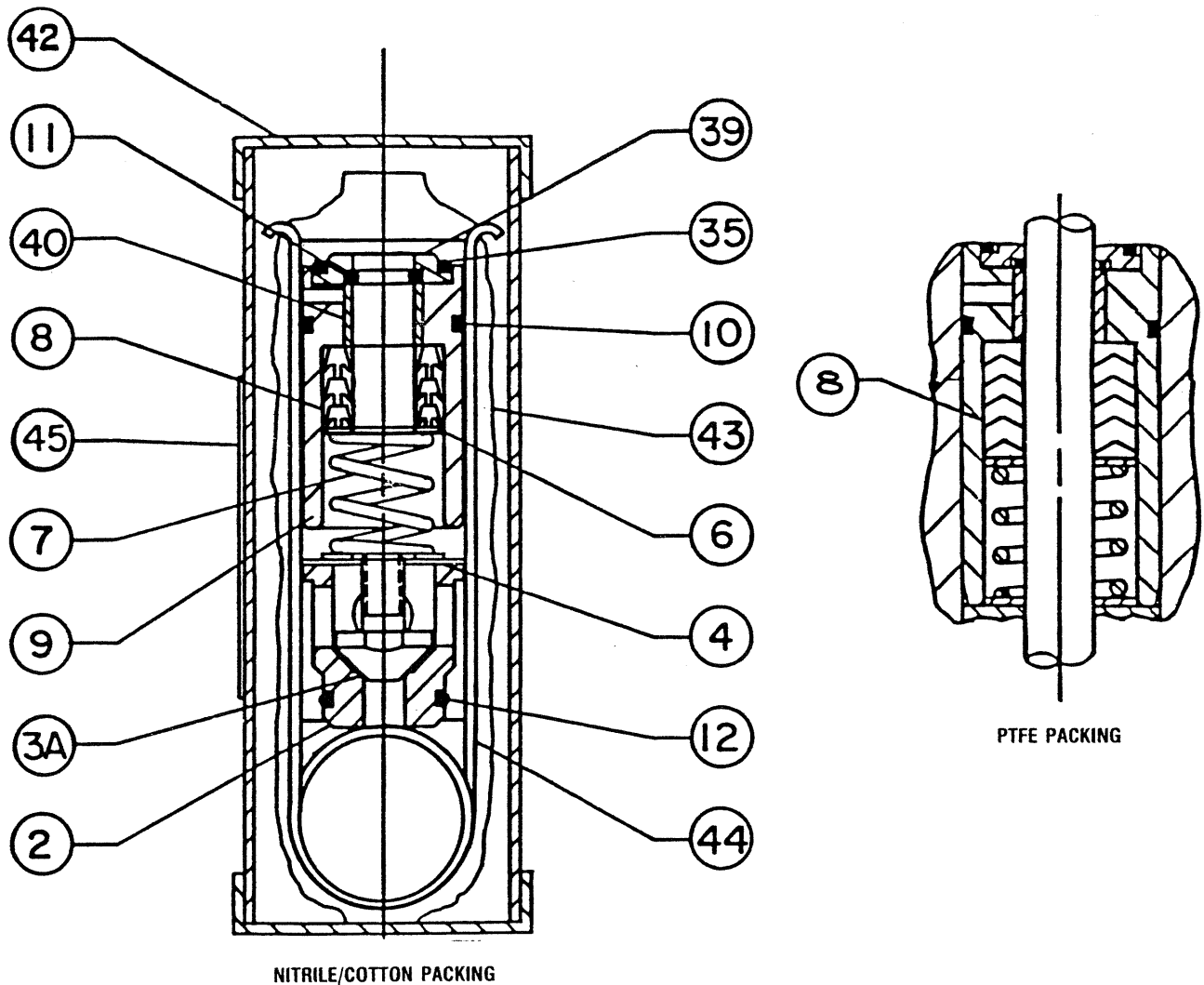


Figure 5. Replacement Packing and Trim Assemblies for Metal-Seated Construction

## Parts Ordering

The Type 128-PQC control valve is assigned a serial number which can be found on the nameplate. A typical nameplate is shown in figure 2. Refer to the serial number when contacting your Fisher sales office for assistance. When ordering replacement parts, refer to the serial number and to the 11-character part number from the following *Parts List*.

## Parts Kits

Key	Description	Part Number
	Type 128-PQC Repair Kits (soft parts only). Kit includes key 5, 8, 10, 11, 12, and 35)	RPQCX000012
	w/ PTFE V-ring packing	RPQCX000022
	w/ Nitrile/cotton packing	

For additional kit information, see the Replacement Packing and Trim Assembly Part Number table.

## Key Description

## Part Number

## Parts List

### Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number
	Travel Indicator Assembly	
1	Valve Body	
2*	Cage	
	440C stainless steel, heat-treated <sup>(1,2)</sup>	
	1/4 inch port	14A8823X022
	3/8 inch port	14A8805X022
	1/2 inch port	14A7157X022
	Nitronic 50 <sup>(1)</sup> stainless steel	
	1/4 inch port	14A8823X032
	3/8 inch port	14A8805X032

\*Recommended spare parts

1. May also be ordered from the Replacement Packing and Trim Assembly Part Numbers table.

2. May also be ordered as part of the cage/plug/stem assembly (key 52).

# Type 128-PQC

Key	Description	Part Number
2*	Cage (continued)	
	1/2 inch port	14A7157X032
	Carbide seating surface <sup>(1,2)</sup>	
	1/4 inch port	15A6800X012
	3/8 inch port	15A6801X012
3A*	Valve Plug	
	Metal Seat,	
	1/4 & 3/8 inch ports	
	440C stainless steel, heat treated <sup>(1)</sup>	16A2087X012
	Nitronic 50 stainless steel <sup>(1)</sup>	16A2087X022
	Carbide seating surface <sup>(2)</sup>	15A6804X012
	1/2 inch (12.7 mm) port	
	440C stainless steel, heat-treated <sup>(1)</sup>	14A6618X012
	Nitronic 50 stainless steel <sup>(1)</sup>	14A6618X022
	Soft Seat	
	3/4 inch port	
	Austenitic stainless steel/nitrile	15A3197X022
	Austenitic stainless steel/polyethylene	15A3197X012
3B*	Stem, 316 stainless steel <sup>(2)</sup>	
	w/o handjack	14A8806X012
	w/handjack	26A1765X012
4	Packing Box Washer <sup>(1)</sup>	
6	Washer <sup>(1)</sup>	
7	Packing Spring <sup>(1)</sup>	
8*	Packing Set, PTFE V-Ring <sup>(1)</sup>	10B7279X012
8*	Packing Ring, nitrile/cotton (6 req'd)	14A9057X012
9	Packing Box <sup>(1)</sup>	
10*	O-Ring, fluoroelastomer <sup>(1)</sup>	1U841806382
11*	O-Ring, nitrile <sup>(1)</sup>	1P420706992
12*	O-Ring, fluoroelastomer <sup>(1)</sup>	11A8741X012
13	Lower Diaphragm Casing	
14	Hex Nut	
15	Flat Washer	
16*	Diaphragm, neoprene w/nitrile insert	14A8813X012
17	Diaphragm Plate	
18	Spring Plate	
19	Main Spring, pl steel	See table 3
20	Upper Diaphragm Casing	
21	Cap Screw	

### Note

Key numbers 22 through 27 are not req'd with a handjack. These parts are also included in the stem travel assembly, part number 35A1588X0A2, but are omitted when a handjack is used.

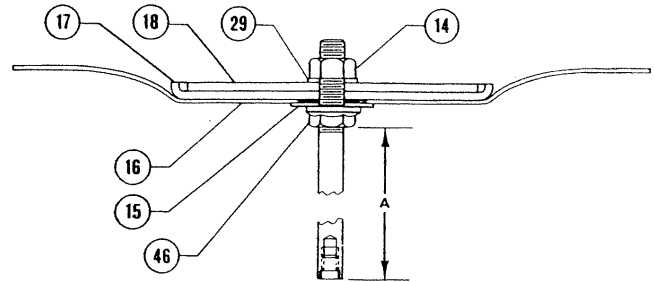
22	Travel Indicator Disk Nut	
23	Indicator Fitting	
24	Indicator Bushing	
25*	O-Ring, nitrile	1H292606992
26	Machine Screw	
27	Spring	
28	Pipe Plug	
29	Lock Washer	
31	Vent Assembly	
35*	Diaphragm Casing O-ring	13A1584X012
39*	O-Ring Retainer, polyethylene	14A9053X012
40*	Bushing, PTFE (used with metal seat only)	10B7431X012
41	Indicator Cover	
42	Paper Tube <sup>(1)</sup>	
43	Web Sleeve <sup>(1)</sup>	
44	Cage Puller <sup>(1)</sup>	
45	Paper Label <sup>(1)</sup>	
46	Locknut	

\*Recommended spare parts

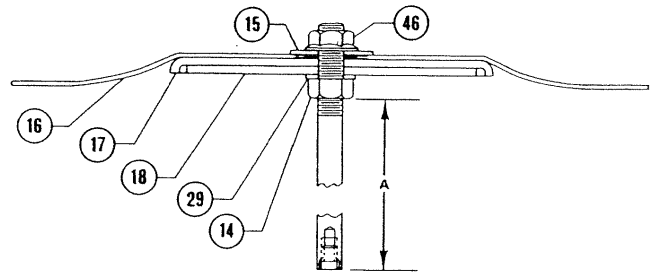
1. May also be ordered from the Replacement Packing and Trim Assembly Part Numbers table.

2. May also be ordered as part of the cage/plug/stem assembly (key 52).

DIMENSION A			
mm		Inches	
Spring-Close Assembly	Spring-Open Assembly	Spring-Close Assembly	Spring-Open Assembly
62.5	69.1	2.46	2.72



SPRING-CLOSE ASSEMBLY



SPRING-OPEN ASSEMBLY

34A8839-G  
34A8838-G  
A2223-2RL

Figure 6. Stem and Diaphragm Assembly Dimensions

Key	Description	Part Number
-----	-------------	-------------

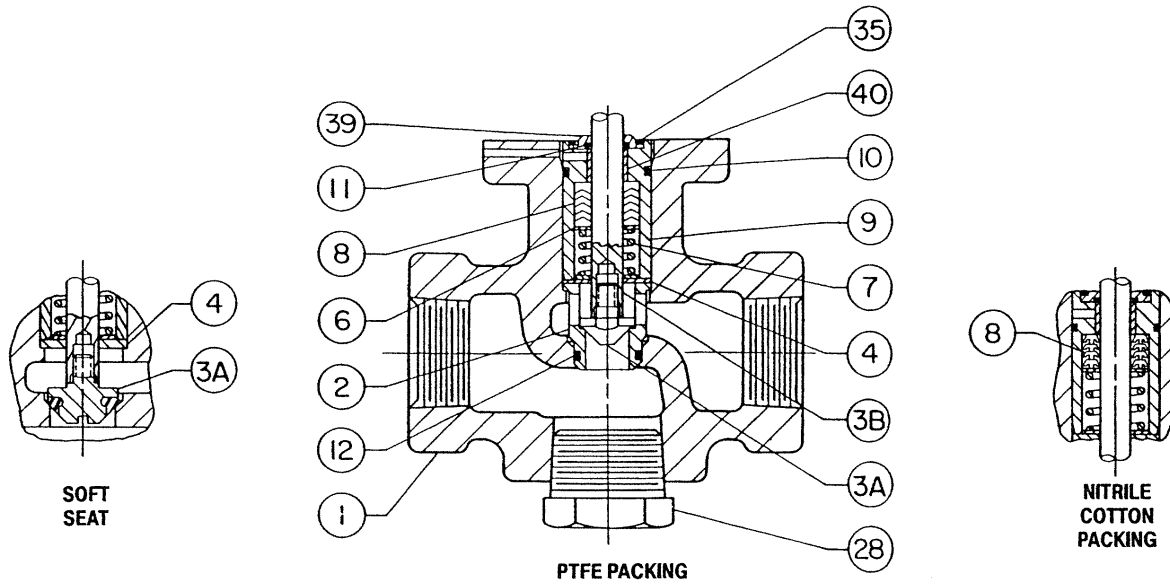
### Note

Key numbers 47 through 51 are handjack parts.

47	Handjack Body	
48	Pipe Plug or Handle	
49	Stem Nut	
50	Groove Pin	
51	Thrust Washer	
52*	Cage/Plug/Stem Assembly, austenitic stainless steel w/carbide seating surface (not shown) (includes keys 2, 3A, and 3B)	
	w/o handjack	
	1/4 inch port	16A4601X012
	3/8 inch port	16A4601X032
	w/handjack	
	1/4 inch port	16A4601X022
	3/8 inch port	16A4601X042
54	Nameplate	



# Type 128-PQC

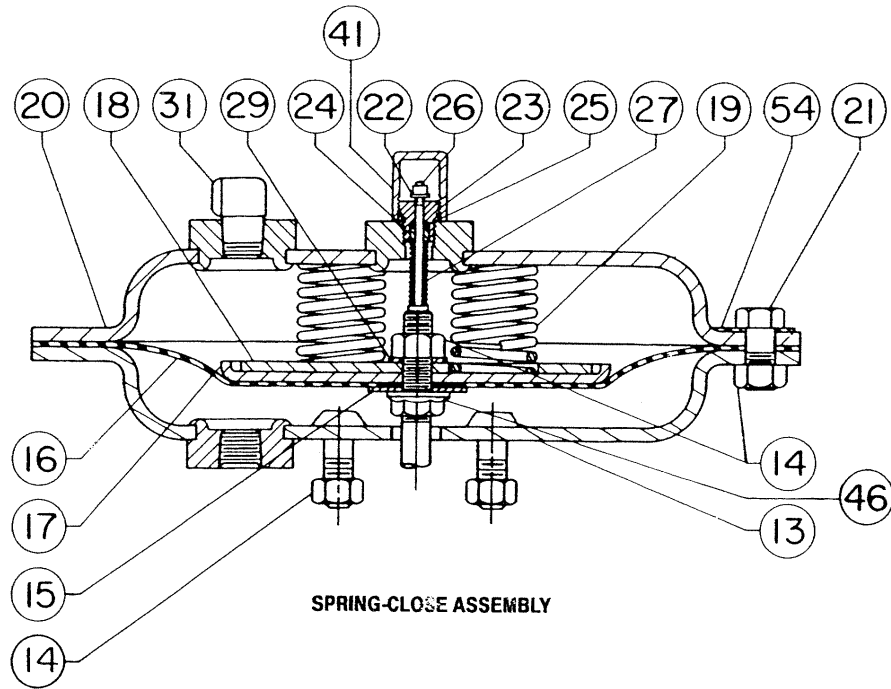


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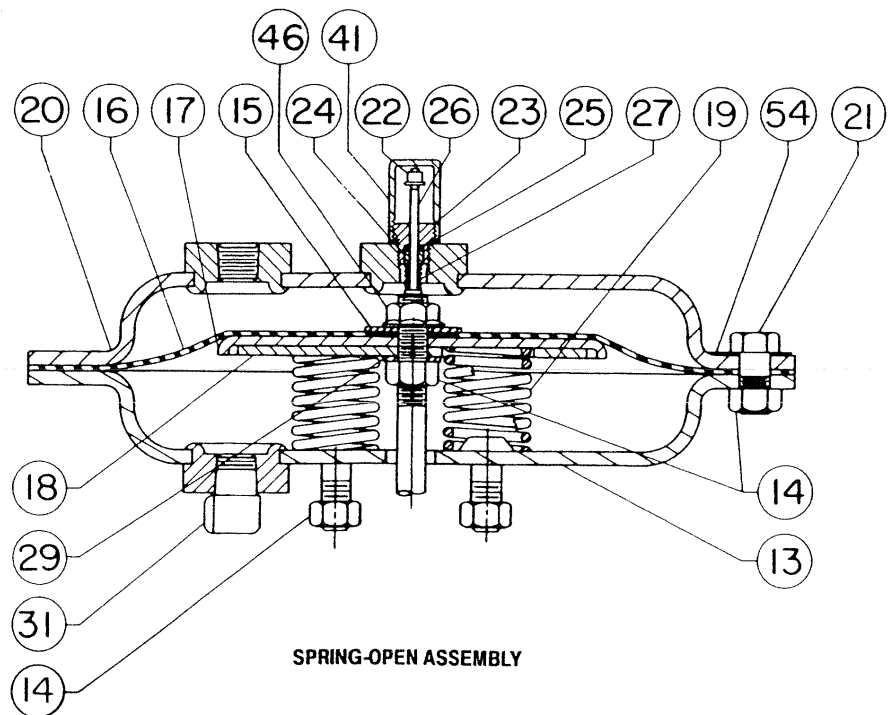
Figure 7. Design PQC Valve Body Assembly

### Replacement Packing and Trim Assembly Part Numbers

PORT DIAMETER		TFE V-RING PACKING, HEAT-TREATED 440C STAINLESS STEEL VALVE PLUG AND CAGE AND 17-7 PH STAINLESS STEEL PACKING SPRING	TFE V-RING PACKING, NITRONIC 50 STAINLESS STEEL VALVE PLUG AND CAGE AND INCONEL X750 PACKING SPRING
mm	Inches		
6.4	1/4	10B7899X012	10B7899X042
9.5	3/8	10B7899X022	10B7899X052
12.7	1/2	10B7899X032	10B7899X062
10.1	3/4	---	---



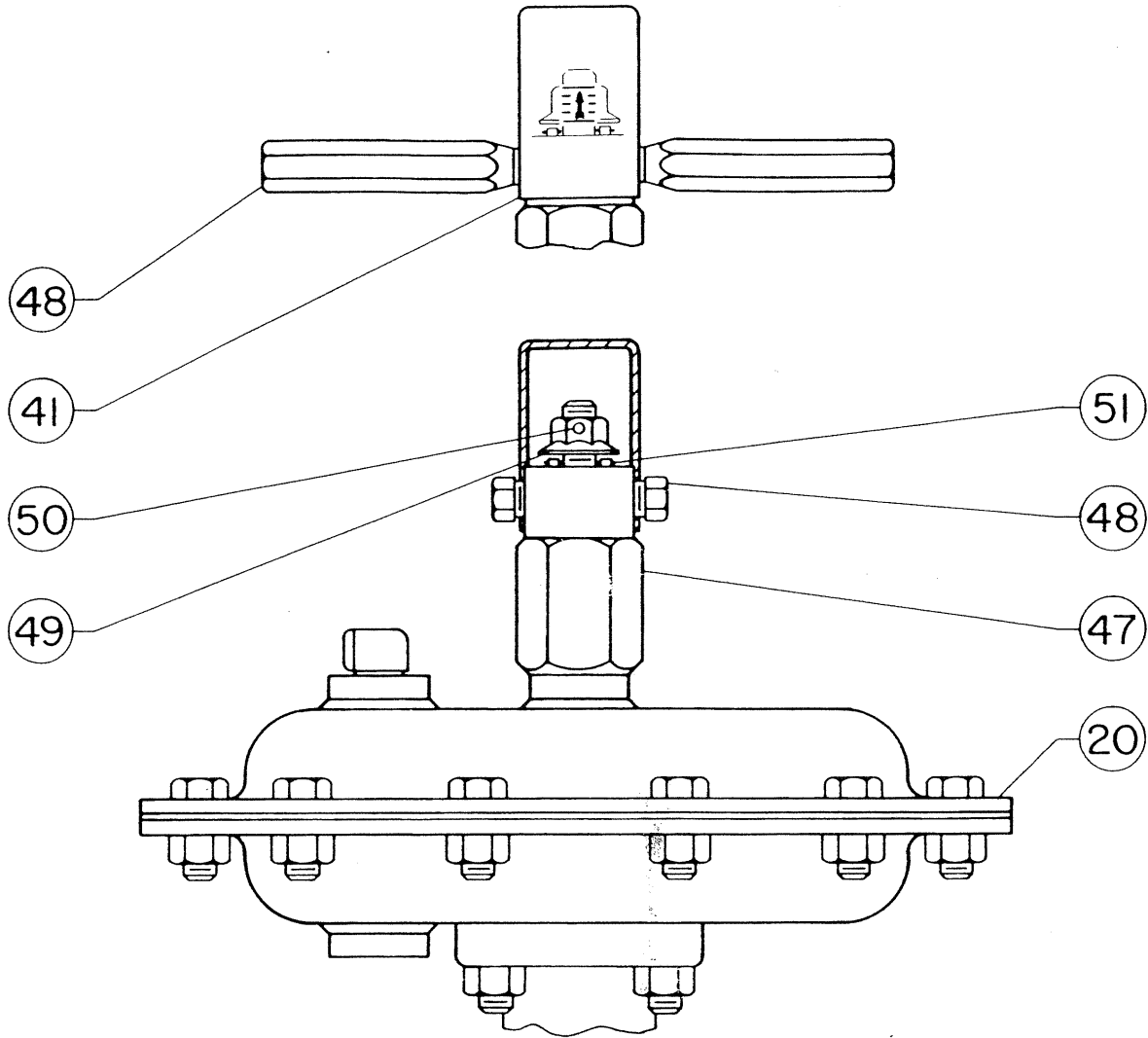
29A0341-A/DOC



29A0343-A/DOC

Figure 8. Type 128 Actuator

# Type 128-PQC



36A1772-A/DOC

Figure 9. Optional Handjack Assembly

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Marshalltown, Iowa 50158 USA  
Cernay 68700 France  
Sao Paulo 05424 Brazil  
Singapore 128461



PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 1		
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE CONTROL VALVES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11	
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468	
								DATE	03/11/2005	
								REQ.		
				BY	CHK'D	APPR.				
G 1	TAG NO.	PCV-631		PCV-630		PCV-680				
E 2	SERVICE	T-630 TO FLARE		T-630 TO RECYCLE		AC-620 BACK PRESSURE				
N 3	LINE NO. / VESSEL NO.	T-630		T-630		AC-620				
E 4	LINE SIZE / SCHED. NO.	33MM SCH.80		60MM SCH 40		48MM SCH.80				
5	TYPE OF BODY	GLOBE		GLOBE		GLOBE				
6	BODY SIZE	PORT SIZE	33 mm	19.0 mm	48 mm	47.6 mm	48 mm	47.6 mm	mm	mm
7	GUIDING	NO. OF PORTS	STD	ONE (1)	STD	ONE(1)	STD	ONE(1)		
B 8	END CONN. & RATING	33 NPT		48 NPT		48 NPT				
O 9	BODY MATERIAL	CS		CS		CS				
D 10	PACKING MATERIAL	STD		STD		STD				
Y 11	LUBRICATOR	ISOLAT. VALVE								
12	BONNET TYPE	STD BONNET		STD BONNET		STD BONNET				
13	TRIM FORM	MICROFORM		EQUAL PERCENTAGE		EQUAL PERCENTAGE				
14	TRIM MATERIAL	SEAT / PLUG	STD	STD	STD	STD	STD	STD		
		SHAFT / MAT'L	STD	STD	STD	STD	STD	STD		
15	REQUIRED SEAT TIGHTNESS									
16	MAX. ALLOW SOUND LEV. dBA									
A 17	MODEL NO. & SIZE	657-30		667-34		667-34				
C 18	TYPE OF ACTUATOR	DIAPHRAGM		DIAPHRAGM		DIAPHRAGM				
T 19	CLOSE AT	OPEN AT	20 kPa	100 kPa	20 kPa	100 kPa	20 kPa	100 kPa	kPa	kPa
U 20	FLOW ACTION TO	OPEN		OPEN		OPEN				
A 21	FAIL POSITION	OPEN		CLOSE		CLOSE				
T 22	HANDWHEEL & LOCATION									
P 23	MFR. & MODEL NO.	3582		3582						
O 24	FILT REG   GAGES   BYPASS	YES	YES	NO	YES	YES	NO			
S 25	INPUT SIGNAL	20-60		60-100						
I 26	OUTPUT SIGNAL	20-100		100-20						
T 27	AIR SUPPLY PRESS	kPa		kPa		kPa		kPa		
T 28	MFR. & MODEL NO.									
R 29	INPUT SIGNAL									
N 30	OUTPUT SIGNAL									
O 31										
P 32										
T 33										
34	FLOW UNITS	KG/HR		KG/HR		KG/HR				
35	FLUID	H.C. GAS		H.C. GAS		PROPANE				
36	QUANT. MAX.	MAX. Cg								
S 37	QUANT. OPER.	OPER Cg	728	74.1	728	318	3103	Cvr=13.63		
E 38	VALVE Cg	VALVE FL	390		1180		Cv=35.8			
R 39	NORM IN PRES	NORM DELTA P	1970 kPa(g)	1930 kPa	1970 kPa(g)	35 kPa	1379 kPa(g)	15 kPa	kPa(g)	kPa
V 40	MAX. INLET PRESS.		3792 kPa	3792 kPa	3792 kPa	1724 kPa	1724 kPa	1724 kPa	kPa	kPa
I 41	MAX. SHUT OFF	MAX. DELTA P	3792 kPa(g)	3792 kPa	3792 kPa(g)	3792 kPa	1724 kPa(g)	1724 kPa	kPa(g)	kPa
C 42	TEMP. MAX.	OPER. TEMP	93 ° C	3.7 ° C	93 ° C	3.7 ° C	93 ° C	43 ° C	° C	° C
E 43	OPER. SP. GR.	MOL. WT.		24.7		24.7	0.463			
44	OPER. VISC.	% FLASH								
45	% SUPERHEAT	% SOLIDS								
46	VAPOR PRESS	CRIT PRESS	kPa(a)	kPa(a)	kPa(a)	kPa(a)	1475 kPa(a)	4266 kPa(a)	kPa(a)	kPa(a)
47	PREDICTED SOUND LEVEL dBA									
48	MANUFACTURER	FISHER		FISHER		FISHER				
49	MODEL NO.	657-D-30		667-ET-34		667-ET-34				
50	P. O. NUMBER									

NOTES:

AREA. UNIT # :

# Type 667 Diaphragm Actuator Sizes 30-76 and 87

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Figure 1. Type 667 or 667-4 Actuator Mounted  
on *easy-e*<sup>®</sup> Valve

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# Type 667 Size 30-76 & 87

Table 1. Specifications

SPECIFICATION <sup>(1)</sup>		ACTUATOR SIZE										
		30	34	40	45	46	50	60	70 <sup>(1)</sup>	76	87 <sup>(1)</sup>	
Nominal Effective Area	Sq Inch	46	69	69	105	156	105	156	220	156	220	
	Sq cm	297	445	445	667	1006	677	1006	1419	1006	1419	
Yoke Boss Diameter	Inch	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	3-9/16	5	
	mm	54	54	71	71	71	90	90	90	90	125	
Acceptable Valve Stem Diameter	Inch	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	3/4	1	
	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	19.1	25.4	
Maximum Allowable Output Thrust <sup>(4)</sup>	LB	2300	2300	2700	5650	7550	5650	6800	8800	6800	8800	
	N	10,230	10,230	12,010	25,131	33,582	25,131	30,246	39,142	30,246	39,142	
Maximum Travel <sup>(2)</sup>	Standard	Inch	3/4	1-1/8	1-1/2	2	2	2	2	3 <sup>(3)</sup>	2	3 <sup>(3)</sup>
	Standard	mm	19	29	38	51	51	51	51	76 <sup>(3)</sup>	51	76 <sup>(3)</sup>
	Top-Loaded	Inch	---	3/4	---	3/4	---	---	1-1/8	---	1-1/8	3
	Top-Loaded	mm	---	19	---	19	---	---	29	---	29	76
Maximum Casing Pressure for Actuator Sizing <sup>(4,6)</sup>	Psig	55	70	70	65	55	65	55	50	50	50	
	Bar	3.8	4.8	4.8	4.5	3.5	4.5	3.5	3.4	3.4	3.4	
Maximum Excess Diaphragm Pressure <sup>(4,5)</sup>	Psig	55	20	20	10	10	10	10	10	10	10	
	Bar	3.9	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Maximum Diaphragm Casing Pressure <sup>(4,6,7)</sup>	Psig	110	90	90	75	65	75	65	60	60	60	
	Bar	7.6	6.2	6.2	5.2	4.5	5.2	4.5	4.1	4.1	4.1	
Approximate Weight	Pounds	34	48	50	90	121	94	122	254	190	260	
	Kg	15	22	23	41	55	43	55	115	86	118	
Material	Nitrile Elastomers	-40 to 180°F (-40 to 82°C)										
Temperature	Silicone Elastomers	-65 to 300°F (-54 to 149°C)										
Capabilities	Fluoroelastomers	0 to 300°F (-18 to 149°C)										

1. These values also apply to the Type 667-4 actuator construction.  
2. Actuator travel may be less than the value listed after connected to the valve.  
3. Maximum actuator travel for Type 667-4 is 4 inches (102 mm).  
4. See also the Specification portion of the introduction section.  
5. Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result. See the Maximum Pressure Limitation section.  
6. Maximum diaphragm casing pressure must not be exceeded and must not produce a force on the actuator stem greater than the maximum allowable actuator output thrust or the maximum allowable stem load. See the Maximum Pressure Limitation section.  
7. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

## Introduction

### Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Type 667 actuator in sizes 30 through 76 and size 87. The Type 667-4 actuator in sizes 70 and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Only personnel qualified through training or experience should install, operate, and maintain a Type 667 actuator (see figure 1). If you have any questions about these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

### Description

The Type 667 actuator (figure 1) and the Type 667-4 actuator are reverse-acting, spring-opposed dia-

phragm actuators. They provide automatic operation of control valves. The Type 667 actuator provides 3 inches (76 mm) maximum actuator travel. The Type 667-4 actuator provides 4 inches (102 mm) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the diaphragm. Figure 2 shows the operation of these actuators.

A Type 667 or 667-4 actuator can be furnished with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is usually used as an adjustable down travel stop. (A down travel stop limits actuator travel in the down direction. "Down" means that the stem is traveling out of the actuator. "Up" means that the stem is traveling into the actuator.) A side-mounted handwheel assembly is usually used as an auxiliary manual actuator. The side-mounted handwheel can also be used as an adjustable up or down travel stop. Casing-Mounted adjustable up or down travel stops are also available on this actuator.

# Type 667 Size 30-76 & 87

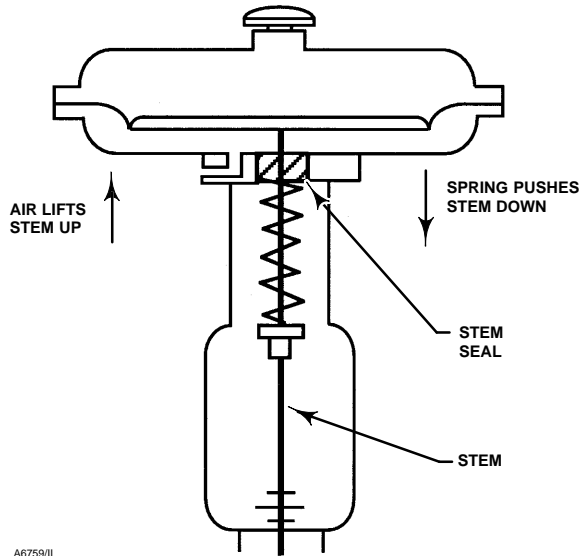


Figure 2. Schematic of Type 667 and 667-4 Actuators

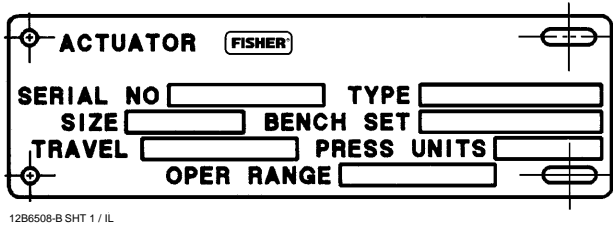


Figure 3. Type 667 and 667-4 Actuator Nameplate

## Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

## Specifications

Refer to table 1 for Specifications of the Type 667 and 667-4 actuators. See the actuator nameplate (figure 3) for specific information for your actuator.

## WARNING

To avoid personal injury and property damage caused by bursting of parts and to avoid parts damage, malfunction of

control valve, or loss of control of the process caused by excessive pressure, do not exceed the Maximum Pressures listed in table 1. Refer to the Maximum Pressure Limitations section below.

## Maximum Pressure Limitations

The casing and diaphragm of Type 667 actuators are pressure operated. This air pressure provides energy to compress the spring, to stroke the actuator, and to seat the valve. The following explanations describe the maximum pressure limits for an actuator. Refer to the nameplate or table 1 for maximum values for your actuator.

- Maximum Casing Pressure for Actuator Sizing:** This is the maximum pressure that can be applied at less than full travel of the actuator. If this stroking pressure is exceeded before the upper diaphragm plate contacts the travel stop, damage to the stem or other parts might result.

- Maximum Excess Diaphragm Pressure:** Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result.

Because the actuator has traveled its specified travel, and the diaphragm head is physically stopped from movement, the energy from any additional air pressure is transmitted to the diaphragm and diaphragm casings. The amount of air pressure that can be added once the actuator has traveled to the stops is limited by the resultant adverse effects that may occur. Exceeding this limiting factor could result in leakage or casing fatigue due to the deformation of the upper diaphragm casing.

- Maximum Diaphragm Casing Pressure:** If the Maximum Diaphragm Casing Pressure is exceeded, damage to the diaphragm, diaphragm casing, or actuator might result.

## Installation

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted. Also, refer to figure 4 for location of parts.

## WARNING

To avoid personal injury or parts damage, do not exceed any of the maximum Diaphragm Pressures listed in table 1.

# Type 667 Size 30-76 & 87

- **Valve/Actuator Assembly:** If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the loading connection procedures.

- **Actuator Mounting:** If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the following actuator mounting procedures before placing the valve in service. It is recommended that you perform the bench set spring adjustment procedures in this section to confirm that the actuator is adjusted correctly for the valve travel.

- **Positioner:** If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.

- **Handwheel Cap:** If the handwheel cap (key 247, figures 10, 11, or 16) is not in place, install the cap by pushing it on by hand until it snaps into place.

## Mounting the Actuator on the Valve



- The Type 667 actuator spring load pushes the stem down out of the actuator yoke (see figure 2), and it can come in contact with the valve stem during actuator mounting.

- If the valve stem is allowed to remain in the up position (towards the actuator) during actuator mounting, it can interfere with the actuator stem during mounting. It is possible to damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

It may be necessary to apply a temporary loading pressure to the actuator to move the actuator stem away from the valve during installation.

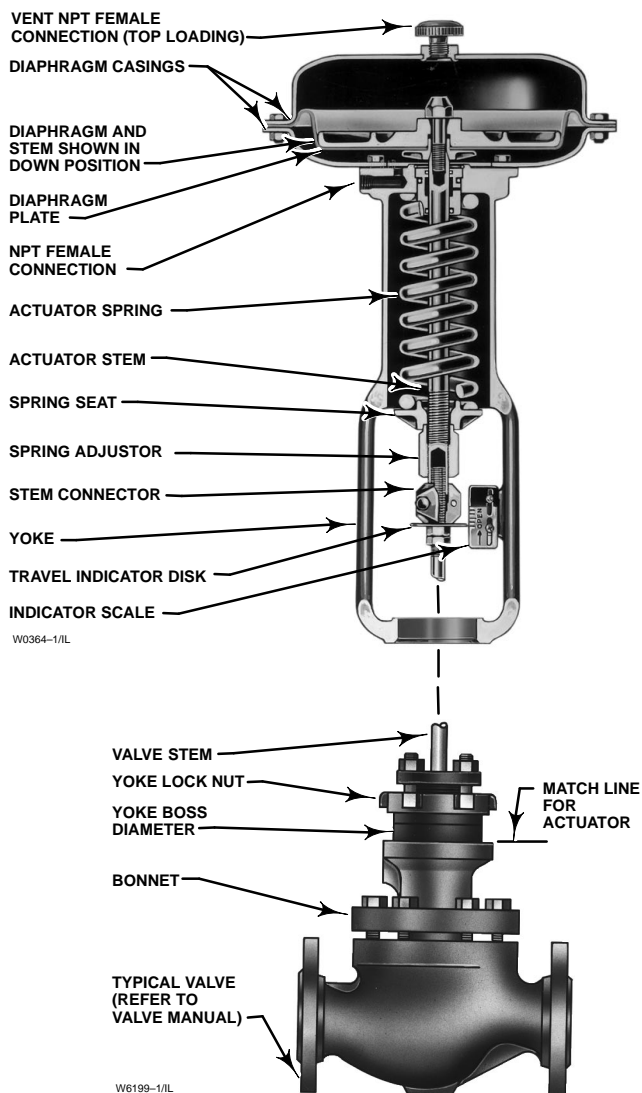


Figure 4. Actuator-Mounting Components for Size 30 through 70 Actuators

If it is not possible to provide a temporary loading pressure, be very careful when lowering the actuator over the valve stem to prevent damage to valve stem and threads.



When moving the actuator stem with loading pressure applied, exercise caution to keep hands and tools out of the actuator stem travel path. If the loading pressure is accidentally disconnected, personal injury and property damage is



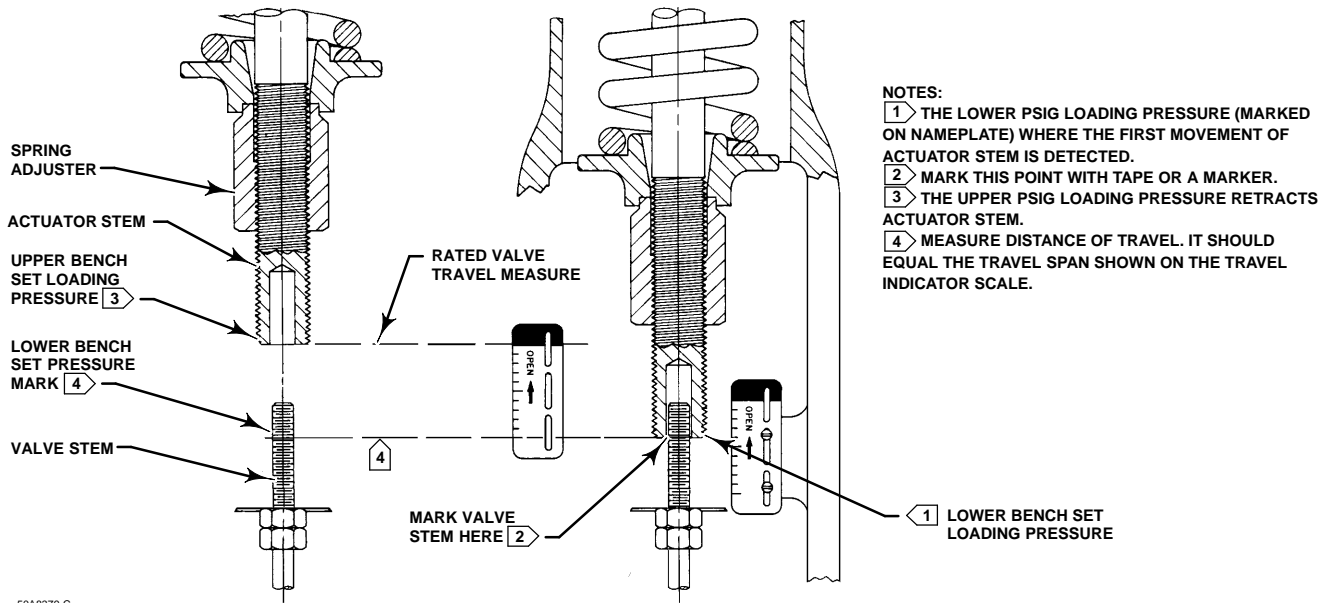


Figure 5. Bench Set Adjustment

possible if something is caught between the actuator stem and other control valve parts.

1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.

2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 34) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)

3. Lift or hoist the actuator onto the valve bonnet:

a. **For size 87 actuators:** Slowly lower the actuator down onto the valve while guiding the valve stem into the opening in the end of the the actuator stem (see figure 5). Once the actuator is in place, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.

b. **For all other size actuators:**

- Slowly lower the actuator down onto the valve. As the yoke passes over the end of the valve stem, place the yoke locknut over the valve stem. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator onto the valve because the disk will not go through the actuator yoke opening).

- Continue to lower the actuator while guiding the valve stem into the opening in the end of the actuator stem until the actuator is in place (see figure 5).

- Screw the yoke locknut onto the valve bonnet and tighten the locknut.

4. Do not connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended that you perform the *Bench Set Spring Adjustment* procedures below, to verify that the actuator is still adjusted correctly.

## Discussion of Bench Set

The bench set pressure range is used to adjust the initial compression of the actuator spring with the valve-actuator assembly "on the bench." The correct initial compression ensures that the valve-actuator assembly will function properly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set range is established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by "loose" packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the *Bench Set Spring Adjustment Procedure*).

If you are attempting to adjust the bench set range after the actuator is connected to the valve and the

# Type 667 Size 30-76 & 87

packing tightened, you must take friction into account. Make the spring adjustment such that full actuator travel occurs at the bench set range (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

For an assembled valve-actuator assembly, the valve friction may be determined by following the procedure described below:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

## Note

**Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.**

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than its mid-travel position.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

5. Calculate the actual friction force:

$$\text{Friction Force, pounds} = 1/2 \left( \begin{array}{c} \text{Difference} \\ \text{in pressure} \\ \text{readings, psig} \end{array} \right) \times \left( \begin{array}{c} \text{Effective} \\ \text{diaphragm area,} \\ \text{inches}^2 \end{array} \right)$$

Refer to table 1 for the effective diaphragm area.

When determining valve friction, you can make diaphragm pressure readings at a travel position other than mid-travel if you desire. If you take readings at zero or at the full travel position, take extra care to ensure that the readings are taken when the travel just begins or just stops at the position selected.

It is difficult to rotate the spring adjustor (key 74, figure 7, 8, and 9) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

## Bench Set Spring Adjustment

The term “bench set” means that the actuator is **not** connected to the valve, or any other loads. Ensure that the actuator diaphragm is at the bottom of its travel as shown in figure 5. (Note: Some spring compression is required to move the diaphragm to the **bottom** of its travel.)

Also, provide a certified pressure gauge that will accurately read the diaphragm pressure from 0 through the upper bench set pressure marked on the nameplate. Apply loading pressure to the diaphragm.

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly. It is important to be sure that the actuator assembly is **not** binding or producing any friction on the actuator stem movement.

Key numbers are shown in figures 7, 8, and 9.

## For Direct-Acting Valves (PDTTC)

1. If not already accomplished, push the valve stem down away from the actuator to the closed position.
2. Set the diaphragm loading pressure to 5 psig (0.3 bar) over the upper bench set pressure. The upper travel stop should be contacting the diaphragm casing.
3. Slowly decrease the pressure towards the upper bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the upper pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the upper bench set pressure. (Note: You may need to lower the loading pressure to reduce spring compression, allowing the spring adjuster to turn.)
5. Be sure the spring adjuster is adjusted to meet the requirements of step 4 above.
6. Apply the lower bench set loading pressure to the diaphragm. This will extend the actuator stem toward the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
7. Slowly increase the diaphragm pressure until the upper bench set loading pressure is applied. Again, the travel stop should be against the diaphragm casing.
8. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
9. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
10. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that

may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## For Reverse-Acting Valves (PDTO)

1. If not already accomplished, push the valve stem down away from the actuator to the open position. Later, when installing the connector, pull up the valve stem to the closed position.
2. Set the diaphragm loading pressure to a value less than the lower bench set pressure (near zero). The down travel stop should be contacting the yoke.
3. Slowly increase the pressure towards the lower bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the lower bench set pressure.
5. Apply the upper bench set loading pressure to the diaphragm. This will retract the actuator stem away from the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
6. Slowly decrease the diaphragm pressure until the lower bench set loading pressure is applied. Again, the down-stops should be against the yoke.
7. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
8. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
9. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## Installing the Stem Connector Assembly

When installing the stem connector assembly (key 31), the actuator and valve stem threads should engage the threads of the stem connector by a distance equal to the diameter of the stem.

### Note

**Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard it, if present, before clamping the actuator and valve stems together.**

1. If necessary, push the valve stem down so that the valve plug is touching the seat ring on direct-acting valves. For reverse-acting valves, pull the stem up to the closed position. Always start with the valve plug on the seat.
2. If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 34) is on top of the locknuts.
3. Apply the diaphragm pressure to the lower bench set pressure. (Or, the upper bench set pressure for reverse-acting valves.) This should be the same pressure used in the bench set steps, and it is marked on the nameplate.
4. Place the stem connector half with the threaded holes, approximately half way between the actuator and valve stems. Refer to figures 7, 8, and 9 to help locate the connector position.

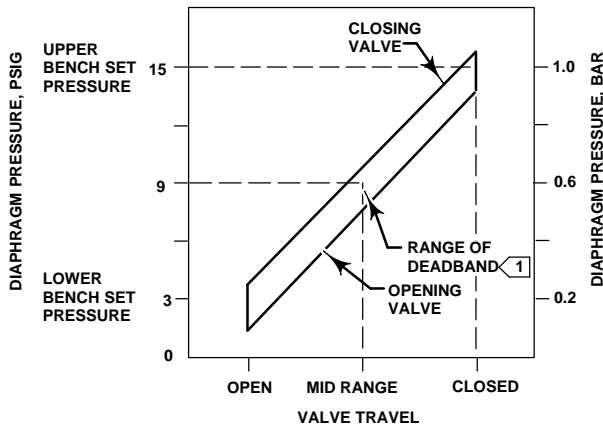
Be sure that the actuator and valve stem threads are engaging the threads of the stem connector by a distance equal to one diameter of the stem.

### CAUTION

**Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely.**

5. Install the other half of the stem connector and insert the cap screws and tighten them. If installing a positioner, also attach the feedback bracket at the same time.
6. Screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector, or for size 87 actuators, tighten the locknuts against the stem connector. Do not overtighten the locknuts.
7. Slowly increase and then decrease pressure several times, stroking the valve from the lower bench set pressure to the upper pressure.

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NOTE:  
 1 DEADBAND IS CAUSED BY FRICTION.  
 A6588 / IL

Figure 6. Typical Direct Acting Valve Response to Deadband

Be sure that the valve is in the closed position (up or down, depending on valve action). Loosen the screws on the travel scale, and align it with the travel indicator disk. Stroke the valve full travel to ensure that the travel matches the valve travel on the travel indicator plate. If valve travel is not correct, repeat the stem connector procedure.

## Note

**For push-down-to-close valves, the valve plug seat is the limit for downward travel and the actuator up-stop is the limit for upward (away from the valve) movement. For push-down-to-open valves, the actuator down-stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement. For Type 667 actuators, a down-stop (key 77, figure 7) is installed to limit actuator diaphragm downward movement when the actuator provides the limit.**

## Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 6). Each actuator spring has a fixed spring rate (force). You have verified that the right spring was installed in the actuator by completing the bench set spring adjustment steps.

Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

Deadband, psi

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn \%}$$

## Loading Connection

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted.

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary. For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT female connection in the side of the yoke (key 73).
2. For size 70 and 87 actuators, if necessary, remove the 1/4-inch NPT bushing if a 1/2-inch NPT female connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.
4. If valve stem travel appears to be incorrect, refer to the bench set spring adjustment procedures at the beginning of this section. Do not place the valve in service if it is not reacting correctly to diaphragm loading pressure changes.

## Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions. Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher Controls.

### WARNING

**Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring pre-compression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

The maintenance instructions are divided into several sections: Actuator, Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop), Side-Mounted Handwheel Assembly (Manual Actuator) for Size 34 through 60 Actuators, Side-Mounted Handwheel Assembly (Manual Actuator) for Size 70, 76 and 87 Actuators, and Casing-Mounted Travel Stops.

## Actuator Maintenance

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key are shown in figures 7, 8, or 9, unless otherwise noted. Figure 7 shows the size 30 through 60 actua-

tors, figure 8 shows the size 70 actuator, and figure 9 shows the size 87 actuator.

## Actuator Disassembly

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

1. Remove the tubing or piping from the connection in the top of the yoke (key 73). For a top-loaded construction, also remove the piping or tubing from the connection in the upper diaphragm casing (key 1).
2. Turn the spring adjuster (key 74) counterclockwise (**toward the valve body**) until all spring compression is relieved.

### WARNING

**To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector cap screws when the stem connector has spring force applied to it.**

3. If necessary, remove the actuator from the valve body by separating the stem connector (key 31). Loosen the stem locknuts for the size 87 actuator, and removing the stem connector nuts. For all other sizes, separate the stem connector by loosening the stem locknuts (keys 69 and 75) and unscrewing the two stem connector cap screws.
4. Unscrew the spring adjuster (key 74) from the actuator stem (key 144). Also lift the spring seat and spring (Key 19 and 18) out of the yoke.
5. Remove the diaphragm casing cap screws and nuts (keys 13 and 14), and lift off the upper diaphragm casing (key 1).
6. Remove the following connected parts: the diaphragm (key 3), upper diaphragm plate (key 4), spacer (key 2), cap screw (key 12), lower diaphragm plate (key 71), and actuator stem (key 144). Be careful when pulling the threads of the actuator stem through the seal bushing (key 7) to avoid damaging the O-rings (key 8).
7. Remove the cap screw (key 12) to separate the parts of this assembly.
8. To remove the seal bushing, remove the snap ring (key 72), and lift out the bushing. Inspect, and if necessary, replace O-rings (8 and 9).
9. Remove cap screws (key 30), and take off the lower diaphragm casing (key 64) and the gasket (key 70),

# Type 667 Size 30-76 & 87

size 30 through 60 and 76) or O-ring (key 70, size 70 or 87). If necessary, the down travel stops (key 77) can be removed.

## Actuator Assembly

1. Coat the O-rings (key 70, sizes 70 and 87) with lubricant (key 237 or equivalent). Or, coat the gasket with sealant (key 238 or equivalent). Place a new gasket or O-ring (key 70) on the yoke (key 73). Position the lower diaphragm casing (key 64) on the yoke, align the holes, and insert and tighten the cap screws (key 30). If down travel stops (key 77) were removed, insert and tighten them.
2. Coat the O-rings (keys 8 and 9) with lubricant (key 237 or equivalent) and place the O-rings in the seal bushing (key 7).
3. Fill the seal bushing with lubricant (key 237 or equivalent), slide the bushing into the yoke (key 73), and install the snap ring (key 72).
4. Assemble the actuator stem (key 144), lower diaphragm plate (key 71), diaphragm (key 3), upper diaphragm plate (key 4), and the travel stop cap screw and spacer (keys 12 and 2). Coat the cap screw threads with Lubriplate Mag-1 or equivalent (key 237). Tighten the cap screw (key 12) to 30 lbf•ft (41 N•m) torque for size 30 actuators, 70 lbf•ft (95 N•m) torque for size 34 and 40 actuators, or 190 lbf•ft (258 N•m) torque for size 45 to 70 and 87 actuators. Place this assembly in the actuator. Take care when pushing the actuator stem through the seal bushing so that the threads do not damage the O-rings.



## CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Install the upper diaphragm casing (key 1), and install the cap screws and nuts (keys 13 and 14). Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Install the actuator spring (key 18) and spring seat (key 19). Apply lubricant (key 239 or equivalent) to the threads of the actuator stem and to the surface of the spring adjuster (key 74) that contacts the spring seat. Thread the spring adjuster onto the actuator stem.
7. Mount the actuator onto the valve in accordance with the procedures in the Installation section.

## Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop)

Actuator key numbers are shown in figures 7, 8, and 9. And, top-mounted handwheels are shown in figures 10, 11, and 12.

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.**

A top-mounted handwheel assembly (figures 10, 11, and 12) is usually used as an adjustable down travel stop to limit full extension of the actuator stem. Turning the handwheel counterclockwise pulls the extension rod (key 150, figures 10, 11, and 12) up, retracting the actuator stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

## Disassembly for Top-Mounted Handwheel

1. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
2. Turn the handwheel (key 58) clockwise so that the handwheel assembly is not causing any spring compression.
3. Turn the actuator spring adjuster (key 74) to relieve all the compression from the spring (key 18).
4. If servicing just the thrust bearing, races, and handwheel screw (keys 180, 181, and 160) only, use the following steps:
  - Remove the cap and drive out the groove pin. Remove the castle nut, bearing retainer, thrust bearing, and races (keys 247, 167, 166, 180, and 181).
  - Use the handwheel to remove the handwheel screw (key 160) from the handwheel body (key 148).
  - It necessary, remove the extension rod (key 150) at this time. Most maintenance procedures do not require the rod to be removed.
  - Clean and inspect all parts or replace parts as necessary. Upon re-assembly, lubricate handwheel threads, bearings, and races with Never-Seez Nickel Special (key 239) or equivalent.

# Type 667 Size 30-76 & 87

- Lubricate and re-install the handwheel screw into handwheel body (key 148). Lubricate and replace the races, bearing, and retainer (keys 181, 180, and 182). Replace the castle nut (key 166), tighten it, and insert the groove pin (key 167). Replace the handwheel cap (key 247).

## 5. For size 30 through 60 and 76 actuator handwheels (figures 10 and 11):

- Remove the cap screws (key 161). Make sure that the guide plate can turn between the handwheel body and the mounting plate (keys 157, 148 and 158).

- Remove the cap (key 247) and drive out the groove pin (key 167). Remove the castle nut (key 166) and, if necessary, unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1) and the mounting plate (key 158).

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## 6. For size 70 and 87 actuator handwheels (figure 12):

- Remove the cap (key 247). Drive out the groove pin (key 167) and remove the castle nut, the bearing retainer, and thrust bearing (keys 166, 182, 181, and 180). It is not necessary to remove the extension rod (key 150) at this time.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1), handwheel body (key 148) and attached parts.

- If travel stops (key 152) are used, note and record their position relative to the cap screws (key 154) for use in assembly. Remove the travel stops and cap screws, and remove either the mounting plate (key 158, figure 12) or the handwheel body (key 148, figure 12) and attached parts.

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## Assembly for Top-Mounted Handwheel

### For size 30 through 60 and 76 actuator handwheels:

Refer to figures 10 and 11 for top-mounted handwheel assemblies.

1. If it was removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place. Also, install the guide post (key 150) if it was removed.

2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).

3. Install the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9) with the cap screws (key 154). Finger tighten the screws.

4. If travel stops were used, install the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

## CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

6. If necessary, screw the extension rod (key 150) into the connector (key 27). Slide the guide plate (key 157) onto the extension rod (key 150). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). If necessary, replace the extension rod (key 150). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

7. Lubricate and install the thrust bearings (keys 181 and 180), install the bearing retainer (key 182), install the castle nut (key 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

8. Refer to the Assembly portion of the Actuator maintenance section.

# Type 667 Size 30-76 & 87

## For size 70 and 87 actuators handwheels (figure 12):

Refer to figure 12 for top-mounted handwheel assemblies.

1. If removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place.
2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).
3. If necessary, install the extension rod (key 150) into the connector (key 27) and tighten it. Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.



### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Lubricate and install the thrust bearings (keys 180 and 181), install the bearing retainer (key 182), install the castle nut (keys 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).
7. Refer to the Assembly portion of the Actuator maintenance section.

## Side-Mounted Handwheel Assembly for Size 34 through 60 Actuators

A side-mounted handwheel assembly (figures 13 and 14) is usually used as a manual actuator. This design is frequently used to drive the valve open or closed under loading conditions. Turning the handwheel clockwise past the neutral position always closes a push-down-to-close valve. A pair of levers (key 146, figure 13) on a handwheel assembly close the valve by moving the valve stem.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

## Disassembly for Side-Mounted Handwheel (34-60)

1. If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the nuts (keys 147 and 170) from the U-bolts (keys 166 and 143) that hold the assembly to the yoke.
2. Remove retaining ring (key 154), and drive out the lever pivot pin (key 153).
3. There are two screws (key 156) that hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove screw (key 161) and pointer mounting bolt (key 159, not shown) located behind pointer (key 160).
5. Remove nut (key 54), lockwasher (key 150), and washer (key 149), and take off the handwheel (key 51). Be careful not to lose the small ball (key 55) and spring (key 56).
6. Unscrew the bearing retainer (key 136) after loosening the locking set screw (key 168, not shown).
7. Pull the screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also, remove the bushing (key 151) on sizes 34 and 40.
8. If required, remove the bearings (key 152), one from the bearing retainer and the other from the handwheel body.
9. **Size 34, 40, 45 and 76 actuator handwheels (figures 10 and 11)**, fasten the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9):
  - If travel stops were used, install the travel stops to their original positions as recorded in preceding disassembly steps.
  - Install the cap screws (key 154). Tighten the screws and travel stops.
10. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.



### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**



11. **Size 60 and 76 actuator handwheels**, position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

- Slide the guide plate (key 157) onto the extension rod (key 150), and screw the extension rod into the connector (key 27). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the guide plate (key 157) or spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

12. **Size 70 or 87 actuator handwheel**, slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Insert and tighten the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9).

13. **Size 34 through 60, and 76 actuator handwheels**, re-lubricate the thrust bearings (key 180), install the washer and castle nut (keys 162 and 166) on the extension rod. Do not overtighten the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

- **Size 70 and 87 actuators handwheels**, screw the extension rod (key 150) into the connector (key 27). Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.

14. **Size 70 or 87 actuator handwheels**, re-lubricate the thrust bearing (key 180), install the thrust bearing and bearing retainer (keys 180 and 181) on the extension rod (key 150), and screw on the castle nut (key 166). Do not overtighten the bearing. Drive in the groove pin (key 167), and replace the cap (key 247).

15. Refer to the Assembly portion of the Actuator maintenance section.

## ***Assembly for Side-Mounted Handwheel (Sizes 34-60)***

1. Pack the bearings (key 152) with lubricant (key 239 or equivalent). Insert one bearing and the bushing (key 151) in the handwheel body (key 142) as shown in figure 13 or 14. The bushing is not used in a handwheel assembly for size 45 through 60 actuators.

2. Coat the screw threads with lubricant (key 239) or equivalent, and thread the operating nut onto the screw. Slide the second bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151) as shown in figure 13 or 14 or into the bearing.

3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, not shown) to hold the bearing retainer in place.

4. Coat the groove in the handwheel body (key 142) with lubricant (key 237 or equivalent). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51). Holding the ball and spring in the handwheel, put the handwheel (key 51), the washer (key 149), the lock-washer (key 150), and the hex nut (key 54) on the end of the screw (key 145). Tighten the hex nut.

5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160) as shown in figure 13 or 14. Insert and tighten the screw (key 161).

6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for size 45, 50, and 60 actuators or with the machine bolts (key 156) for handwheel assemblies on size 34 and 40 actuators.

7. If the handwheel assembly was removed from the yoke, remount the handjack assembly to the yoke using the dowel pins for alignment. Position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten nuts (key 144). Finish tightening the U-bolt nuts to 120 lbf•ft [163 N•m] (key 170) and 30 lbf•ft [41 N•m] (key 147). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

8. Position the levers (key 146) as shown in figure 13 or 14. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

## **Side-Mounted Handwheel Assembly (Sizes 70, 76, and 87)**

A side-mounted handwheel assembly (figure 15) is usually used as a manual actuator. Turning the handwheel clockwise past the neutral position always closes the valve body. A sleeve (key 123, figure 15) on a handwheel assembly for a size 70, 76 or 87 actuator opens the valve body by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

# Type 667 Size 30-76 & 87

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## **Disassembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

Bypass the control valve. Reduce the loading pressure to atmospheric. Disconnect the loading pressure tubing or piping at the yoke.

Remove cover band (key 87), and relieve spring compression by turning the spring adjuster (key 74) counterclockwise.

Remove the cap screws and nuts (keys 13 and 14) and lift off the upper diaphragm casing (key 1).

Remove the travel stop screw (key 12) and spacer (key 2), and take off the diaphragm plate (key 4), the diaphragm (key 3), and the lower diaphragm plate (key 71).

Unscrew the cap screws (key 90) and remove the following connected parts: the lower diaphragm casing (key 64), the O-ring (key 70), spring case adaptor (key 89), the seal bushing, O-rings, and snap ring (keys 7, 8, 9, and 72).

Remove the snap ring (key 72), and slide the seal bushing and O-rings (keys 7, 8, and 9) out of the spring case adaptor (key 89).

Take out the actuator spring (key 18).

Remove the stem connector (key 31) and stem connector cap screws.

Pull the actuator stem (key 144) up and out of the yoke. The spring seat (key 19), spring adjuster (key 74), thrust bearing (key 128), and the pinned adjusting screw (key 131) will come out with the actuator stem.

Turn the handwheel so that the lower sleeve (key 123) extends out of the bottom of the yoke. DO NOT move the neutral indicator scale (key 125).

Loosen two set screws (key 121), and unscrew the bearing retainer flange (key 45). Take out the worm gear and two thrust bearings (key 132), one on each side of the gear.

The worm shaft (key 51) and associated parts can be disassembled, if desired, by first removing handwheel nut (key 127) and the handwheel (key 58). Do not lose the small ball (key 141) and spring (key 142).

Loosen the set screw (key 52) for each worm shaft retainer (keys 48 and 49). Unscrew the two worm retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers.

## **Assembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

1. The front and back worm retainers (keys 48 and 49) each have a slot in their threads for a set screws (key 52). Pack the ball bearings (key 50) with lubricant (key 239) or equivalent, and insert one ball bearing in the back worm retainer (key 49) as shown in figure 15.

2. Thread the back bearing retainer and ball bearing (keys 49 and 50) into the yoke. Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 52), and tighten it.

3. Coat the worm shaft (key 51) threads with lubricant (key 239 or equivalent), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back bearing retainer.

4. Insert the bearing in the front bearing retainer (key 49), and thread the retainer and ball bearing into the yoke. Align the slot in the retainer with the hole in the yoke, insert the set screw (key 52), and tighten it.

5. Put the spring and ball (keys 141 and 142) in the handwheel (key 58). Slide the handwheel onto the worm shaft (key 51). Thread the hex nut (key 127) onto the worm shaft.

6. Pack the two needle bearings (key 132) and coat the worm gear (key 44) threads with lubricant (key 239) or equivalent. Insert the key (key 122), the bearings, and the worm gear in the yoke (key 73) as shown in figure 15.

7. Slots are cut in the threads of the bearing retainer flange (key 45). Thread the flange into the yoke so that the slots and the holes for the set screws (key 121) align. Insert the screws, and tighten them.

8. The lower sleeve (key 123) has a milled groove in one end. Coat the sleeve threads with lubricant (key 239 or equivalent), slide the end of the lower sleeve with the groove into the bearing retainer flange, turn the handwheel, and feed the sleeve through the worm gear so that the slot in the lower sleeve engages the key (key 122) in the yoke. Continue turning the handwheel until the lower sleeve protrudes 3.19 inches (81 mm) below the surface of the yoke. The bottom of the lower sleeve should be even with the bottom of the extension on the neutral indicator.

9. Pack the thrust bearing (key 128) with lubricant (key 239) or equivalent. Slide the actuator stem (key 144) and the attached adjusting screw (key 131), pin (key 130), thrust bearing (key 128), spring seat (key 19), and spring adjuster (key 74) into the yoke. The lower end of the stem slides through the lower sleeve (key 123) and the lower sleeve slides into the adjusting screw (key 131), as shown in figure 15.

10. Position the actuator stem (key 144) against the valve stem. Clamp both stems between the two halves of the stem connector (key 31), and be sure the threads are engaged properly on both stems. The stem connector should not be closer than 0.125 inches (3.2 mm) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 0.125 inches (3.2 mm) of free travel of the lower sleeve in either direction for manual operation. Fasten the halves together with the cap screws.

11. Put the actuator spring (key 18) in the yoke on the spring seat (key 19).

12. Coat the O-rings (keys 8 and 9) with lubricant (key 237) or equivalent, and insert them in the seal bushing (key 7). Slide the seal bushing and O-rings into the spring case adaptor (key 89).
13. Install the snap ring (key 72).
14. Slide the seal bushing and O-rings (keys 7, 8, and 9) over the actuator stem (key 144), and position the spring case adaptor (key 89), lower diaphragm casing (key 64), and O-ring (key 70) on the yoke.
15. Insert and tighten the cap screws (key 90).
16. Slide the lower diaphragm plate (key 71), the diaphragm (key 3) with the patterned side up, the diaphragm plate (key 4), the spacer (key 2), and the cap screw (key 12) on the actuator stem (key 144). Tighten the cap screw.
17. Put the diaphragm casing (key 1) on the diaphragm. Align the holes in the diaphragm (key 3) and the diaphragm casings (keys 1 and 64).



## CAUTION

**Over-tightening the cap screws and hex nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) of torque.**

18. Install the cap screws and hex nuts (keys 13 and 14) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a criss-cross pattern.
19. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

## Casing-Mounted Travel Stops

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as manual operator.**

Casing-mounted adjustable travel stops (shown in figures 16 through 20) are available to limit travel in the down direction (extending the actuator stem) or in the up direction (retracting the actuator stem). The travel stop in figure 16 is a down travel stop, the travel stop in figure 17 is an up and down travel stop, and the travel stops in figures 18, 19, and 20 are up travel stops.

Use the locknuts (key 151, figures 16 and 17), stem (key 150, figure 18), handwheel (key 58, figure 19) or cap screw (key 177, figure 20) to set the point at which the travel stop limits travel. Be sure to tighten the locknuts and replace the cap (key 149, figures 16 and 18; key 247, figure 17) after setting the travel stop.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 16 through 20.

1. Remove the cap (key 149 or 247) if the travel stop uses one. For down travel stops, loosen the locknuts (key 151, figures 16 and 17) so that the stop is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
3. For down travel stops, turn the spring adjuster (key 74, figures 7, 8, and 9) out of the yoke toward the stem connector (key 31) to relieve all the compression in the spring (key 18).
4. **For style 11 travel stops (figure 17)**, unscrew the cap screws (key 161), and make sure that the guide plate (key 157) can turn between the handwheel body (key 148) and the mounting plate (key 158).
5. Use a wrench on the nuts (key 151) to unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
6. Unscrew the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1, figures 7, 8, and 9) and, for the style 11 travel stop, the mounting plate (key 158). For styles 10, 12 and 13, the travel stop assembly will be removed with the casing.
7. Note and record the position of travel stops (key 152) relative to the cap screws (key 154) for use in assembly. Unscrew the travel stops and cap screws, and remove either the mounting plate (key 158) or the handwheel body (key 148) and attached parts.
8. Separate the stem (key 150) and screw (key 160, figure 17) from the handwheel body.
9. Before reassembling, lubricate parts indicated by key 239 in figures 16 through 20. Use lubricant (key 239 or equivalent).
10. Reassemble parts in the reverse order of removal.
11. When replacing the cap screws (key 154) and, if used, the travel stops (key 152), be sure to return them to their original position as recorded in step 6.

# Type 667 Size 30-76 & 87



## CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14), figures 7, 8, and 9 can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

12. Install the cap screws and nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

13. Return the spring adjuster (key 74, figure 7, 8, and 9) to its original position. Re-adjust the travel stop.

## Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Fisher Controls sales office or sales representative regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts Kits and Parts List sections.

## Parts Kits

### Side-Mounted Handwheels Retrofit Kits

Key	Description	Part Number
	RETROFIT KIT INCLUDES PARTS TO ADD A SIDE-MOUNTED HANDWHEEL.	
	SIZE 34 PUSH-DOWN-TO-CLOSE	30A8778X0E2
	SIZE 34 PUSH-DOWN-TO-OPEN	30A8778X0F2
	SIZE 40 PUSH-DOWN-TO-CLOSE	30A8778X0G2
	SIZE 40 PUSH-DOWN-TO-OPEN	30A8778X0H2
	SIZE 45 & 46 PUSH-DOWN-TO-CLOSE	40A8779X0A2
	SIZE 45 & 46 PUSH-DOWN-TO-OPEN	40A8779X0B2
	SIZE 50 & 60 PUSH-DOWN-TO-CLOSE	40A8779X0C2
	SIZE 50 & 60 PUSH-DOWN-TO-OPEN	40A8779X0D2

### Top-Mounted Handwheels Retrofit Kits

RETROFIT KIT INCLUDES PARTS TO ADD A TOP-MOUNTED HANDWHEEL. KIT NUMBER 1 INCLUDES THE HANDWHEEL ASSEMBLY ONLY. KIT NUMBER 2 INCLUDES KIT NUMBER 1 AND A NEW DIAPHRAGM CASE THAT IS REQUIRED TO MOUNT THE HANDWHEEL ASSEMBLY.

Key	Description	Part Number
	<b>KIT 1</b>	
	SIZE 30	30B3940X102
	SIZES 34	39B3940X022
	SIZES 40	39B3940X042
	SIZES 45 & 50	33B9224X012
	SIZES 46, 60, AND 76	33B9224X012
	SIZES 70 & 87	CV8060X0012

Key	Description	Part Number
	<b>KIT 2</b>	
	SIZE 30	30B3940X052
	SIZES 34	30B3940X062
	SIZES 40	30B3940X092
	SIZES 45 & 50	33B9224X022
	SIZES 46, 60 AND 76	33B9224X032
	SIZES 70 & 87	CV8060X0022

## Actuator Repair Kits

PARTS KIT INCLUDES KEYS 8, 9, AND 70. O-RING MATERIAL IS NITRILE, AND GASKET MATERIAL IS COMPOSITION.

Key	Description	Part Number
	SIZE 30	R667X000302
	SIZE 34 & 40	R667X000402
	SIZE 45 THROUGH 60	R667X000502
	SIZE 70 & 87	R667X000702
	SIZE 76	R667X000762

## Parts List

### Actuator Assembly

Key	Description	Part Number	Qty
1	UPPER DIAPHRAGM CASING [STEEL, ZINC PLATED (ZN PL)]		
	SIZE 30	2E800728992	1
	SIZE 34 & 40	2E681428992	1
	SIZE 45 & 50	3E844628992	1
	SIZE 46, 60 & 76	3E846728992	1
	SIZE 70 & 87	2N127828992	1
	W/TOP-MOUNTED HANDWHEEL		
	SIZE 30	2E792225062	1
	W/TOP-MTD HANDWHEEL OR STYLE 11 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	SIZE 46, 60 & 76	2E847425062	1
	SIZE 70 & 87	2N127125062	1
	W/STYLE 10 OR 13 TRAVEL STOP		
	SIZE 30	2E792225062	1
	W/STYLE 10 OR 12 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	W/STYLE 10, 12, OR 13 STOP		
	SIZE 46, 60 & 76	2E847425062	1
	W/STYLE 12 STOP OR REVERSE VALVE		
	SIZE 70 & 87	2N127125062	1
	W/STYLE 14 TRAVEL STOP		
	SIZE 30	2F486225062	1
	SIZE 34 & 40	2F753428992	1
	SIZE 45 & 50	3F860628992	1
	SIZE 46, 60 & 76	1K131025062	1
2	TRAVEL STOP SPACER	SEE FOLLOWING TABLE	
3*	DIAPHRAGM		
	MOLDED NITRILE/NYLON		
	SIZE 30	2E800002202	1
	SIZE 34 & 40	2E669902202	1
	SIZE 45 & 50	2E859602202	1
	SIZE 46, 60 & 76	2E859802202	1
	SIZE 70 & 87	2N130902202	1
	FLUOROELASTOMER/NOMEX		
	SIZE 30	1K7982X00A2	1
	SIZE 34 & 40	1F3620X00A2	1
	SIZE 45 & 50	1J381902402	1
	SIZE 46, 60 & 76	1R7728X00A2	1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
3*	DIAPHRAGM (Cont'd)		12	SCREW, CAP, HEX HD	
	MOLDED SILICONE/POLYESTER			STANDARD HANDWHEEL, TRAVEL STOP STYLE 13, ADJ.	
	SIZE 30	2E8000X0022 1		UP STOP STYLE 14, FOR:	
	SIZE 34 & 40	2E6699X0042 1		SIZE 30	
	SIZE 45 & 50	2E8596X0012 1		1/4, 5/16, & 11/16-INCH (6, 8, & 17 mm)	
	SIZE 46, 60 & 76	2E8598X0012 1		TRAVEL	1A8678X0012 1
	SIZE 70 & 87	2N1309X0012 1		7/16, 5/8, & 3/4-INCH (11, 16, & 19 mm)	
4	UPPER DIAPHRAGM PLATE			TRAVEL	1B227523052 1
	ALUMINUM [200°F (93°C) MAXIMUM]			3/8, 7/16, 1/2, 9/16, & 5/8-INCH (10, 11, 13,14, & 16 mm)	
	SIZE 30	31B2028X012 1		TRAVEL	1A8678X0032 1
	SIZE 34 & 40	31B2029X012 1		11/16 & 3/4-INCH (17 & 19 mm)	
	SIZE 45 & 50	41B2030X012 1		TRAVEL	1B2275X0022 1
	SIZE 46, 60 & 76	41B2031X012 1	13	HEX HD CAP SCREW (STEEL, ZN PL)	
	CAST IRON			SIZE 30	1E760324052 12
	SIZE 30	2E880419042 1		SIZE 34 & 40	1E760324052 16
	SIZE 34 AND 40	3E880519042 1		SIZE 45 & 50	1A675124052 20
	SIZE 45 & 50	2E831519042 1		SIZE 46, 60 & 76	1A675124052 24
	SIZE 46, 60, & 76	2E847519042 1		SIZE 70 & 87	1A582824052 28
	SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	2N127019042 1			
	SIZE 70 & 87 4 IN. (102 mm) TRAVEL	10A2421X012 1	14	HEX NUT (STEEL, ZN PL)	
	SIZE 70 & 87 TYPE 667-4	10A2421X012 1		SIZE 30	1A346524122 12
	WCB STEEL			SIZE 34 & 40	1A346524122 16
	SIZE 30	2H510922012 1		SIZE 45 & 50	1A346524122 20
	SIZE 34 & 40	3H511122012 1		SIZE 46, 60 & 76	1A346524122 24
	SIZE 45 & 50	2H511322012 1		SIZE 70 & 87	1A346524122 28
	SIZE 46, 60, & 76	2H511522012 1	17	VENT ASSEMBLY	
	SIZE 70 & 87	2N757522012 1		ALL SIZES	17A5515X012 1
7*	BUSHING, SEAL		18	SPRING	SEE FOLLOWING TABLE
	BRASS		19	SEAT, LOWER SPRING	
	SIZE 30	1E791214012 1		G10300 (STEEL, ZN PL)	
	SIZE 34 & 40	1E682814012 1		SIZE 30	1U425623122 1
	SIZE 45 THROUGH 60	1E845714012 1		SIZE 34 & 40	1R179923122 1
	SIZE 70, 76 & 87	1N1316X0052 1		SIZE 45 THROUGH 60	1R180023122 1
	S41600 [416 STAINLESS STEEL (SST)]			CAST IRON	
	SIZE 30	1E7912X0012 1		STANDARD	
	SIZE 34 & 40	1E6828X0012 1		SIZE 70, 76 & 87	1N129619052 1
	SIZE 45 THROUGH 60	1E8457X0012 1		WCB STEEL	
	PTFE W/25% GLASS			STANDARD	
	SIZE 70, 76 & 87	1N1316X0042 1		SIZE 70 & 87	1N757722012 1
8*	O-RING			CAST IRON	
	NITRILE			W/HANDWHEEL	
	SIZE 30	1E591406992 2		SIZE 70, 76 & 87	1N887119042 1
	SIZE 34 & 40	1D237506992 2	27	EXTENSION ROD CONN (STEEL, ZN PL)	
	SIZE 45 THROUGH 60	1C562206992 2		W/TOP-MOUNTED HANDWHEEL	
	SIZE 70, 76 & 87	1E736906992 2		SIZE 30	1F118824092 1
	FLUOROELASTOMER			W/TOP-MTD HANDWHEEL OR STYLE 11	
	SIZE 30	1E5914X0062 2		SIZE 34 & 40	1F135924092 1
	SIZE 34 & 40	1D237506382 2			
	SIZE 45 THROUGH 60	1N285406382 2	27	EXTENSION ROD CONN (STEEL, ZN PL) (CONT.)	
9*	O-RING			SIZE 45 THROUGH 60 & 76	1F119424092 1
	NITRILE			STEEL, ZN PL	
	SIZE 30 THROUGH 40	1C415706992 1		W/TOP-MOUNTED HANDWHEEL	
	SIZE 45 THROUGH 87	1E845806992 1		SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	1N838331012 1
	FLUOROELASTOMER			SIZE 70 & 87 W/4 IN. (102 mm) TRAVEL	11A8130X012 1
	SIZE 30 THROUGH 40	1C4157X0032 1	30	HEX HD CAP SCREW (STEEL, ZN PL)	
	SIZE 45 THROUGH 87	1E8458X0022 1		SIZE 30	1D529824052 6
12	SCREW, CAP, HEX HD	SEE FOLLOWING TABLE		SIZE 34 & 40	1A368424052 6
				SIZE 45 THROUGH 60 & 76	1A368424052 8
				SIZE 70 & 87	1N129328992 12

# Type 667 Size 30-76 & 87

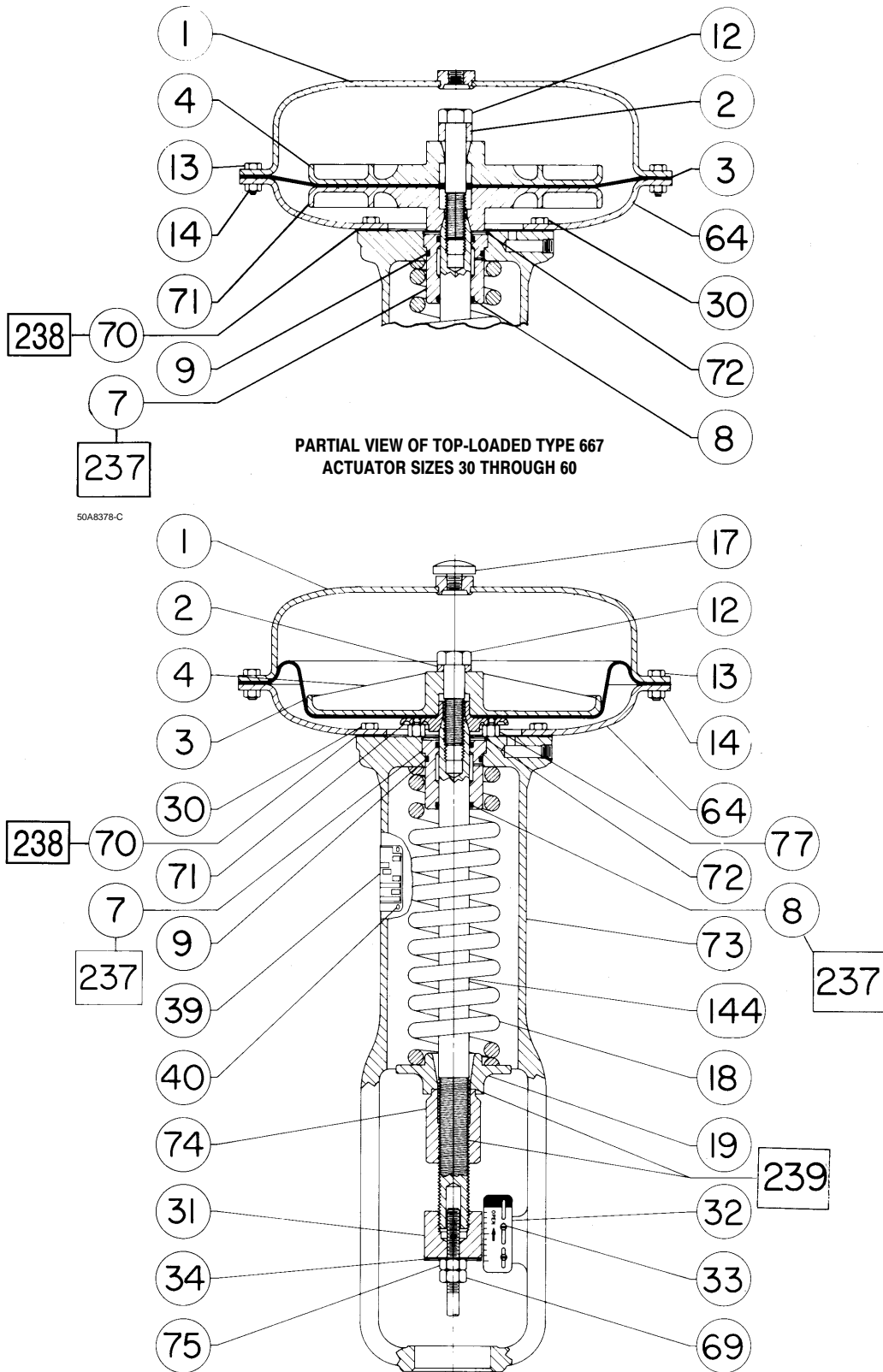
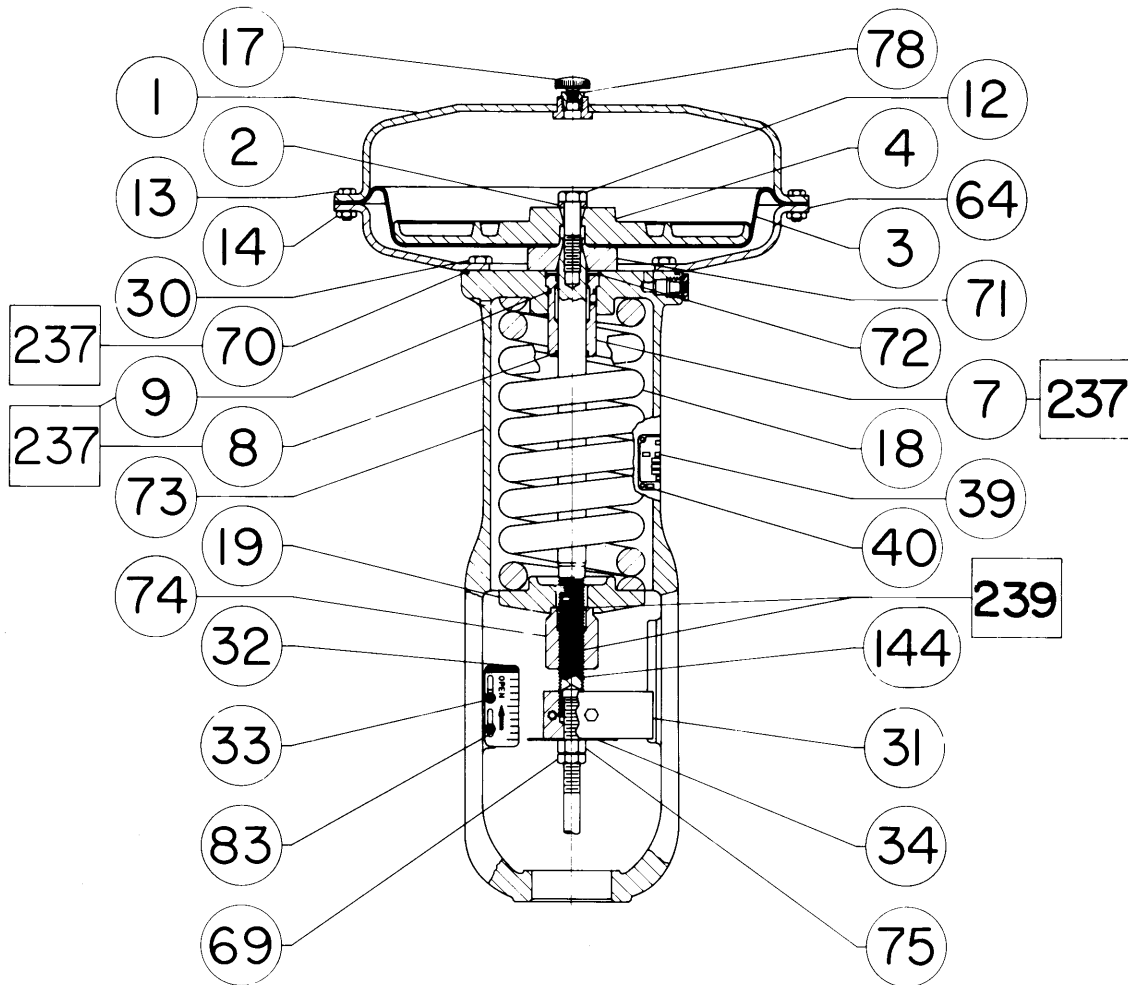


Figure 7. Type 667 Actuator Sizes 30 through 60

# Type 667 Size 30-76 & 87



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Figure 8. Type 667 Size 70 Actuator

Key	Description	Part Number	Key	Description	Part Number
31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL)		31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL) (Con't.)	
	STANDARD			W/PMV POSITIONER	
	SIZE 30 & 34	18A1243X012 1		SIZE 70 3/4 TO 4 IN. (19 TO 102 mm)	
	SIZE 40	18A1668X012 1		TRAVEL	11B2000X012 1
	SIZE 45 & 46	18A1671X012 1			
	SIZE 50 & 60	18A1672X012 1	32	TRAVEL INDICATOR SCALE	SEE FOLLOWING TABLE
	SIZE 70 & 76	18A1675X012 1			
	SIZE 87	18A1825X012 1	33	SCREW, SELF TAPPING	
	W/SIDE-MOUNTED HANDWHEEL			STAINLESS STEEL	
	SIZE 34	1F659225142 1		STANDARD	
	SIZE 40	1F659125142 1		SIZE 30 THROUGH 46	1E793238992 2
	SIZE 45 & 46	2F1678000A2 1		SIZE 50 THROUGH 87	1E831338992 2
	SIZE 50 & 60	2F1672000A2 1			
	SIZE 70 3/4 THROUGH 3 IN. (19 TO 76 mm)		33	SCREW, MACH. FILL HD (STEEL, PLATED)	
	TRAVEL	18A1678X012 1		W/HANDWHEEL	
	SIZE 70 3/4 THROUGH 4 IN. (19 TO 102 mm)			SIZE 45 & 46	1B992528992 2
	TRAVEL	21A8254X012 1		SIZE 70, 76 & 87	1A340628982 2
	SIZE 76	18A1678X012 1			
	SIZE 87 1 IN. (25.4 mm) VALVE STEM	18A1825X012 1			
	SIZE 87 1-1/4 (31.8 mm) VALVE STEM	18A1833X012 1			

# Type 667 Size 30-76 & 87

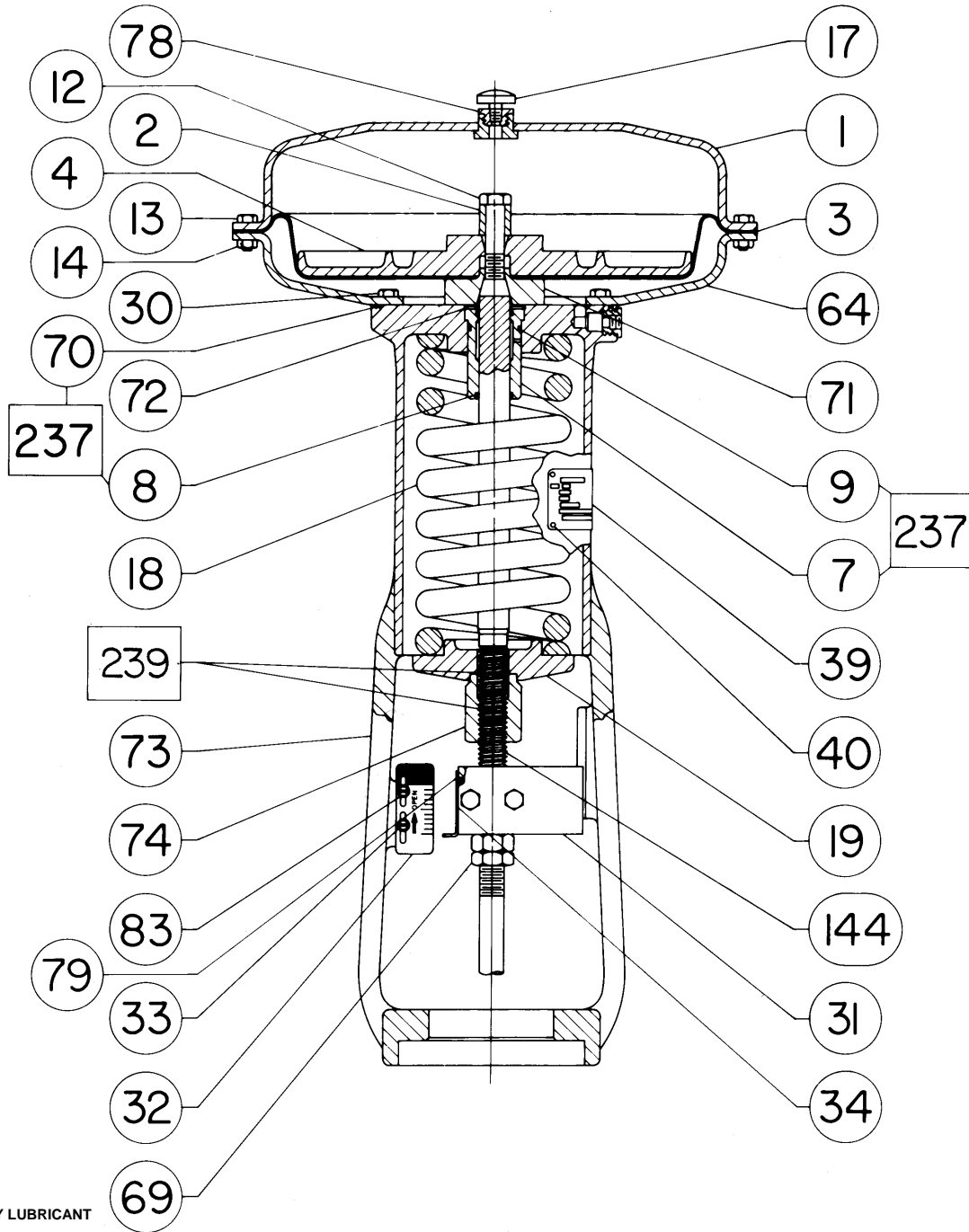


Figure 9. Type 667 Size 87 Actuator

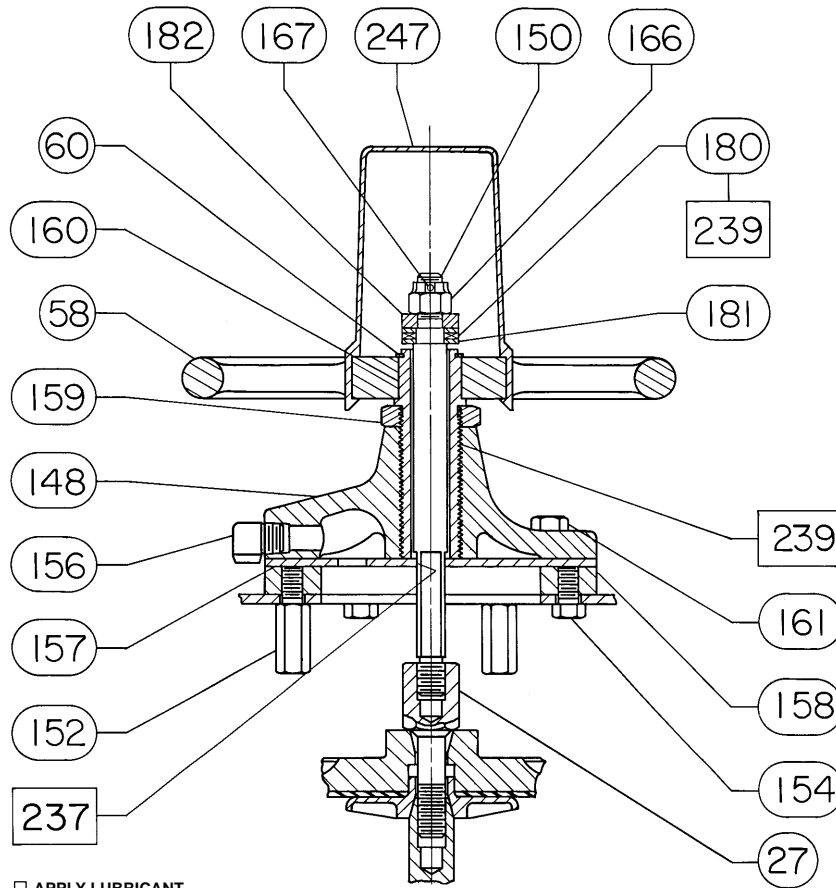
Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) STANDARD		34	DISC, TRAVEL INDICATOR (SST) (Cont'd) W/SIDE-MOUNTED HANDWHEEL	
	SIZE 30 & 34	1E793138992 1		SIZE 34	1E793138992 1
	SIZE 40 THROUGH 46	1E807538992 1		SIZE 40	1E807538992 1
	SIZE 50 & 60	1E832838992 1		SIZE 46	11B7008X012 1
	SIZE 70 & 76	1B971838992 1		SIZE 60 & 70	1E832838992 1
	SIZE 87	10A8487X012 1		SIZE 76	1B971838992 1



# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) (Cont'd)		73	YOKE	
	W/TYPE 304 SWITCH			CAST IRON	
	SIZE 30 & 34	10A0038X012 2		MOUNTING BOSS UNTAPPED	
	SIZE 40 THROUGH 46	1N253936012 2		SIZE 30	3E801419042 1
	SIZE 50 & 60	1N254036012 2		SIZE 34	3E884619042 1
39	NAMEPLATE			SIZE 40	3E820819042 1
	STAINLESS STEEL			SIZE 45 & 46	3E900819042 1
	ALL SIZES	12B6508X0A2 1		SIZE 50 & 60	3E845919042 1
40	SCREW, DRIVE			SIZE 70	3N130319042 1
	STAINLESS STEEL			SIZE 76	42B5909X012 1
	ALL SIZES	1A368228982 6		SIZE 87	3N664219042 1
64	LOWER DIAPHRAGM CASING (STEEL)			MOUNTING BOSS UNTAPPED W/HANDWHEEL	
	STANDARD			SIZE 70 & 76	4N890119042 1
	SIZE 30	2E801125062 1		SIZE 87 TO 3 IN. (76 mm) TRAVEL	4N886619042 1
	SIZE 34 & 40	2E682625062 1		MOUNTING BOSS TAPPED	
	SIZE 45 & 50	3E845325062 1		SIZE 30	3L921419042 1
	SIZE 46, 60 & 76	3E847725062 1		SIZE 34	3L9203X0012 1
	SIZE 70 & 87	2N131025062 1		SIZE 40	3L921619042 1
	W/ 1/2 NPT CONNECTION			SIZE 45 & 46	3L894219042 1
	SIZE 30	2H3822X00A2 1		SIZE 50 & 60	3L921919042 1
	SIZE 34 & 40	2K506725062 1		SIZE 70	3N130419042 1
	SIZE 45 & 50	2H3081X00A2 1		SIZE 76	42B6795X012 1
	SIZE 46 & 60	2F803325062 1		SIZE 70 TYPE 667-4	31A7392X012 1
69	NUT, HEX, JAM (STEEL ZN PL)			SIZE 87	3N664319042 1
	STANDARD			SIZE 87 TYPE 667-4	31A3813X012 1
	SIZE 45	1A353724122 2		MOUNTING BOSS TAPPED W/HANDWHEEL	
	SIZE 40 & 46	1A353724122 1		SIZE 70 & 76	4N890219042 1
	SIZE 50 THROUGH 70 & 76	1A351124122 1		SIZE 70 TYPE 667-4	4N890119042 1
	1 IN. (25.4 mm) VALVE STEM			SIZE 87	4N889019042 1
	SIZE 87	1C635224122 2		SIZE 87 TYPE 667-4	4N889019042 1
	1-1/4 (31.8 mm) VALVE STEM			WCB (STEEL)	
	SIZE 87	0W073524122 2		MOUNTING BOSS UNTAPPED	
70*	GASKET			SIZE 30	3K815622012 1
	COMPOSITION [UP TO 450°F (232°C)]			SIZE 34	3H787122012 1
	SIZE 30 THROUGH 40	1E801204022 1		SIZE 40	3H787322012 1
	SIZE 45 THROUGH 60 & 76	1E845404022 1		SIZE 45 & 46	3H787522012 1
				SIZE 50 & 60	3K830322012 1
				SIZE 70	3N130622012 1
				SIZE 87	3N758722012 1
70*	O-RING			MOUNTING BOSS TAPPED	
	NITRILE			SIZE 30	3L921522012 1
	SIZE 70 & 87	1D269106992 1		SIZE 34	3L9202X0012 1
71	LOWER DIAPHRAGM PLATE			SIZE 40	3L921722012 1
	ZINC			SIZE 45 & 46	3L921822012 1
	SIZE 30	1E791344022 1		SIZE 50 & 60	3L922022012 1
	SIZE 34 & 40	1E682744022 1		SIZE 70	3N130722012 1
	SIZE 45 THROUGH 60 & 76	1E845544022 1		SIZE 87	3N758822012 1
	STEEL		74	SPRING ADJUSTER (STEEL, ZN PL)	
	SIZE 34 & 40	1F885824092 1		SIZE 30	1E801724102 1
	SIZE 45 THROUGH 60	1F890924092 1		SIZE 34 & 40	1E821024102 1
	STANDARD CONSTRUCTION			SIZE 45 THROUGH 60	1E846224102 1
	SIZE 70 & 87 TO 3-IN. (76 mm) TRAVEL	1N131524092 1		SIZE 70 & 87 W/HANDWHEEL	1N886924392 1
	STANDARD OR W/SIDE-MTD HANDWHEEL			SIZE 70 & 87 TYPE 667-4	11A3811X012 1
	SIZE 70 & 87 W/4-IN. (102 mm) TRAVEL	1V7826X0012 1		SIZE 70 & 87 TYPE 667-4 W/HANDWHEEL	1N886924392 1
72	RING, SNAP			SIZE 76	
	S30200 (302 SST)			MAX SPRING ADJUSTMENT (ADJ)	
	STANDARD			2-INCH (51 mm)	1N131824102 1
	SIZE 30 THROUGH 40	1E801337022 1		2.5-INCH (64 mm)	1N909524502 1
	SIZE 45 THROUGH 87	1E845638992 1		3.5-INCH (89 mm)	1U1079X00A2 1
				MAX SPRING ADJ W/SIDE-MOUNTED HANDWHEEL	
				2.25-INCH (57 mm)	1N886924392 1
				2.75-INCH (70 mm)	1V176624092 1

# Type 667 Size 30-76 & 87



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NOTE:

THE TOP MOUNTED HANDWHEEL IS NOT DESIGNED FOR USE UNDER HEAVY LOAD OR FREQUENT USE.

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Figure 10. Top-Mounted Handwheel Assembly for Size 30 through 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
75	NUT, HEX (STEEL, ZN PL) STANDARD SIZE 30 & 34	1P131224142 2	81	SCREW, MACH, RD HD (CARBON STEEL, PLATED) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1A331928982 2
	SIZE 40 & 46	1A413224122 1			
75	NUT, HEX (Cont.) SIZE 50 THROUGH 76	1A375424122 1	82	INDICATOR, TRAVEL, ADAPTOR (BRASS) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1F548214012 2
76	NUT, SPEED, TWIN STAINLESS STEEL STANDARD SIZE 30 & 34	1E793938992 1	83	WASHER, PLAIN CARBON STEEL-PLATED SIZE 70, 76 & 87 W/HANDWHEEL	1E873028992 2
	SIZE 40 THROUGH 46	1E808438992 1		BRASS SIZE 70, 76 & 87 W/HANDWHEEL	1F565618992 2
	SIZE 50 THROUGH 87	1E833538992 1			
77	STOP, TRAVEL (STEEL, ZN PL) (USE FOR PUSH-DOWN-TO-OPEN) SIZE 30 THROUGH 40	1H493524092 2	89	SPRING CASE ADAPTOR (CAST IRON) STANDARD SIZE 70 & 87 TYPE 667-4	2N889419042 1
	SIZE 45 THROUGH 60	1H494324092 2		W/HANDWHEEL SIZE 70 & 87 TYPE 667-4	3R675819042 1
78	BUSHING, PIPE, HEX (STEEL, PLATED ) SIZE 70 & 87	1C379026232 1	90	SCREW, CAP (STEEL, ZN PL) SIZE 70 & 87 TYPE 667-4	1N872428992 12
79	SCREW, MACH, FLAT HD (STEEL PLATED) SIZE 87	1H736528982 2	102	PLUG, PIPE, HEX HD (STEEL) W/ 1/2 NPT CONNECTION SIZE 30 THROUGH 60	1A767524662 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
144	ACTUATOR STEM (CHROMIUM PLATED STEEL)			<b>Top-Mounted Handwheel (Figures 10, 11, And 12)</b>	
	STANDARD		58	HANDWHEEL (CAST IRON)	
	SIZE 30	2E8016X0022 1		SIZE 30	1F119119042 1
	SIZE 34	3E8847X0012 1		SIZE 34 & 40	1F115819042 1
	SIZE 40	2E8209X0042 1		SIZE 45 TO 60 & 76	1F119819042 1
	SIZE 45 & 46	2J3328X0042 1		SIZE 70 & 87	2N837919042 1
	SIZE 50 & 60	2E8461X0042 1		STEEL	
	SIZE 70 & 76	2N131724222 1		SIZE 34 & 40	1H551922012 1
	SIZE 87	2N664724222 1		SIZE 45 TO 60 & 76	1H552122012 1
	W/SIDE-MOUNTED HANDWHEEL			SIZE 70 & 87	23B9744X012 1
	SIZE 34	2E8209X0042 1	60	RETAINER RING (STEEL, ZN PL)	
	SIZE 40	2F3259X0012 1		SIZE 34 & 40	1A911628992 1
	SIZE 70 3-IN. (76 mm) TRAVEL	2N890624222 1		Size 45 To 60 & 76	
	SIZE 70 TO 4-IN. (102 mm) TRAVEL	21A9816X012 1		8-INCH (203 mm) HANDWHEEL	1F120028992 1
	SIZE 76	23B7066X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	SIZE 87 3-IN. (76 mm) TRAVEL	2N889624222 1		SIZE 70 & 87	
	SIZE 87 TO 4-IN. (102 mm) TRAVEL	22A1501X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	TYPE 667-4 STANDARD		148	HANDWHEEL BODY	
	SIZE 70	21A3812X012 1		CAST IRON	
	SIZE 87	22A1963X012 1		SIZE 30 TO 40	27A9446X012 1
	TYPE 667-4 W/HANDWHEEL			SIZE 45 TO 60 & 76	27A9444X012 1
	SIZE 70	23A1793X012 1		SIZE 70 & 87	2N837719022 1
	SIZE 87	23A0125X012 1		STEEL	
	S31600 (316 SST)			SIZE 34 & 40	27A9636X012 1
	STANDARD			SIZE 45 TO 60 & 76	27A9445X012 1
	SIZE 30	1N429135162 1		SIZE 70 & 87	
	SIZE 34	1N429235162 1		EXTENSION ROD (416 SST)	
	SIZE 40	1N429335162 1		SIZE 30	29A9896X012 1
	SIZE 45	1N429535072 1		SIZE 34 & 40	29A9897X012 1
	SIZE 46 & 50	1N429435072 1		SIZE 45 TO 60 & 76	
	SIZE 60	1N429535072 1		UNDER 4000 LB (17,000 N·M)	23B9217X012 1
227	WASHER, PLAIN (STEEL, ZN PL)			4000 TO 6000 LB (17,000 TO 26,700 N·M)	23B9219X012 1
	W/TYPE 304 SWITCH			SIZE 45 TO 60 P-2	29A9900X012 1
	SIZE 40 THROUGH 46	1E658828982 2		SIZE 70 & 87	
	CARBON STEEL			3/4 IN. (19 mm) THROUGH	
	W/TOP-MOUNTED HANDWHEEL			3 IN. (76 mm) TRAVEL	24B0242X012 1
	SIZE 70 TO 3-IN. (76 mm) TRAVEL	1A521228992 1		4 IN. (102 mm) TRAVEL	24B0243X012 1
	W/TYPE 304 SWITCH		152	TRAVEL STOP (STEEL, ZN PL)	SEE FOLLOWING TABLE
	SIZE 60	1A375728992 2		154	CAP SCREW (PL STEEL)
	SIZE 70 & 76	1A375728992 1		SIZE 30 TO 40	1D529824052 3
228	STEM DISC SPACER [S41600 (416 SST)]			SIZE 45 TO 60 & 76	1A368424052 4
	W/TYPE 304 SWITCH			SIZE 70 & 87	1N129328992 9
	SIZE 70 TO 3-IN (76 mm) TRAVEL	1N952635132 1		156	VENT ASSEMBLY
	SIZE 76	1N952635132 1		SIZE 30 TO 60 & 76	27A5516X012 1
237	LUBRICANT, LUBRIPLATE MAG-1			SIZE 70 & 87	17A6572X022 1
	OR EQUIVALENT	---		157	GUIDE PLATE (STEEL)
	NOT FURNISHED WITH ACTUATOR	---		SIZE 30 TO 40	1F116428992 1
238	SEALANT, PERMATEx #2,			SIZE 45 TO 60 & 76	1F119528992 1
	FORM-A-GASKET			SIZE 70 & 87	1N837528982 1
	NOT FURNISHED WITH ACTUATOR	---		158	MOUNTING PLATE
239	LUBRICANT, ANTI-SIZE LUB-3			CAST IRON	
	NEVER-SEEZ OR EQUIVALENT			SIZE 30 TO 40	1F116519042 1
	NOT FURNISHED WITH ACTUATOR	---		SIZE 45 TO 60 & 76	1F119319042 1
254	WARNING NAMEPLATE	14B6769X0A2		STEEL, ZN PL	
				SIZE 34 & 40	1H552622012 1
				SIZE 45 TO 60 & 76	1H550922012 1

# Type 667 Size 30-76 & 87

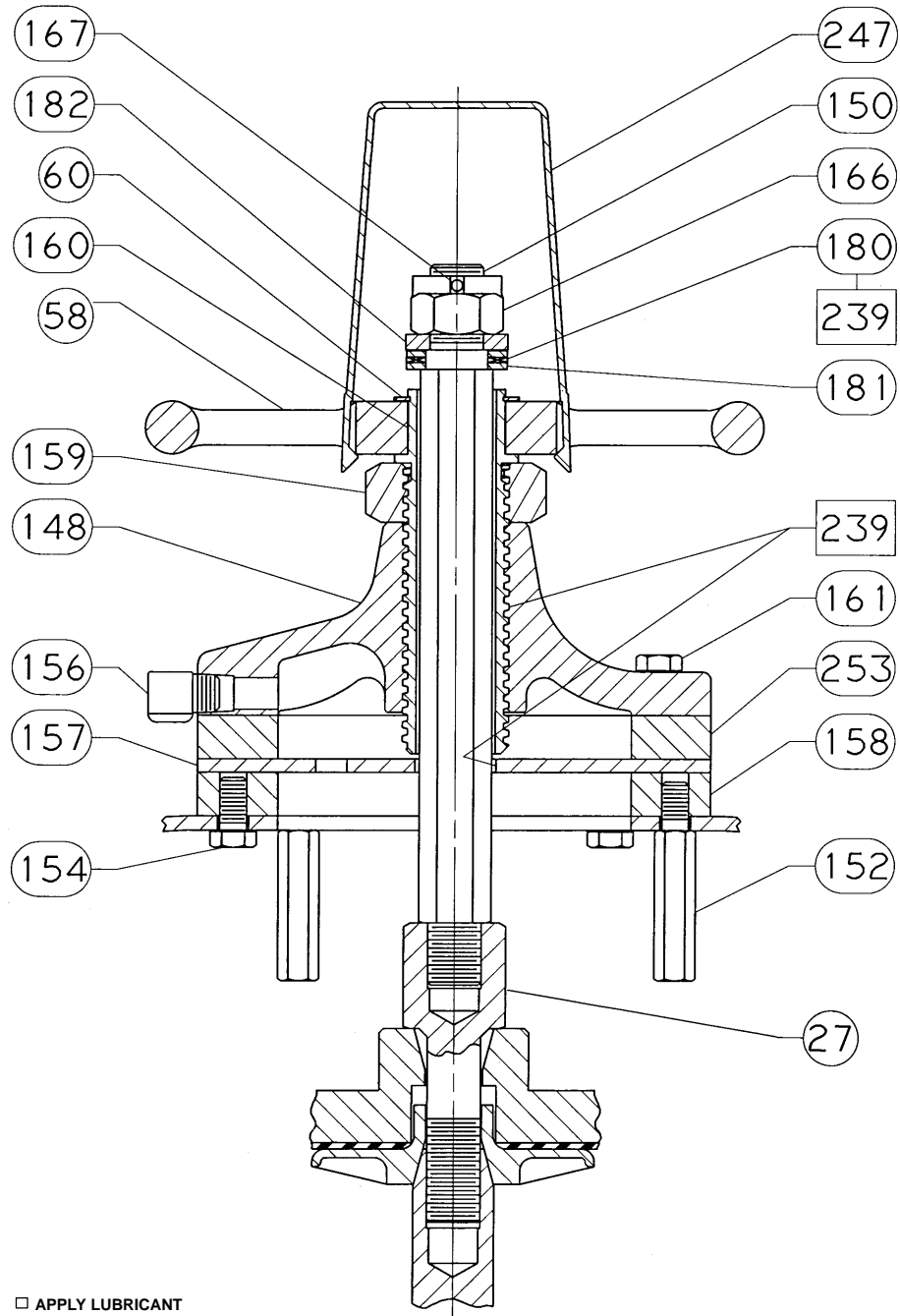


Figure 11. Top-Mounted Handwheel Assembly for Size 45-76 Actuators

# Type 667 Size 30-76 & 87

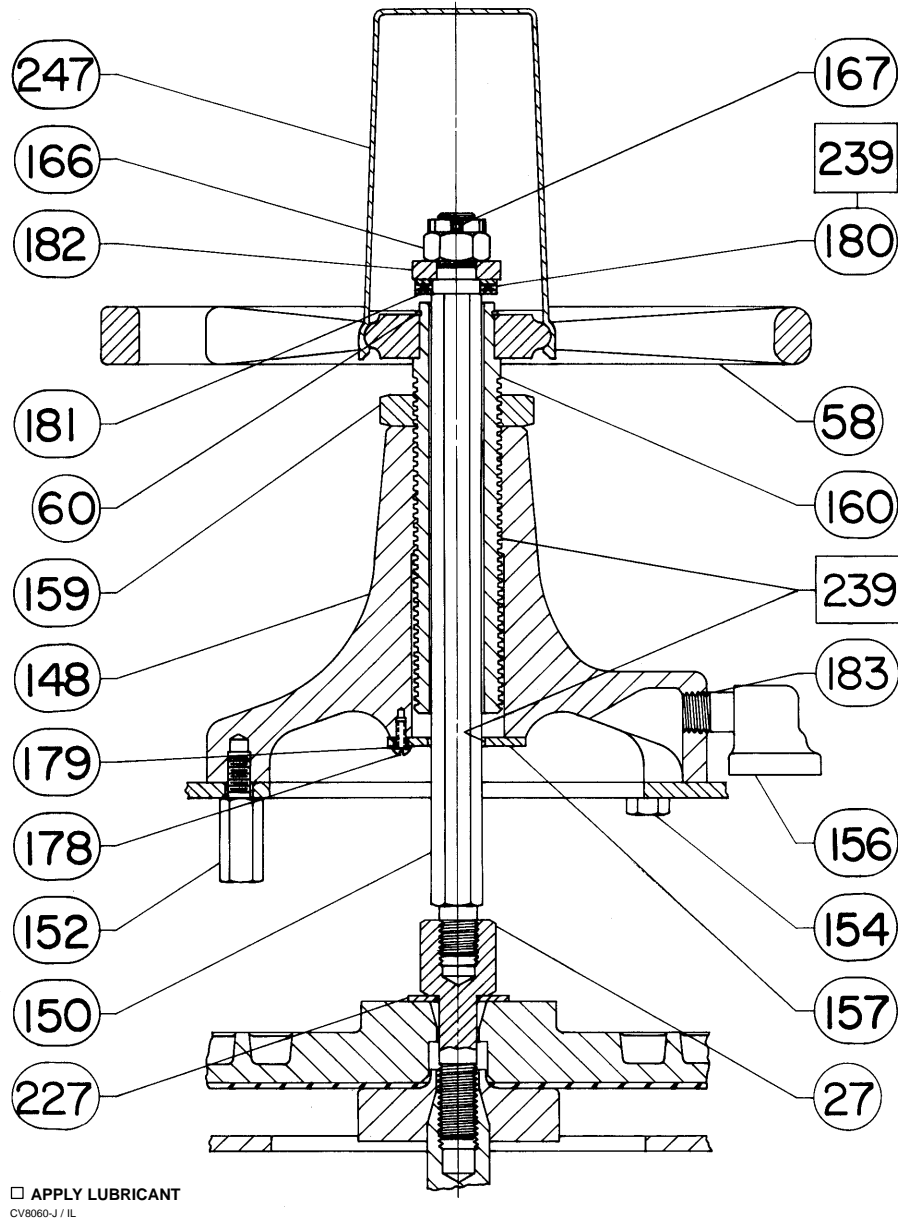


Figure 12. Top-Mounted Handwheel Assembly for Size 70 and 87 Actuators

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
159	LOCK NUT BRASS SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 STEEL, ZN PL SIZE 70 & 87	18A1271X012 1 18A2302X012 1 18A2302X012 1 1N837824102 1	247	HANDWHEEL CAP PLASTIC FOR CAST IRON HANDWHEEL SIZE 30 SIZE 34 TO 60 & 76 FOR STEEL HANDWHEEL SIZE 34 TO 60 & 76 FOR CAST IRON OR STEEL HANDWHEEL SIZE 70 & 87	27A8621X012 1 27A8622X012 1 28A1609X012 1 37A8623X012 1
160	HANDWHEEL SCREW (BRONZE) SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 SIZE 45 TO 60 P-2 SIZE 70 & 87	27A9639X012 1 27A9640X012 1 27A9637X012 1 27A9638X012 1 1N837414042 1	253	SPACER, HANDJACK CAST IRON SIZE 45 TO 76 STEEL SIZE 45 TO 76	23B9218X012 1 23B9221X012 1
161	CAP SCREW (PL STEEL) CAST IRON HANDWHEEL BODY SIZE 30 TO 40 STEEL HANDWHEEL BODY SIZE 34 & 40 CAST IRON & STEEL HANDWHEEL BODIES SIZE 45 TO 60 & 76	1A344924052 6 1N568232982 6 1A341824052 8	<b>Side-Mounted Handwheel (30-60, Figures 13 and 14)</b>		
166	CASTLE NUT (PL STEEL) SIZE 30 TO 40 SIZE 45 TO 87	1K193424122 1 1F120224122 1	51	HANDWHEEL CAST IRON SIZE 34 & 40 SIZE 45 TO 60	2D358519052 1 2D405019042 1
167	COTTER PIN SST SIZE 30 TO 40 SIZE 45 TO 87	1C5959X0012 1 1J340238992 1	54	HEX JAM NUT PL STEEL SIZE 34 & 40 SIZE 45 TO 60	1A352424112 1 1A352424122 1
178	MACHINE SCREW (PL STEEL) SIZE 70 & 87	1B877428992 4	55	BALL STEEL	1A342732992 1
179	LOCKWASHER (PL STEEL) SIZE 70 & 87	1A329128982 4	56	SPRING BRONZE	0D005916012 1
180	THRUST BEARING (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5444X012 1 1N838099012 1 13B9737X012 1	132	OPERATING NUT (STEEL) LEFT-HAND (DIRECT-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60 RIGHT-HAND (REVERSE-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60	1F659024092 1 2F548524092 1 1F658924092 1 2F548424092 1
181	THRUST RACE (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5446X012 2 1N838199012 2 13B9737X012 2	136	BEARING RETAINER STEEL SIZE 45 TO 60	1D385224092 1
182	BEARING RETAINER (STEEL, ZN PL) SIZE 30 TO 40 SIZE 45 THROUGH 60 & 76 SIZE 70 & 87	19A9895X012 1 19A9898X012 1 13B9741X012 1	142	HANDWHEEL BODY CAST IRON SIZE 34 & 40 SIZE 45 TO 60	3F6572000A2 1 3F1446000A2 1
183	PIPE NIPPLE (STEEL, GALV, ZN PL) SIZE 70 & 87	1K201526022 1	143	MOUNTING BOLTS STEEL SIZE 34 & 40 SIZE 45 & 46 SIZE 50 & 60	10A8522X012 2 18A9147X012 2 1F155624092 2
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	144	HEX NUT PL STEEL SIZE 34, 40, 50 & 60 SIZE 45 & 46	1A375324122 4 1A375324122 2
			145	HANDWHEEL SCREW BRONZE	

# Type 667 Size 30-76 & 87

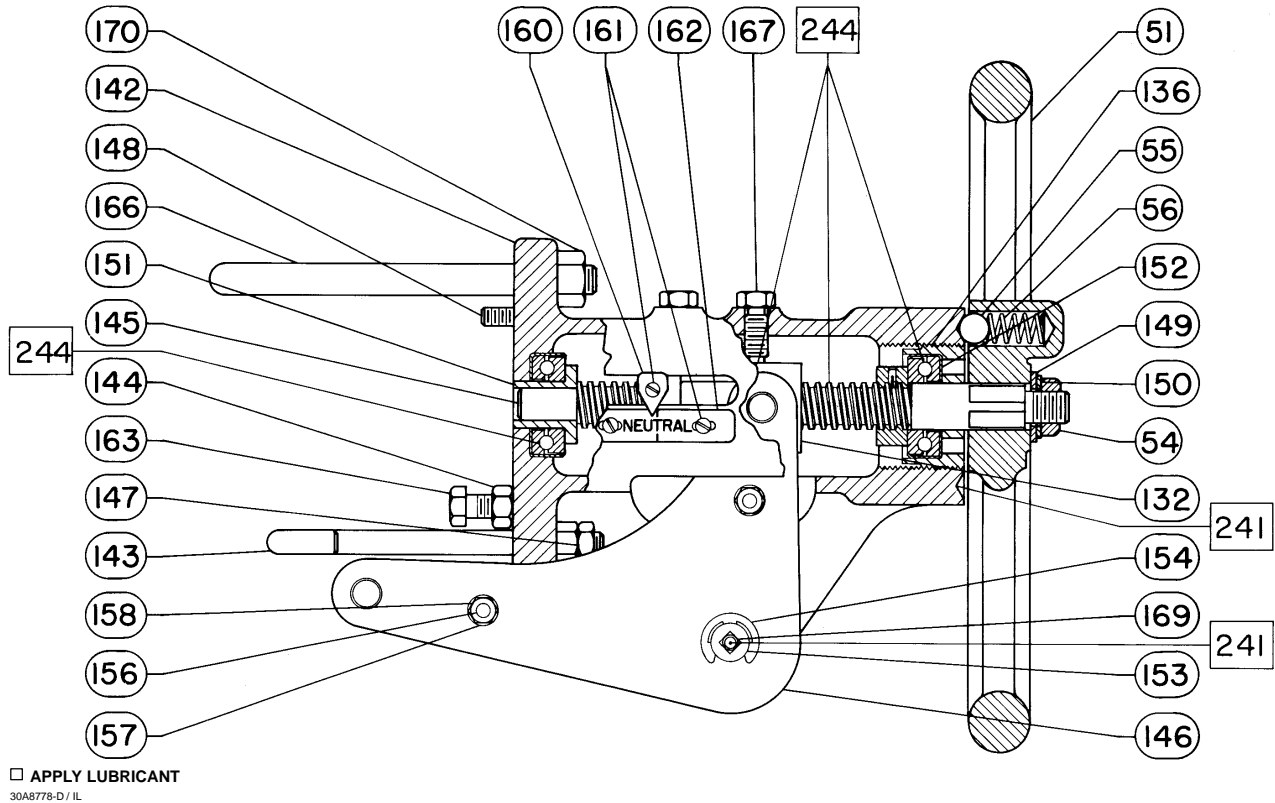
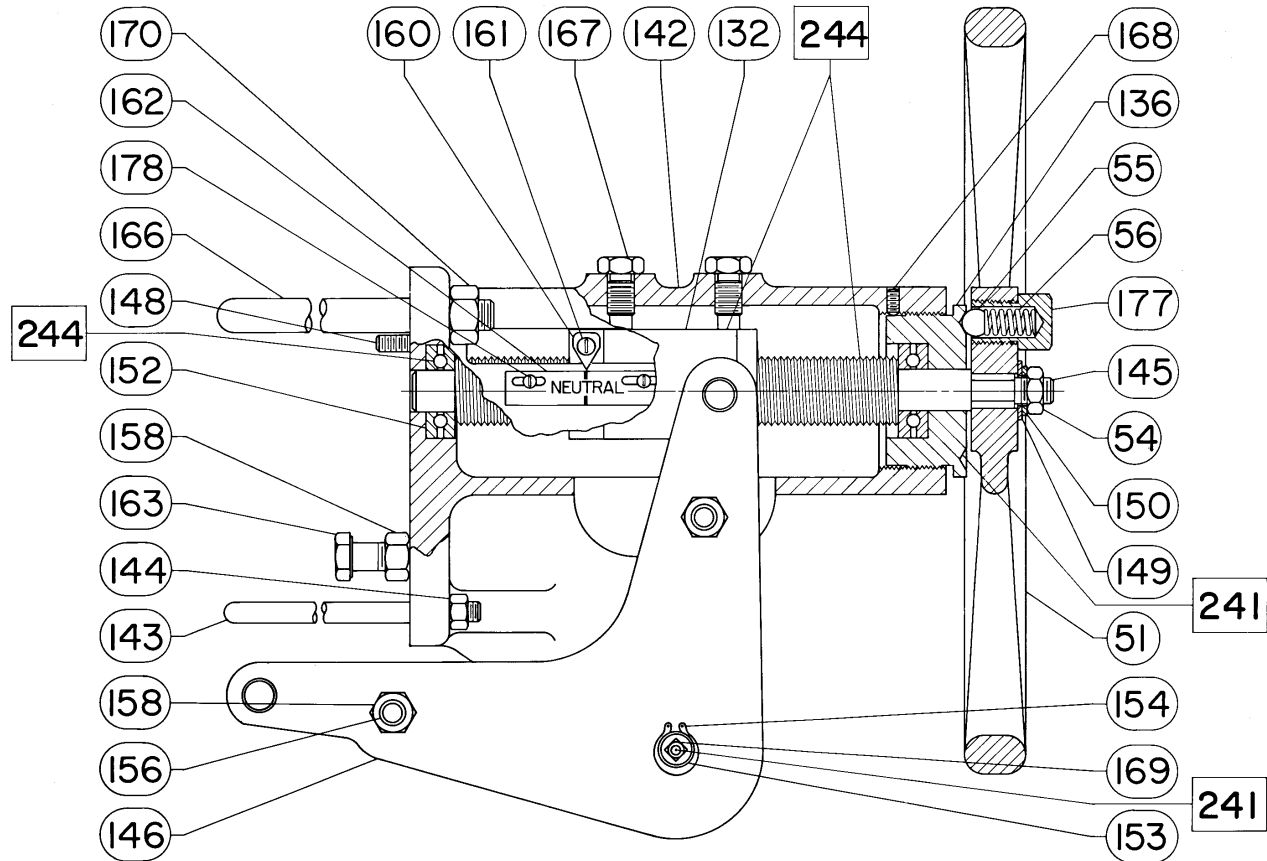


Figure 13. Side Mounted Handwheel Assembly for Size 34 and 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
	LEFT-HAND (DIRECT-ACTING VALVE)		153	LEVER PIVOT PIN (416 SST)	
	SIZE 34 & 40	1F6584000A2 1		SIZE 34 & 40	1F658135232 1
	SIZE 45 TO 60	1F548614052 1		SIZE 45 TO 60	1F156235232 1
	RIGHT-HAND (REVERSE-ACTING VALVE)		154	RETAINING RING (PL STEEL)	
	SIZE 34 & 40	1F6583000A2 1		SIZE 34 & 40	1F599428982 2
	SIZE 45 TO 60	1F548714052 1		SIZE 45 TO 60	1A903028992 2
146	LEVER & PIN ASSEMBLY		155	SPACER (STEEL)	
	STEEL			SIZE 34 & 40	1F658224092 2
	RIGHT-HAND SIDE			SIZE 45 TO 60	1F162524092 2
	SIZE 34 & 40	1F6614000A2 1	156	SCREW (PL STEEL)	
	SIZE 45 TO 60	1F1541000A2 1		SIZE 34 & 40	1D980628982 2
	LEFT-HAND SIDE			SIZE 45 TO 60	1F157624052 2
	SIZE 34 & 40	1F6613000A2 1	157	LOCKWASHER (PL STEEL) SIZE 34 & 40	1C225628982 2
	SIZE 45 TO 60	1F1539000A2 1	158	HEX NUT (PL STEEL) SIZE 34 & 40	1A345724122 2
147	HEX JAM NUT (PL STEEL)	1A352224122 2		SIZE 45 TO 60	1A341224122 4
148	DOWEL PIN (STEEL, ZN PL)	1D419828992 2	159	POINTER MOUNTING BOLT (416 SST)	
	SIZE 34 TO 60			SIZE 34 & 40	1F657835132 1
149	WASHER (PL STEEL)	1A518925072 1		SIZE 45 TO 60	1F156535132 1
150	LOCKWASHER (PL STEEL)	1A353828982 1	160	POINTER (302 SST)	1F157536012 1
151	BUSHING (PL STEEL)		161	MACHINE SCREW (PL STEEL)	
	SIZE 34 & 40	1F657924092 1		SIZE 34 & 40	1A344524052 8
152	BALL BEARING (STEEL)	1D361399012 2		SIZE 45 TO 60	1E175828982 1

# Type 667 Size 30-76 & 87



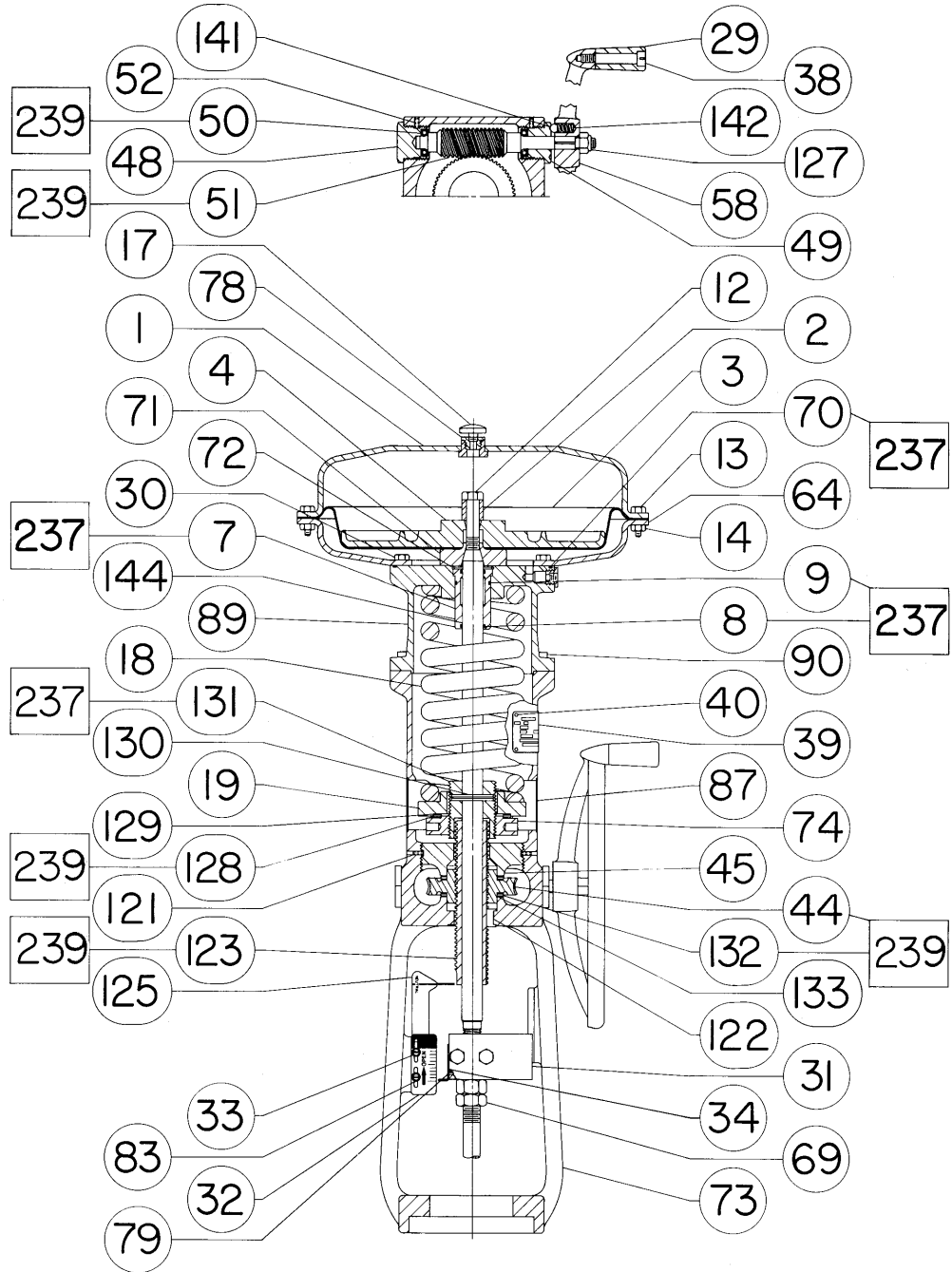
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Figure 14. Side-Mounted Handwheel Assembly for Size 45 and 60 Actuators

Key	Description	Part Number	Key	Description	Part Number
162	INDICATOR PLATE (ALUMINUM) SIZE 34 & 40 SIZE 45 TO 60	1F936411992 1 1D357411992 1	177	SPRING CAP (STEEL) SIZE 45 TO 60	1D385124092 1
163	CAP SCREW (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1C403824052 2 1A344424052 2	178	MACHINE SCREW (PL STEEL) SIZE 45 TO 60	1A331928982 2
166	U-BOLT (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1F657724092 1 1F155524092 1	241	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
167	GUIDE BOLT (416 SST) SIZE 34 & 40 SIZE 45 TO 60	1F657535132 2 1F155235132 2	244	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
168	SET SCREW (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A344724182 1 1A341528992 1	<b>Side-Mounted Handwheel, Size 70, 76 &amp; 87 (Figure 15)</b>		
169	GREASE FITTING	1H306199012 1	29	HANDGRIP (STEEL)	0U075624092 1
170	HEX NUT (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A341224112 2 1A343324122 2	38	HANDGRIP BOLT (STEEL)	0U077424092 1
			44	WORM GEAR (BRONZE)	2N886212052 1
			45	BEARING RETAINER FLANGE CAST IRON	1N889219042 1



# Type 667 Size 30-76 & 87



PART NOT SHOWN: 57  
 APPLY LUBRICANT  
 50A8604-F / IL

Figure 15. Size 70, 76, and 87 Actuator with Side Mounted Handwheel Assembly

# Type 667 Size 30-76 & 87

Key	Description	Part Number	
48	BACK WORM RETAINER (STEEL, ZN PL)	1N888324492	1
49	FRONT WORM RETAINER (STEEL, ZN PL)	1N888424092	1
50	BALL BEARING (STEEL)	1A339228992	2
51	WORM SHAFT (STEEL)	2N886331092	1
52	SET SCREW (STEEL)	1A710328992	2
57	GREASE FITTING	1A926728982	2
58	HANDWHEEL (CAST IRON)	3H734319052	1
87	COVER BAND ASS'Y	1N8879X00A2	1
89	SPRING CASE ADAPTOR (CAST IRON)		
	SIZE 70 & 87	2N889419042	1
	SIZE 76	33B8000X012	1
90	CAP SCREW (STEEL, ZN PL)	1N872428992	12
121	SET SCREW (PL STEEL)	1A712228992	2
122	KEY (STEEL)	1N888025092	1
123	LOWER SLEEVE (STEEL)		
	SIZE 70 & 87		
	3 IN. (76 mm) TRAVEL	2N888224092	1
	4 IN. (102 mm) TRAVEL	21A8262X012	1
	SIZE 76	2N888224092	1
125	HANDWHEEL INDICATOR (SST)	10A2446X012	1
127	STOP NUT (STEEL, ZN PL)	1A780528992	1
128	NEEDLE BEARING (STEEL)	1N888599012	1
129	NEEDLE BEARING RACE (STEEL)	1N888699012	2
130	ROLL PIN (STEEL)	1N889828992	1
131	SPRING ADJUSTING SCREW (STEEL, ZN PL)		
	SIZE 70 & 87		
	3/4 TO 3 IN (19 TO 76 mm) TRAVEL	1N889724092	1
	4 IN. (102 mm) TRAVEL	11A9817X012	1
	SIZE 76	1N889724092	1
132	NEEDLE BEARING (STEEL)	1N888799012	2
133	NEEDLE BEARING RACE (STEEL)	1N888899012	4
141	BALL (STEEL)	1A342732992	1
142	SPRING (BRONZE)	0D005916012	1
237	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	

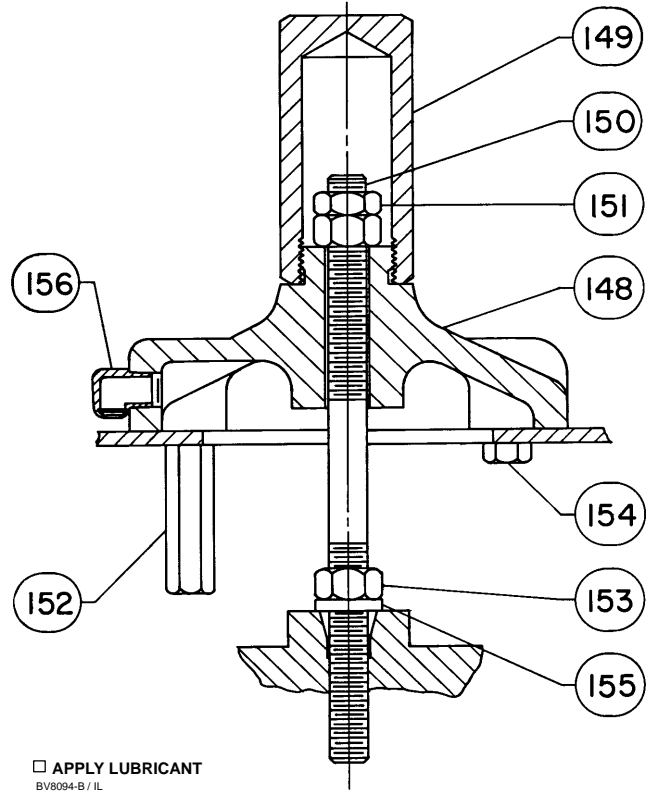


Figure 16. Style 10 Down Travel Stop (Casing Mounted)

Key	Description	Part Number
<b>Casing-Mounted Travel Stops (Figures 16 Through 20)</b>		
58	HANDWHEEL CAST IRON STYLE 13 UP TRAVEL STOP	
	SIZE 30	1F143819052 1
	SIZE 34 THROUGH 60	1F118119042 1
102	PLUG, PIPE STYLE 12 UP TRAVEL STOP	
	SIZE 70 & 87	1D754828982 1
127	HEX NUT (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A353724122 1
148	TRAVEL STOP BODY (CAST IRON)	
	STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 40	1K723519012 1
	SIZE 45 THROUGH 60	2K723019012 1
	SIZE 70 & 87	2U141819022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9446X012 1
	SIZE 45 THROUGH 60	27A9444X012 1
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	37A9437X012 1
	SIZE 45 THROUGH 60	37A9432X012 1
	SIZE 70 & 87	37A9661X012 1

# Type 667 Size 30-76 & 87

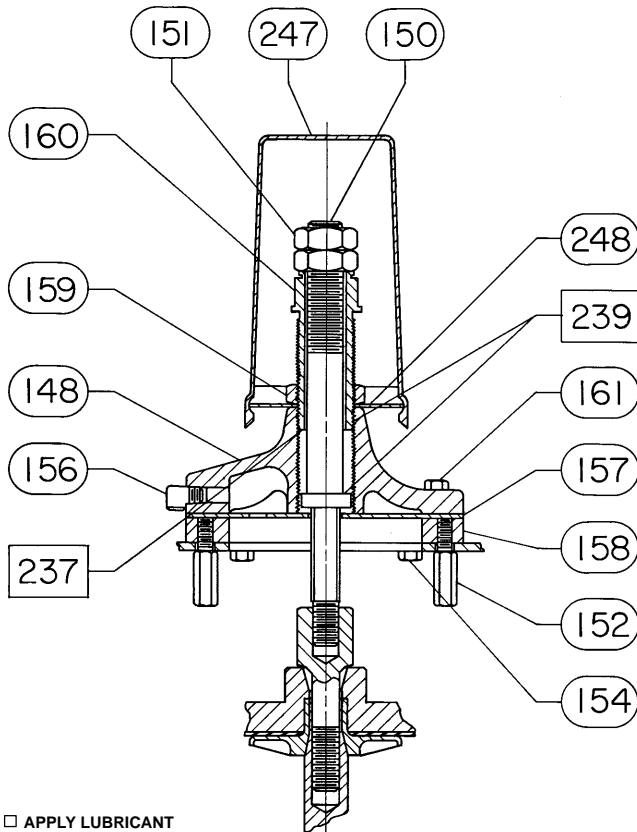


Figure 17. Style 11 Up Or Down Travel Stop (Casing Mounted)

Key	Description	Part Number	
148	TRAVEL STOP BODY (CAST IRON) (Cont'd)		
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 W/ 1/4 NPT CONNECTION	37A9437X012	1
	STYLE 13 UP TRAVEL STOP (CONT.)		
	SIZE 30 W/ 1/2 NPT CONNECTION	37A9438X012	1
	SIZE 34 & 40 W/ 1/4 NPT CONNECTION	37A9439X012	1
	SIZE 34 & 40 W/ 1/2 NPT CONNECTION	37A9440X012	1
	SIZE 45 THROUGH 60 W/ 1/4 NPT CONNECTION	37A9432X012	1
	SIZE 45 THROUGH 60 W/ 1/2 NPT CONNECTION	37A9434X012	1
149	TRAVEL STOP CAP (BRASS)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1H111114012	1
	SIZE 70 & 87	1R387614012	1
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1F839614012	1
	SIZE 70 & 87	1R387614012	1
	STEEL		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597824092	1
150	EXTENSION ROD		
	S41600 (416 SST)		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	28A1267X022	1
	STEEL, ZN PL		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 45 THROUGH 60	28A1266X012	1

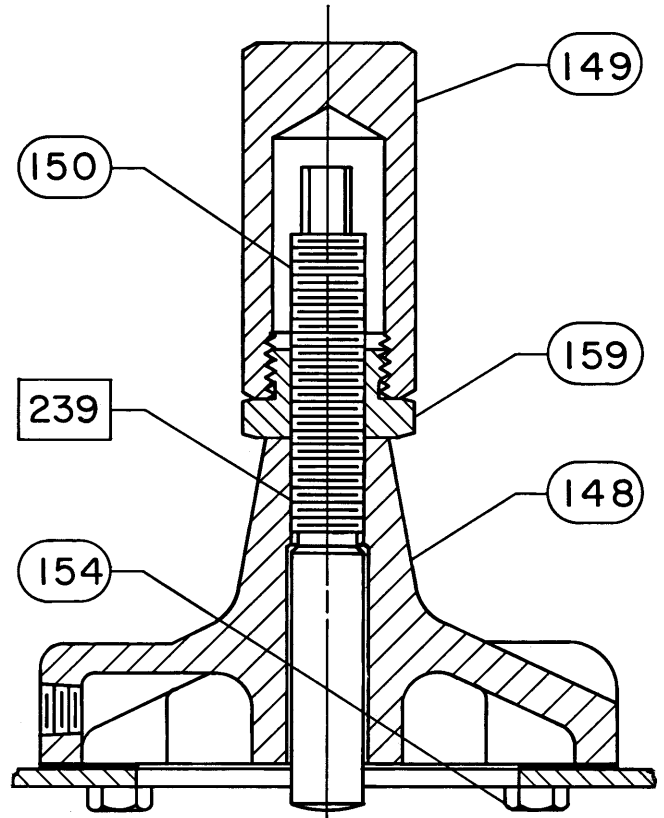
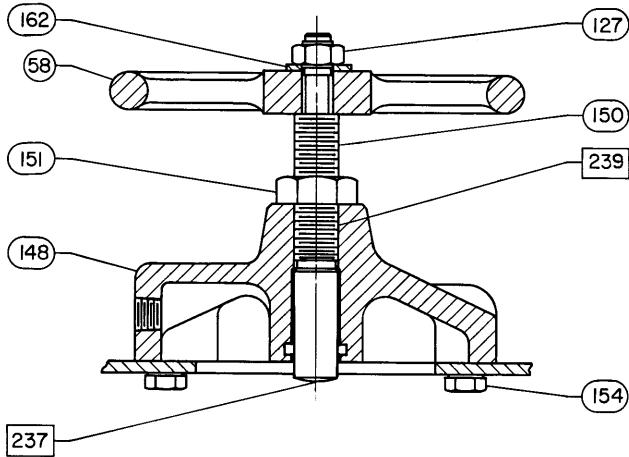


Figure 18. Style 12 Up Travel Stop (Casing Mounted)

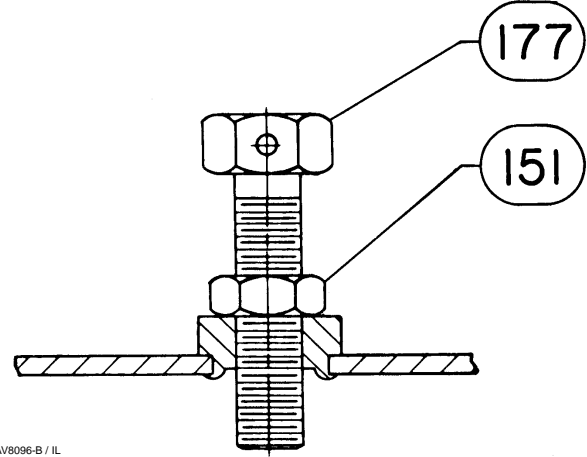
Key	Description	Part Number	
150	TRAVEL STOP STEM		
	S30300 (303 SST)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30	1H330735032	1
	SIZE 34 & 40	1F753635032	1
	SIZE 45 THROUGH 60	1J232735032	1
	SIZE 70 & 87	1V7764X00A2	1
	BRONZE		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	27A9655X012	1
	SIZE 45 THROUGH 60	27A9656X012	1
	SIZE 70 & 87	27A9763X012	1
	STYLE 13 UP TRAVEL STOP		
	SIZE 30	27A9652X012	1
	SIZE 34 & 40	27A9653X012	1
	SIZE 45 THROUGH 60	27A9654X012	1
151	HEX JAM NUT (STEEL, ZN PL)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1A353724122	1
	SIZE 45 THROUGH 87	1A351124122	1
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	1K130824122	2
	SIZE 45 THROUGH 60	1K130424122	2
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	18A2300X012	1
	STYLE 14 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	1A319224122	1
	SIZE 70, 87	1F118724122	1

# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT  
28A1204-B / IL

Figure 19. Style 13 Up Travel Stop  
(Casing Mounted), size 30 shown



AV8096-B / IL

Figure 20. Style 14 Up Travel Stop  
(Casing Mounted)

Key	Description	Part Number
152	TRAVEL STOP STYLE 10 AND 11 TRAVEL STOPS	SEE TABLE
153	NUT, HEX (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP (TOTAL OF 2 REQ'D FOR SIZE 30)	
	SIZE 30	1A413224122 1
	SIZE 30	1A346524122 1
	SIZE 34 & 40	1A413224122 2
	SIZE 45 THROUGH 87	1A375424122 2
154	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	1A368424052 4
	SIZE 70 & 87	1N129328992 9
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1D529824052 3
	SIZE 45 THROUGH 60	1A368424052 4
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
	SIZE 70 & 87	1N129328992 12
	STYLE 13 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
155	WASHER, LOCK, SPLIT (STEEL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30	1D716228982 1
	SIZE 34 & 40	1A487828992 1
	SIZE 45 THROUGH 60	1A873228992 1
	SIZE 70 & 87	1A549328982 1
156	VENT STYLE 10 & 12 TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	SIZE 70 & 87	17A6572X022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	STYLE 13 UP TRAVEL STOP	
	1/4 NPT CONNECTION	27A5516X012 1
	1/2 NPT CONNECTION	17A6572X022 1

Key	Description	Part Number
157	GUIDE PLATE (STEEL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116428992 1
	SIZE 45 THROUGH 60	1F119528992 1
158	MOUNTING PLATE (CAST IRON) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116519042 1
	SIZE 45 THROUGH 60	1F119319042 1
159	NUT, TRAVEL STOP BRONZE	
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	18A2301X012 1
	SIZE 45 THROUGH 60	18A2302X012 1
	BRASS	
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	18A2303X012 1
	STEEL	
	SIZE 30 THROUGH 40	18A2303X022 1
159	TRAVEL STOP NUT (BRASS) STYLE 12 UP TRAVEL STOP	
	SIZE 45 THROUGH 60	18A1272X012 1
160	SCREW, HANDWHEEL (BRONZE) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9640X012 1
	SIZE 45 THROUGH 60	27A9638X012 1
161	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1A336924052 6
	SIZE 45 THROUGH 60	1A341824052 8
162	WASHER (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A518925072 1
177	TRAVEL STOP SCREW S41600 (416 SST) STYLE 14 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1F753735132 1
	SIZE 45 THROUGH 60	1K131135132 1
	SIZE 70 & 87	13A2133X012 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
184	NIPPLE, PIPE, NPT (STEEL ZN PL)		239	LUBRICANT, ANTI-SEIZE LUB-3	
	STYLE 10 & 12 TRAVEL STOP			NEVER-SEEZ OR EQUIVALENT	
	SIZE 70 & 87	1K201526022 1		NOT FURNISHED WITH HANDWHEEL	---
	STYLE 13 UP TRAVEL STOP		247	TRAVEL STOP CAP, PLASTIC	
	W/ 1/2-IN NPT CONNECTION			STYLE 11	
	SIZE 30	1A473526012 1		SIZE 34 THROUGH 60	37A8623X012 1
	SIZE 34 & 40	1C782526012 1			
	SIZE 45 THROUGH 60	1H392826012 1	284	MOUNTING PLATE (STEEL, ZN PL)	
237	LUBRICANT, LUBRIPLATE MAG-1			STYLE 11 UP & DOWN TRAVEL STOP	
	OR EQUIVALENT			SIZE 34 & 40	17A9360X012 1
	NOT FURNISHED WITH TRAVEL STOP	---		SIZE 45 THROUGH 60	17A9361X012 1

# Type 667 Size 30-76 & 87

Key 2. Spacer, Steel, and Key 12 Travel Stop Cap Screw, Steel

TRAVEL		KEY	ACTUATOR SIZE					
Inches	mm		30	34	40	45 Through 60	76	70 & 87
3/16	5	2	---	1U721324092	1U721324092	---	---	---
		12	---	1R4088X0022	1R4088X0022	---	---	---
1/4	6	2	1R737024092	1U145024092	1U145024092	1U417824092	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	1R4098X0022	---	---
5/16	8	2	1R773024092	1U569824092	1U569824092	---	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	---	---	---
11/32	9	2	1U437224052	---	---	---	---	---
		12	1A8678X0012	---	---	---	---	---
3/8	10	2	1R767724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
7/16	11	2	1R408724092	1R409324092	1R409324092	1R410324092	---	---
		12	1A6857X0032	1R4088X0022	1R4088X0022	1R4098X0022	---	---
1/2	13	2	1U328924092	1R782324092	1R782324092	1R411424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
9/16	14	2	1J830724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
5/8	16	2	1R408624092	1R409424092	1R409424092	1R410424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
11/16	17	2	1U726324092	1U726224092	1U726224092	---	---	---
		12	1B2275X0022	1R4089X0042	1R4089X0042	---	---	---
3/4	19	2	1R408524092	1R409524092	1R409524092	1R410524092	1R410524092	1R411624092
		12	1B2275X0022	1R4089X0042	1R4089X0042	1R4098X0022	1R4110X0012	1R4110X0012
7/8	22	2	---	---	1R927624092	17A4720X012	17A4720X012	---
		12	---	---	1U8659X0022	1R4099X0022	1R4099X0022	---
1	25	2	---	1U866024092	1U866024092	1R411324092	1R411324092	1U803124092
		12	---	1U8659X0022	1U8659X0022	1R4099X0022	1R4099X0022	1R4111X0012
1-1/8	29	2	---	1R409624092	1R409624092	1R410824092	1R410824092	1R411524092
		12	---	1R4091X0032	1R4091X0032	1R4099X0022	1R4099X0022	1R4111X0012
1-3/16	30	2	---	---	1U137724092	1U164824092	---	---
		12	---	---	1R4092X0022	1R4099X0022	---	---
1-1/4	32	2	---	---	11A2680X012	1U143224092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-3/8	35	2	---	---	1U176124092	1U276824092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-1/2	38	2	---	---	1R409724092	1R410624092	1R410624092	1R411424092
		12	---	---	1R4092X0022	1R4101X0022	1R4101X0022	1R4098X0022
1-5/8	41	2	---	---	---	1R712924092	---	1R410424092
		12	---	---	---	1R4101X0022	---	1R4098X0022
1-7/8	48	2	---	---	---	1U256124092	---	---
		12	---	---	---	1R4102X0012	---	---
2	51	2	---	---	---	1R410724092	1R410724092	1R411324092
		12	---	---	---	1R4102X0012	1R4102X0012	1R4099X0022
2-1/8	54	2	---	---	---	---	---	1R410824092
		12	---	---	---	---	---	1R4099X0022
2-1/2	64	2	---	---	---	---	---	1R410624092
		12	---	---	---	---	---	1R4101X0022
3	76	2	---	---	---	---	---	1R410724092 <sup>(1)</sup>
		12	---	---	---	---	---	1R4102X0012
4	102	2	---	---	---	---	---	10A2426X012
		12	---	---	---	---	---	1E7246X0022

1. For Type 667-4, part number is 17A2270X012.

# Type 667 Size 30-76 & 87

Key 18. Actuator Spring, Steel<sup>(1)</sup>

ACTUATOR SIZE	DIAPHRAGM PRESSURE RANGE		TRAVEL, INCHES (mm)					
			7/16 (11)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (38)	2 (51)
	Psig	Bar						
30	3-15	0.2-1.0	1E795327082 Light Blue	1E795527092 Brown	1E792327092 Dark Gray	---	---	---
	6-30	0.4-2.0	1E795627082 White	1E795427082 Light Gray	1E792427082 Light Green	---	---	---
34 <sup>(2)</sup> & 40	3-15	0.2-1.0	1E805127082 Aluminum	1E804927082 Yellow	1E805827082 Light Gray	1E805327092 Dark Gray	1E805627092 <sup>(3)</sup> Dark Green	---
	6-30	0.4-2.0	1E805027082 Purple	1E804827082 Light Blue	1E805227082 Orange	1E805527082 Dark Blue	1E805827082 <sup>(3)</sup> Light Gray	---
45 & 50	3-15	0.2-1.0	---	1E826727082 Purple	1E826227082 Light Green	1E826127082 Dark Gray	1E826627082 Orange	1E826927082 Dark Green
	6-30	0.4-2.0	---	1E825627082 Light Blue	1E825527082 Aluminum & Red	1E826427082 Light Gray	1E826227082 Light Green	1E826527082 Red
46 & 60	3-15	0.2-1.0	---	1E825827082 Yellow	1E825727082 Brown	1E826227082 Light Green	1E826527082 Red	1E827027082 Aluminum & Dark Blue
	6-30	0.4-2.0	---	---	1E826027082 Bronze	1E825527082 Aluminum & Red	1E825727082 Brown	1E826327082 Aluminum & Dark Green
			<b>3/4 (19)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102)</b>
70 & 87	3-15	0.2-1.0	1N127927082 Red	1N719327082 White	1N128727082 Yellow	1N128427082 Light Green	1N128627082 Dark Gray	---
	6-30	0.4-2.0	---	1N128127082 Brown	1N127927082 Red	1N128527082 Light Blue	1N128727082 Yellow	1R67607082 <sup>(4)</sup> Black

1. Other spring selections are available by contacting your Fisher Controls sales office or sales representative.  
2. 1-1/8 inch travel is available for size 34, and 1-1/2 inch travel is available for size 40 only.  
3. For size 40 only.  
4. Diaphragm pressure range for this spring and travel combination is 3-30 psig (0.2-2.0 bar).

Key 32. Travel Indicator Scale, Stainless Steel

SIZE	TRAVEL, INCHES (mm) <sup>(1)</sup>								
	7/16 (11)	1/2 (12)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (28)	2 (51)	3 (76)	4 (102)
30	1E793438992	1E793538992	1E793538992	1E793638992	---	---	---	---	---
34	1E793438992	1E807738982	1E807738982	1E793638992	17A9814X012	---	---	---	---
40	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(2)</sup>	1E808238992	1E808338992	---	---	---
45	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(3)</sup>	1E808238992	1E808338992	1R444538982	---	---
46	1E807638992	1E807738982	1E807738982	1E808138992	1E808238992	1E808338992	1R444538982	---	---
50	1E833038982	1E833038982	1E833038982	1E833138992 <sup>(4)</sup>	1E833238992	1E833338992	1E833438992	---	---
60	1F535238982	1E833038982	1E833138992	1E833138992	1E833238992	1E833338992	1E833428992	---	---
70	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012
76	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	---	---
87	---	---	---	1H745738992 <sup>(5)</sup>	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012

1. 2-inch maximum travel for size 76 actuator.  
2. 1U356138982 is for 1-inch (25 mm) travel.  
3. 1H147938992 is for 7/8-inch (22 mm) travel.  
4. 1U356238982 is for 1-inch (25 mm) travel.  
5. 1H745838992 is for 7/8-inch (22 mm) travel.

# Type 667 Size 30-76 & 87

Key 152. Travel Stop for Top-Mounted Handwheels and Style 10 and 11 Adjustable Travel Stops, Steel

ACTUATOR SIZE	TRAVEL INCHES (mm)							
	7/16 (11)	5/8 (16)	3/4 (19)	7/8 (22)	1 (25)	1-1/8 (29)	1-1/2 (38)	2 (51)
30 (3 req'd)	1F393224092 <sup>(1)</sup>	1E797924092 <sup>(1)</sup>	1E792524092 <sup>(1)</sup>	---	---	---	---	---
34 & 40 (4 req'd)	1E806424092 <sup>(2)</sup>	1E806524092	1E806624092	1F424624092	1H797624092	1E806724092	1E806824092	---
45 thru 60 & 76 (4 req'd)	---	1E827324092	1E831924092	1H1912X0012	1H355824092	1E831924092	1E806424092	1E832124092 <sup>(1)</sup>
	<b>3/4 (19)</b>	<b>7/8(22)</b>	<b>1 (25)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102) (3)</b>
70 & 87 <sup>(1)</sup> (3 req'd)	1N128824092	18A0351X012	---	1N128924092	1N129024092	1N12914092	1N129224092	11A8131X012

1. For top-mounted handwheels and style 10 travel stops.  
 2. For style 11 travel stops.  
 3. Type 667-4.

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## Design D and DA Valves

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### Introduction

#### Scope of Manual

This instruction manual includes installation, maintenance, and parts information for the Design D and DA valves. Refer to separate manuals for instructions covering the actuator, positioner, and accessories.



W0232- / IL

Figure 1. Design D Valve with Type 657 Actuator

Only persons qualified through training or experience should install, operate, and maintain this valve. If you have any questions about these instructions, contact your Fisher sales office before proceeding.



FISHER-ROSEMOUNT™

# Design D & DA

Table 1. Specifications

<p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b>          If the valve nameplate shows an ANSI pressure-temperature class, maximum inlet pressure and temperature is consistent with applicable ANSI class per ASME B16.34. If the nameplate does not show an ANSI class, it will show a maximum cold working pressure at 38°C (100°F) (for example, 3600, 6000, 9000, or 10,000 psi)</p> <p><b>Maximum Allowable Pressure Drops<sup>(2)</sup></b>  <b>Flow up:</b> Capable of full rated pressure drops  <b>Flow down:</b> See table 2 for pressure drop limits for ceramic trim</p> <p><b>Shutoff Classification Per ANSI/FCI 70-2 and IEC 60534-4</b>  <b>Standard:</b> Class IV  <b>Optional:</b> Class V</p>	<p><b>Maximum Service Temperature</b>          232°C (450°F)</p> <p><b>Flow Characteristic</b>          Equal Percentage</p> <p><b>Flow Direction</b>  <b>Design D Valve:</b> Flow up through the seat ring and out past the valve plug  <b>Design DA Valve:</b> Flow in either direction</p> <p><b>Approximate Weight</b>  <b>Design D:</b> 34 kg (75 lbs)  <b>Design DA:</b> 46 kg (100 lbs)</p>
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1. Do not exceed the pressure or temperature limits in this manual and any applicable standard limitations.  
 2. The pressure-temperature limits in this manual and in any applicable standard limitations should not be exceeded.

Table 2. Flow Down Pressure Drop Limits - Ceramic Trim Only

VALVE SIZE INCHES	SEAT RING DIAMETER, mm (INCHES)					
	6.4 (1/4)	9.5 (3/8)	12.7 (1/2)	19.1 (3/4)	25.4 (1)	31.8 (1-1/4)
	Pressure Drop, bar					
1	414	414	414	193	---	---
2	689	689	689	462	262	165
	Pressure Drop, psi					
1	6000	6000	6000	2800	---	---
2	10,000	10,000	10,000	6700	3800	2400

## Description

The Design D globe-style (figure 1) and Design DA angle-style (figure 4) valves are single-port, metal-seated valves for high-pressure applications.

## Specifications

Specifications for these valves are in table 1. Some of the specifications for a given valve appear on a nameplate, which is attached to the valve actuator or wired to the valve assembly if the valve was purchased without an actuator.

## Ceramic Trim

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

## WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

## Installation

## WARNING

**To avoid personal injury or property damage resulting from the sudden release of process pressure or bursting of parts, do not install the valve**

assembly where service conditions could exceed the limits given in this manual or on the appropriate nameplates. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

## CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Some body/trim material combinations are limited in their pressure drop and temperature ranges. Do not apply any other conditions to the valve without first contacting your Fisher sales office.

1. Before installing the valve, inspect it to be certain that the valve body cavity is free of foreign material. Clean out all pipelines to remove scale, welding slag, and other foreign materials.
2. Install the valve so that flow through the valve is in the direction shown by the arrow cast on the valve body. The control valve assembly may be installed in any position unless limited by seismic considerations. However, the normal method is with the actuator vertical above the valve. With some valves, the actuator may need support when it is not vertical. For more information, consult your Fisher sales office.
3. Use accepted piping and welding practices when installing the valve in the line. For flanged valve bodies, use suitable gaskets between the body flanges and pipeline flanges.

### Note

Depending on valve body materials used, post-weld heat treating might be needed. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrink-fit pieces and threaded connections may also loosen. In general, if post-weld heat treating is needed, remove all trim parts. Contact your Fisher sales office for additional information.

For screwed end connections, apply pipe compound to pipeline threads.

4. To allow continuous operation during inspection or maintenance, install a three-valve bypass around the control valve assembly.
5. If you received the actuator and valve body shipped separately, refer to the appropriate actuator instruction manual for the actuator mounting procedure.

## WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however the packing might require some readjustment to meet specific service conditions.

## Maintenance

### WARNING

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

# Design D & DA

Table 3. Bolting Torque for Packing Box Nuts (Key 15)

VALVE RATING	STEM DIAMETER		MINIMUM RECOMMENDED TORQUE		MAXIMUM RECOMMENDED TORQUE	
	mm	Inches	N•m	Lbf•in	N•m	Lbf•in
3600 or to Class 1500	9.5	3/8	4	36	5	48
	12.7	1/2	7	66	11	96
	19.1	3/4	16	144	24	216
6000 or Class 2500	9.5	3/8	5	42	7	60
	2.7	1/2	9	78	12	108
	19.1	3/4	20	180	30	264
9000 psi	12.7	1/2	6	54	8	72
	19.1	3/4	20	180	30	264
10,000 psi	12.7	1/2	6	54	8	72
	19.1	3/4	20	180	30	264

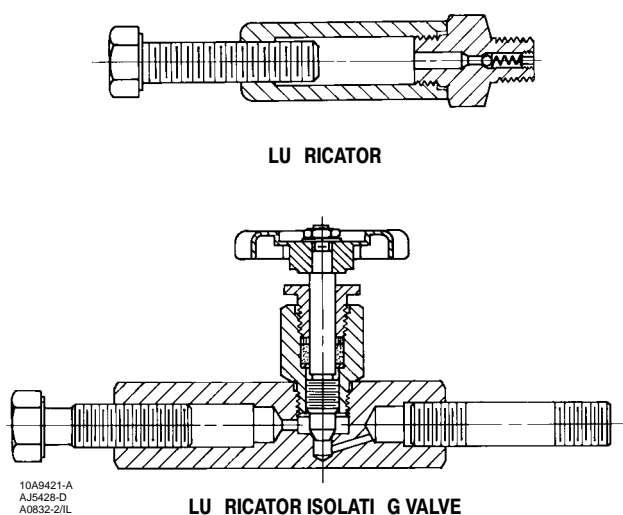


Figure 2. Lubricator and Lubricator/Isolating Valve (optional)

Valve body parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and lapping seating surfaces. All maintenance operations can be performed with the valve in the line.

Because of the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher.

### Note

**Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket upon reassembly. This is necessary to ensure a good gasket seal because the used gasket might not seal properly.**

## Packing Lubrication

The valve might have an optional lubricator or lubricator/isolating valve (figure 2) in the tapped bonnet. Use the lubricator or lubricator/isolating valve for PTFE/composition or other packings that need lubrication. Use a silicon-base lubricant. Do not lubricate packing used in oxygen service. To operate the lubricator, turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except open the isolating valve before turning the cap screw. Close the isolating valve after lubrication is completed.

## Packing Maintenance

Refer to figures 3, 4, and 5 for key number locations.

For spring-loaded single PTFE V-ring packing, the packing spring (key 9) maintains a sealing force on the packing. If you find leakage around the packing follower (key 10), check to be sure the packing follower is touching the bonnet (key 5). If the packing follower is not touching the bonnet, tighten the packing flange nuts (key 15) until the packing follower touches the bonnet. If you cannot stop leakage in this way, proceed to the *Replacing Packing* procedure.

If there is unwanted packing leakage with other than spring-loaded packing, first try to limit the leakage and seal the stem. To limit the leakage, tighten the packing flange nuts (key 15) to at least the minimum recommended torque in table 3. However, do not exceed the maximum recommended torque in table 3, or excessive friction might result. If the packing (key 8) is relatively new and tight on the stem, and tightening the packing flange nuts does not stop the leakage, a worn or nicked valve stem might prevent a seal. If the leakage comes from the outside diameter of the packing, nicks or scratches around the packing box wall might cause the leakage. While replacing the packing per the numbered steps below, inspect the valve stem and packing box wall for nicks and scratches.

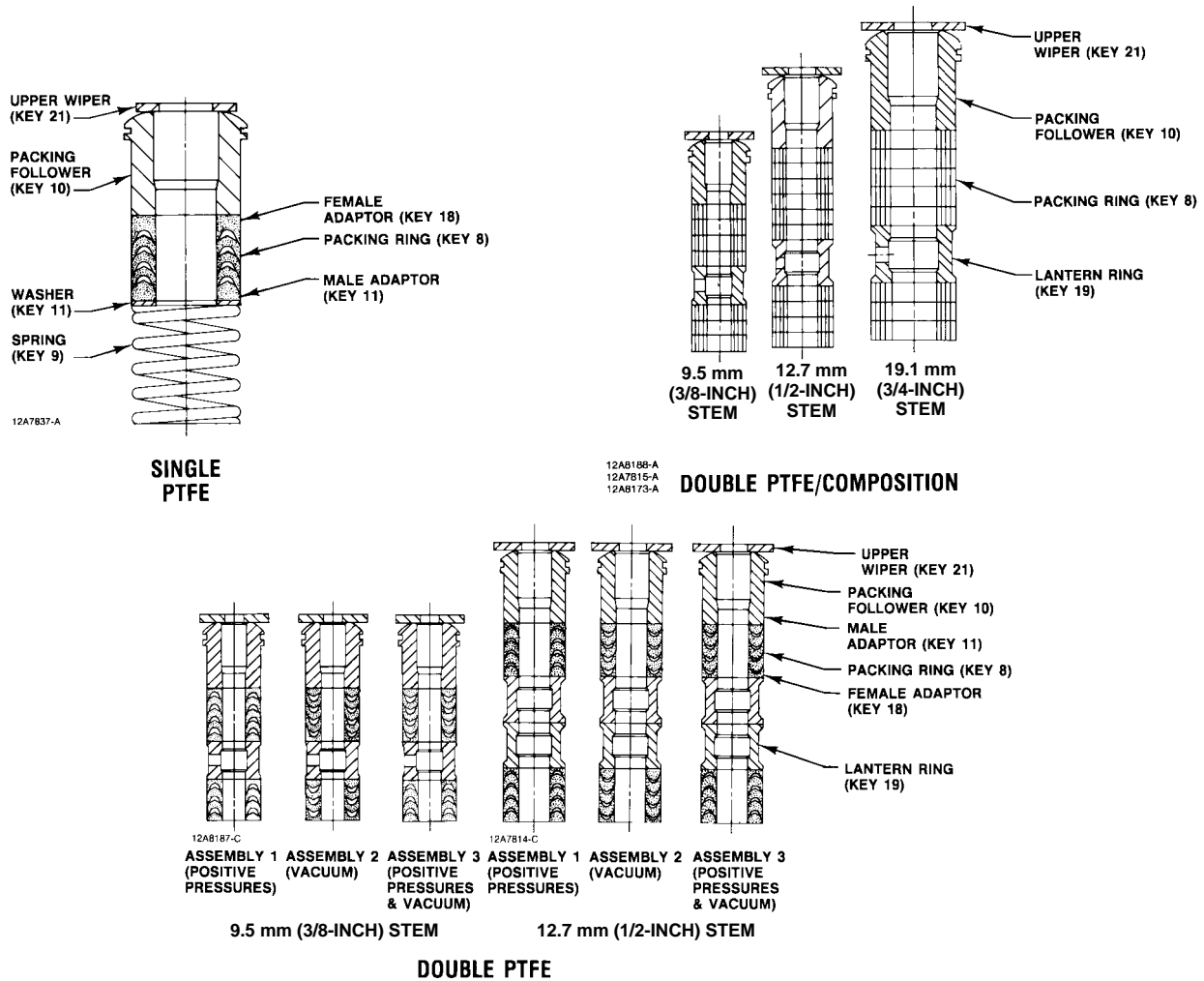


Figure 3. Packing Arrangements.

## Replacing Packing

Except where indicated, refer to figures 3, 4, and 5 for key number locations.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut-off all pressure lines to the power actuator and any leak-off piping from the bonnet. Release all pressure from the actuator and relieve spring precompression. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

Disconnect the stem connector, and then remove the actuator from the valve body by unscrewing the actuator yoke locknut (key 14).

2. Loosen the packing flange nuts (key 15) so the packing is not tight on the valve stem. Remove any

travel indicator parts and stem locknuts from the valve stem threads.

3. Unscrew the bonnet (key 5) from the valve body (key 1). Carefully lift off the bonnet and valve plug/stem assembly (key 4) as a unit. Set the bonnet on a protective surface to prevent damage to the bonnet threads and gasket surface.

4. Remove the valve plug/stem assembly from the bonnet. If you plan to re-use the valve plug, tape or otherwise protect the valve plug seating surface and the stem threads to prevent damage.

5. Remove the bonnet gasket (key 7). Cover the opening in the valve body to protect the gasket surface and prevent foreign material from getting into the body cavity.

6. Remove the packing flange nuts, packing flange, upper wiper, and follower (keys 15, 12, 21, and 10). Carefully push out all the remaining packing box parts from the bonnet using a rounded rod or other tool that will not scratch the packing box wall or bottom guide

# Design D & DA

bushing. Clean the packing box and the metal packing box parts.

7. Inspect the valve stem threads and packing box surfaces for any sharp edges that might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If you cannot improve the surface condition by light sanding, replace the damaged parts.

8. Install a new bonnet gasket (key 7), making sure the gasket seating surfaces are clean and smooth. Carefully install the valve plug/stem assembly into the valve body. Then slide the bonnet over the stem and thread it tightly into the valve body, per the torque values in table 4.

9. Install new packing and the metal packing box parts according to the correct arrangement in figure 3. Place a smooth-edged pipe over the valve stem, and gently tap each soft packing part into the packing box.

10. Slide the packing follower, upper wiper, and packing flange (keys 10, 21, and 12) into position. Lubricate the packing flange studs (key 13) and the faces of the packing flange nuts (key 15). Install the packing flange nuts.

11. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts (key 15) until the packing follower (key 10) contacts the bonnet. For other packing arrangements, tighten the packing flange nuts (key 15) alternately in small equal increments. Continue until one of the nuts reaches the minimum recommended torque shown in table 3. Then tighten the remaining packing flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

12. Mount the actuator on the bonnet (key 5) and connect the actuator and valve plug stem according to the procedure in the appropriate actuator instruction manual. Check for leakage around the packing follower when you put the control valve assembly into service. Retighten the packing flange nuts as required.

## Trim Maintenance

Refer to figure 4 and 5 for key number locations.

## Disassembly

1. Remove the actuator and the bonnet as described in steps 1 through 3 of the *Replacing Packing* procedure.

## CAUTION

**Use care to avoid damaging the gasket sealing surfaces.**

Table 4. Torque for Body-to-Bonnet Joint

VALVE SIZE, INCHES	RECOMMENDED TORQUE	
	N•m	Lbf•ft
1	1060	780
2 - 6000 <sup>(1)</sup>	2030	1500
2 - 10,000 <sup>(1)</sup>	9080	6700

1. Valve rating.

Table 5. Torque for Seat Ring (Key 2)

VALVE SIZE		RECOMMENDED TORQUE	
mm	Inches	N•m	Lbf•ft
25.4	1	407	300
50.8	2	698	515

**The stem surface finish of the valve plug/stem assembly (key 4) is critical for making a good packing seal. The seating surfaces of the seat ring (key 2) and the plug of the valve plug/stem assembly (key 4) are critical for tight shutoff. Protect these parts from damage if you plan to re-use them in the valve.**

2. If you wish, remove the valve plug/stem assembly (key 4) and the packing parts from the bonnet. If you plan to re-use the valve plug, tape or otherwise protect the valve plug seating surface and the stem threads to prevent damage. Remove the packing parts as described in the *Packing Maintenance* procedure.
3. Use a socket wrench to remove the seat ring (key 2).
4. Remove the seat ring (key 2) and seat ring gasket (key 3) from the valve body.
5. Inspect parts for wear or damage that would prevent proper operation of the valve body. Clean the gasket surfaces.
6. Replace trim parts as necessary or use the *Lapping Metal Seats* procedure.

## Lapping Metal Seats

A certain amount of leakage should be expected with metal-to-metal seating in any valve body. If the leakage becomes excessive, however, the condition of the seating surfaces of the valve plug and seat ring (keys 4 and 2, figures 4 and 5) can be improved by lapping. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Partially assemble the valve so the seat ring and valve plug are in place and the bonnet (with bushing installed) is screwed hand-tight into the body. Make a simple handle from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction with light downward pressure to lap the seats. If you think there is not

enough lubrication (for example, if you hear a squeaking noise or feel vibration), stop the procedure, and apply more lapping compound before continuing. After lapping, remove the bonnet and valve plug/stem assembly as a unit, and clean the seating surfaces. Completely assemble as described in the *Assembly* portion of the *Trim Maintenance* procedure.

Test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

## Assembly

1. Thoroughly clean the seat ring and bonnet threads in the valve body (key 1). Also clean the valve body seat ring gasket surfaces.
2. Apply Never-Seez Nickel Special lubricant or equivalent to the threads of the seat ring (key 2), bonnet (key 5), and their mating threads in the body.
3. Put the seat ring gasket (key 3) into the body.
4. Screw the seat ring into the body. Use a socket wrench to tighten the seat ring to the torque values shown in table 4. Remove all excess lubricant after tightening.
5. Clean the bonnet gasket seating surfaces, and install a new bonnet gasket (key 7).
6. If you had not removed the valve plug/stem assembly and packing from the bonnet, then install the bonnet (key 5) and valve plug/stem assembly (key 4) as a unit, into the valve body. Keeping the valve plug/stem assembly in an “up” position, thread the bonnet tightly into the valve body, per torque values in table 4.
7. If you had previously chosen to remove the valve plug/stem assembly and packing from the bonnet, then remove any protective tape or covering from the valve plug/stem assembly (key 4) and carefully install it into the valve body. Slide the bonnet (key 5) over the stem and thread it tightly into the valve body. Install new

packing and the metal packing box parts according to the correct arrangement in figure 3. Place a smooth-edged pipe over the valve stem, and gently tap each soft packing part into the packing box.

8. Slide the packing follower, upper wiper, and packing flange (keys 10, 21, and 12) into position. Lubricate the packing flange studs (key 13) and the washer surfaces of the packing flange nuts (key 15). Install the packing flange nuts.
9. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts (key 15) until the packing follower (key 10) contacts the bonnet. For other packing arrangements, tighten the packing flange nuts (key 15) alternately in small equal increments. Continue until one of the nuts reaches the minimum recommended torque shown in table 3. Then tighten the remaining packing flange nut until the packing flange is level and at a 90-degree angle to the valve stem.
10. Mount the actuator on the bonnet (key 5) and connect the actuator and valve plug stem according to the procedure in the appropriate actuator instruction manual. Check for leakage around the packing follower (key 10) when you put the control valve assembly into service. Retighten the packing flange nuts as required.

## Parts Ordering

Each body-bonnet assembly is assigned a serial number, which is on the body or nameplate. The serial number also appears on the actuator nameplate if you bought a valve and actuator assembly. Refer to this serial number when contacting your Fisher sales office for technical advice. When ordering replacement parts, mention the serial number. Also specify key number, part description, material, and part number from the following lists of *Parts Kits* and part numbers.

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## Parts Kits

Key	Description	Part Number
---	Packing Box Parts for Double PTFE V-Ring Packing (Includes keys 3, 7, 8, 11, 18, 19, and 21)	
	9.5 mm (3/8-Inch) Stem	RDX0000CN12
	12.7 mm (1/2-Inch) Stem	RDX0000CN22
---	Trim Package (31600) [Includes Equal Percentage S31600 (316 SST) W/R30006 (alloy 6) tip valve plug/stem (key 4), S316000 w/alloy 6 seat ring (key 2), stainless steel gaskets (keys 3 & 7), and single PTFE packing parts (keys 8, 9, 11, 17, 18, and 21) or double PTFE packing parts (keys 8, 11, 18, 19, and 21)]	
	Double PTFE V-Ring Packing	
	1 In. Valve w/ 9.5 mm (3/8-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXCNTRM112
	9.5 mm (3/8-Inch) port dia.	RDXCNTRM122
	12.7 mm (1/2-Inch) port dia.	RDXCNTRM132
	19.1 mm (3/4-Inch) port dia.	RDXCNTRM142
	2 In. Valve w/ 12.7 mm (1/2-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXCNTRM212
	9.5 mm (3/8-Inch) port dia.	RDXCNTRM222
	12.7 mm (1/2-Inch) port dia.	RDXCNTRM232
	19.1 mm (3/4-Inch) port dia.	RDXCNTRM242
	25.4 mm (1-Inch) port dia.	RDXCNTRM252
	31.8 mm (1-1/4-Inch) port dia.	RDXCNTRM262
---	Trim Package (Ceramic) Includes seat ring and valve plug/stem assembly (keys 2 and 4)	
	1-In. Valve w/ 9.5 mm (3/8-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXVTC00012
	9.5 mm (3/8-Inch) port dia.	RDXVTC00022
	12.7 mm (1/2-Inch) port dia.	RDXVTC00032
	19.1 mm (3/4-Inch) port dia.	RDXVTC00042
	2-In. Valve w/ 12.7 mm (1/2-Inch) Stem Dia.	
	6.4 mm (1/4-Inch) port dia.	RDXVTC00052
	9.5 mm (3/8-Inch) port dia.	RDXVTC00062
	12.7 mm (1/2-Inch) port dia.	RDXVTC00072
	19.1 mm (3/4-Inch) port dia.	RDXVTC00082
	25.4 mm (1-Inch) port dia.	RDXVTC00092
	31.8 mm (1-1/4 In) port dia.	RDXVTC00102

## Parts List

### Note

**Abbreviations used in this parts list are: SST (stainless steel), RTJ (ring-type joint), RF (raised face), SCH (schedule), BWE (buttwelding end), dia. (diameter), in. (inches), mm (millimeters), psi (pounds per square inch), and zn pl (zinc plated).**

**Sizes shown in inches are valve sizes unless otherwise stated.**

**Select parts titled 3600 PSI if your valve has a Class 1500 or lower rating and select parts titled 6000 PSI if your valve has a Class 2500 rating.**

Key	Description	Part Number
001	Valve Body If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
002*	Seat Ring CF8M or S31600 (316 SST) w/COCR-A seat	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	2B5097X0012
	9.5 mm (3/8-inch) port dia.	2B5098X0012
	12.7 mm (1/2-inch) port dia.	2B5099X0012
	19.1 mm (3/4-inch) port dia.	2B5100X0012
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	2B5106X0012
	9.5 mm (3/8-inch) port dia.	2B5107X0012
	12.7 mm (1/2-inch) port dia.	2B5108X0012
	19.1 mm (3/4-inch) port dia.	2B5109X0012
	25.4 mm (1-inch) port dia.	2B5110X0012
	31.8 mm (1-1/4 inch) port dia.	2K1801X0012
	316 SST w/tungsten carbide insert	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	1J6886000A2
	9.5 mm (3/8-inch) port dia.	1J6887000A2
	12.7 mm (1/2-inch) port dia.	1J6888000A2
	19.1 mm (3/4-inch) port dia.	1J6889000A2
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	1J6899000A2
	9.5 mm (3/8-inch) port dia.	1J8154000A2
	12.7 mm (1/2-inch) port dia.	1J8156000A2
	25.4 mm (1-inch) port dia.	1J8160000A2
	Ceramic	
	1-inch valve	
	6.4 mm (1/4-inch) port dia.	22B8996X012
	9.5 mm (3/8-inch) port dia.	22B8997X012
	12.7 mm (1/2-inch) port dia.	22B8998X012
	19.1 mm (3/4-inch) port dia.	22B8999X012
	2-inch valve	
	6.4 mm (1/4-inch) port dia.	22B9000X012
	9.5 mm (3/8-inch) port dia.	22B9001X012
	12.7 mm (1/2-inch) port dia.	22B9002X012
	19.1 mm (3/4-inch) port dia.	22B9003X012
	25.4 mm (1-inch) port dia.	22B9004X012
	31.8 mm (1-1/4 inch) port dia.	22B9005X012
003*	Gasket S31600 (316 SST)	
	For 1 In. valves and NACE MR0175 <sup>(1)</sup>	1B198636042
	For 2 In. valves and NACE MR0175 <sup>(1)</sup>	1B198836042
004*	Micro-Flute™ valve plug/stem assembly NACE MR0175 <sup>(1)</sup> S31600, COCR-A seat - S20910	
	1-In. valve, 9.5 mm (3/8-in.) stem	
	1 flute	
	6.4 mm (1/4-inch) port dia.	2N7147X0032
	3 flutes	
	6.4 mm (1/4-inch) port dia.	2F3280X0022
	9.5 mm (3/8-inch) port dia.	2N7389X0022
	12.7 mm (1/2-inch) port dia.	2N7338X0022
	19.1 mm (3/4-inch) port dia.	2N7393X0022

\*Recommended spare parts

1. These materials are listed in NACE standard MR0175 as being acceptable for direct exposure to sour environment when used under conditions stated in that standard.



# Design D & DA

Key	Description	Part Number	Key	Description	Part Number
004*	Equal percentage valve plug/stem assembly		005	Bonnet/Bushing Assy	
	S31600 (316 SST) w/S20910 (22-13-5) & Alloy 6 for NACE MR0175 <sup>(1)</sup>			If you need a bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
	1 in. valve, 9.5 mm (3/8-in.) stem		007*	Gasket	
	6.4 mm (1/4-inch) port dia.	2F1388X0042		S31600 (316 SST)	
	9.5 mm (3/8-inch) port dia.	2F1389X0032		For 1 in. valves and NACE MR0175 <sup>(1)</sup>	1B198236042
	12.7 mm (1/2-inch) port dia.	2F1390X0032		For 2 in. valves and NACE MR0175 <sup>(1)</sup>	1B198436042
	19.1 mm (3/4-inch) port dia.	2F1391X0032	008*	Packing Ring	
	2 in. valve, 12.7 mm (1/2-in.) stem			Double PTFE/Composition packing	
	6.4 mm (1/4-inch) port dia.	2F1427X0022		9.5 mm (3/8-in.) stem (7 req'd)	1F3370X0012
	9.5 mm (3/8-inch) port dia.	2F1428X0022		12.7 mm (1/2-in.) stem (10 req'd)	1E319001042
	12.7 mm (1/2-inch) port dia.	2F1429X0022		19.1 mm (3/4-in.) stem (8 req'd)	1E319101042
	19.1 mm (3/4-inch) port dia.	2F1430X0022		Double PTFE V-Ring	
	25.4 mm (1-inch) port dia.	2F1431X0022		9.5 mm (3/8-in.) stem (6 req'd)	1C752601012
	31.8 mm (1-1/4 inch) port dia.	2L5331X0032		12.7 mm (1/2-in.) stem (6 req'd)	1C752701012
	S31600 (316 SST) w/tungsten carbide tip for NACE MR0175 <sup>(1)</sup>			19.1 mm (3/4-in.) stem (6 req'd)	1C752801012
	1 in. valve, 9.5 mm (3/8-in.) stem		010	Packing Follower	
	6.4 mm (1/4-inch) port dia.	2J6894X0022	011*	Packing Adaptor, male	
	9.5 mm (3/8-inch) port dia.	2J6895X0022		Double PTFE V-Ring packing	
	12.7 mm (1/2-inch) port dia.	2J6896X0022		9.5 mm (3/8-in.) stem (2 req'd)	1F124801012
	19.1 mm (3/4-inch) port dia.	2J6897X0022		12.7 mm (1/2-in.) stem (2 req'd)	1F124701012
	2 in. valve, 12.7 mm (1/2-in.) stem			19.1 mm (3/4-in.) stem (2 req'd)	1F124601012
	6.4 mm (1/4-inch) port dia.	2J8189X0022	012	Packing Flange	
	9.5 mm (3/8-inch) port dia.	2J8191X0022	013	Packing Box Stud	
	12.7 mm (1/2-inch) port dia.	2J8193X0022	014	Yoke Locknut, steel	
	19.1 mm (3/4-inch) port dia.	2J8195X0022	015	Hex Nut	
	25.4 mm (1-inch) port dia.	2J8197X0052	016	Pipe Plug	
	31.8 mm (1-1/4 inch) port dia.	2V2234X0022	016	Stem Lubricator/Isolating Valve	
	Ceramic		016	Pipe Nipple, for lubricator/isolating valve	
	1-in. valve, 9.5 mm (3/8-in) stem		016	Stem Lubricator	
	6.4 mm (1/4-inch) port dia.	22B8956X012	018*	Packing Adaptor, female	
	9.5 mm (3/8-inch) port dia.	22B8957X012		Double PTFE V-Ring	
	12.7 mm (1/2-inch) port dia.	22B8958X012		9.5 mm (3/8-in.) stem (2 req'd)	1F124401012
	19.1 mm (3/4-inch) port dia.	22B8959X012		12.7 mm (1/2-in.) stem (2 req'd)	1F124301022
	1-in. valve, 12.7 mm (1/2-inch) stem			19.1 mm (3/4-in.) stem (2 req'd)	1F124201012
	6.4 mm (1/4-inch) port dia.	22B8960X012	019	Lantern Ring	
	9.5 mm (3/8-inch) port dia.	22B8961X012	021*	Upper Wiper, felt	
	12.7 mm (1/2-inch) port dia.	22B8962X012		9.5 mm (3/8-in.) stem	1J872606332
	19.1 mm (3/4-inch) port dia.	22B8963X012		12.7 mm (1/2-in.) stem	1J872706332
	1-in. valve, 19.1 mm (3/4-in) stem			19.1 mm (3/4-in.) stem	1J872806332
	6.4 mm (1/4-inch) port dia.	22B8964X012	025	Seal & Wire (not shown), lead	
	9.5 mm (3/8-inch) port dia.	22B8965X012		Required only if actuator is not furnished	
	12.7 mm (1/2-inch) port dia.	22B8966X012	---	Tag,warning (not shown)	
	19.1 mm (3/4-inch) port dia.	22B8967X012			
	2-in. valve, 12.7 mm (1/2-in) stem				
	6.4 mm (1/4-inch) port dia.	22B8968X012			
	9.5 mm (3/8-inch) port dia.	22B8969X012			
	12.7 mm (1/2-inch) port dia.	22B8970X012			
	19.1 mm (3/4-inch) port dia.	22B8971X012			
	25.4 mm (1-inch) port dia.	22B8972X012			
	31.8 mm (1-1/4 inch) port dia.	22B8973X012			
	2-in. valve, 19.1 mm (3/4-inch) stem				
	6.4 mm (1/4-inch) port dia.	22B8974X012			
	9.5 mm (3/8-inch) port dia.	22B8975X012			
	12.7 mm (1/2-inch) port dia.	22B8976X012			
	19.1 mm (3/4-inch) port dia.	22B8977X012			
	25.4 mm (1-inch) port dia.	22B8978X012			
	31.8 mm (1-1/4 inch) port dia.	22B8979X012			

\*Recommended spare parts

1. These materials are listed in NACE standard MR0175 as being acceptable for direct exposure to sour environment when used under conditions stated in that standard.

# Design D & DA

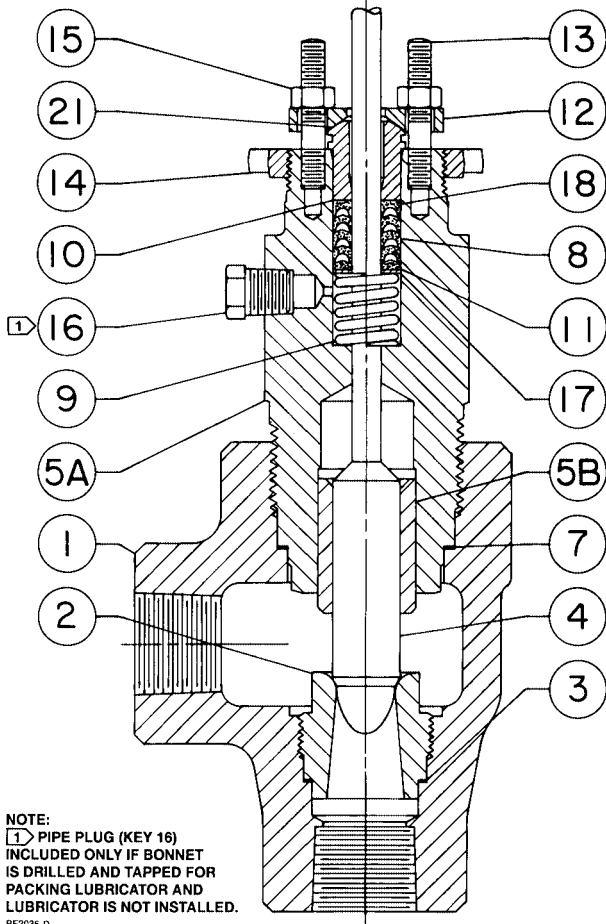


Figure 4. Design DA Angle-Style Valve

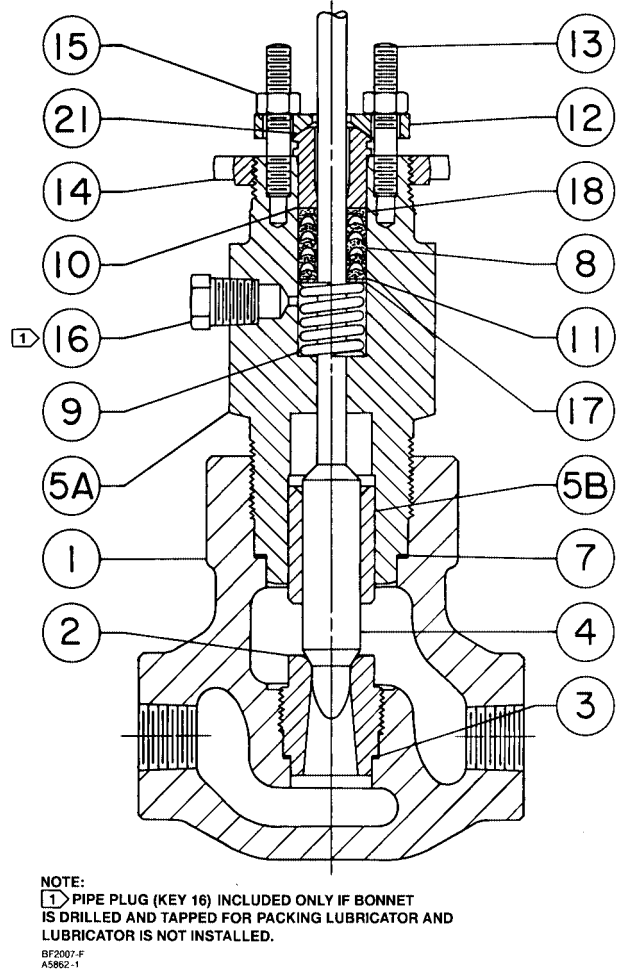


Figure 5. Design D Globe-Style Valve



# Design D & DA

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# Design ET and EAT easy-e<sup>®</sup> Valves Class 125 through 600

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## Introduction

### Scope of Manual

This instruction manual includes installation, maintenance, and parts information for 1- through 8-inch Design ET valves, and 1- through 6-inch Design EAT valves, through Class 600 ratings. Refer



W1916-3 / IL

Figure 1. Design ET Control Valve with Type 667 Actuator

to separate manuals for instructions covering the actuator and accessories.

No person may install, operate, or maintain a Design ET valve without first (1) being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and (2) carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher sales office before proceeding.



# ET Valve

Table 1. Specifications

<p><b>End Connection Styles</b></p> <p><b>Cast Iron Valves</b>  <i>Flanged:</i> Class 125 flat-face or 250 raised-face flanges per ASME B16.1  <i>Screwed:</i> Consistent with ASME B16.4</p> <p><b>Steel and Stainless Steel Valves</b>  <i>Flanged:</i> Class 150, 300, and 600 raised-face or ring-type joint flanges per ASME B16.5  <i>Screwed or Socket Welding:</i> All available ASME B16.11 schedules that are consistent with Class 600 per ASME B16.34  <i>Buttwelding:</i> Consistent with ASME B16.25</p> <p><b>Maximum Inlet Pressure<sup>(1)</sup></b></p> <p><b>Cast Iron Valves</b>  <i>Flanged:</i> Consistent with Class 125B or 250B pressure-temperature ratings per ASME B16.1  <i>Screwed:</i> Consistent with Class 250 pressure-temperature ratings per ASME B16.4</p> <p><b>Steel and Stainless Steel Valves</b>  <i>Flanged:</i> Consistent with Class 150, 300, and 600 pressure-temperature ratings per ASME B16.34  <i>Screwed or Welding:</i> Consistent with Class 600 pressure-temperature ratings per ASME B16.34</p>	<p><b>Shutoff Classifications</b></p> <p>See table 2</p> <p><b>Flow Characteristics</b></p> <p>Linear (all cages), quick-opening (all except Whisper Trim®, WhisperFlo®, and Cavitrol® cages), or equal percentage (all except Whisper Trim, WhisperFlo, and Cavitrol cages)</p> <p><b>Flow Directions</b></p> <p><b>Linear, Quick Opening, or Equal Percentage Cage:</b> Normally down  <b>Whisper Trim and WhisperFlo Cages:</b> Always up  <b>Cavitrol Cage:</b> Always down</p> <p><b>Approximate Weights</b></p> <table border="1"> <thead> <tr> <th rowspan="2">VALVE SIZE, INCHES</th> <th colspan="2">WEIGHT</th> </tr> <tr> <th>kg</th> <th>Pounds</th> </tr> </thead> <tbody> <tr> <td>1 &amp; 1-1/4</td> <td>14</td> <td>30</td> </tr> <tr> <td>1-1/2</td> <td>20</td> <td>45</td> </tr> <tr> <td>2</td> <td>39</td> <td>67</td> </tr> <tr> <td>2-1/2</td> <td>45</td> <td>100</td> </tr> <tr> <td>3</td> <td>54</td> <td>125</td> </tr> <tr> <td>4</td> <td>77</td> <td>170</td> </tr> <tr> <td>6</td> <td>159</td> <td>350</td> </tr> <tr> <td>8</td> <td>408</td> <td>900</td> </tr> </tbody> </table>	VALVE SIZE, INCHES	WEIGHT		kg	Pounds	1 & 1-1/4	14	30	1-1/2	20	45	2	39	67	2-1/2	45	100	3	54	125	4	77	170	6	159	350	8	408	900
VALVE SIZE, INCHES	WEIGHT																													
	kg	Pounds																												
1 & 1-1/4	14	30																												
1-1/2	20	45																												
2	39	67																												
2-1/2	45	100																												
3	54	125																												
4	77	170																												
6	159	350																												
8	408	900																												

1. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.

Table 2. Available Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

Valve Design	Seating	Shutoff Class
All except those with Cavitrol III cages	PTFE (standard)	Standard air test <sup>(1)</sup>
		V (optional)
	Metal	IV
ET with Cavitrol III one-stage cage	Metal	V (optional) <sup>(2)</sup>
		IV (standard)
ET with Cavitrol III two-stage cages	Metal	V (optional)
		V
ET w/PEEK Anti-Extrusion Rings	Metal	V to 316°C (600°F)
ET w/ 3-7/16 to 7-inch port	Soft or Metal	VI
ET and EAT w/ TSO (Tight Shutoff Trim)	Replaceable, protected soft seat	TSO <sup>(1)</sup>

1. This is a special non-ANSI/FCI leakage class.  
2. Class V shutoff requires spring-loaded seal ring, radiused-seat plug, and wide-bevel seat ring (not available with 8-inch port, quick-opening cage). Not available with trims 4, 29, and 85.

## Description

These single-port valves have cage guiding, quick-change trim, and balanced push-down-to-close valve plug action. Valve configurations are as follows:

**Design ET**—Globe-style valve (figure 1) with metal-to-PTFE seating (standard for all except Cavitrol III cages) for stringent shutoff requirements, or metal-to-metal seating (standard for Cavitrol III cages, optional for all others) for higher temperatures.

**Design EAT**—Angle version of Design ET, used to facilitate piping or in applications which require a self-draining valve.

## Specifications

Typical specifications for these valves are shown in table 1.

## Installation



### WARNING

**Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.**

**Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.**

**Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

### CAUTION

**When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions.**

**Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some valve body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Fisher sales office.**

**Fisher does not assume final responsibility for the selection, use, or maintenance of any product. Final responsibility for the selection, use, and maintenance of any Fisher product remains with the purchaser and end-user.**

1. Before installing the valve, inspect the valve and associated equipment for any damage and any foreign material.
2. Make certain the valve body interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.
3. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve. Other positions may result in uneven valve plug and cage wear, and improper operation. With some valves, the actuator may also need to be supported when it is not vertical. For more information, consult your Fisher sales office.
4. Use accepted piping and welding practices when installing the valve in the line. For flanged valves, use a suitable gasket between the valve and pipeline flanges.

### Note

**Depending on valve body materials used, post weld heat treating may be required. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrink-fit pieces and threaded connections may also loosen. In general, if post weld heat treating is to be performed, all trim parts should be removed. Contact your Fisher sales office for additional information.**

5. With a leak-off bonnet construction, remove the pipe plugs (keys 14 and 16, figure 14) to hook up the leak-off piping. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.
6. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

# ET Valve



## WARNING

Personal injury could result from packing leakage. Valve packing was tightened prior to shipment; however, the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valves with ENVIRO-SEAL live-loaded packing or HIGH-SEAL™ live-loaded packing will not require this initial readjustment. See the Fisher instruction manuals, ENVIRO-SEAL Packing System for Sliding-Stem Valves or HIGH-SEAL Live-Loaded Packing System (as appropriate), for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the Parts Kits section.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and ENVIRO-SEAL bellows seal bonnet replacement. All maintenance operations may be performed with the valve in the line.



## WARNING

**Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.

- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.

- Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.

- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.

- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

### Note

**Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket during reassembly. This ensures a good gasket seal because the used gasket may not seal properly.**

## Packing Lubrication

### Note

**ENVIRO-SEAL and HIGH-SEAL packing do not require lubrication.**

If a lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in place of the pipe plug (key 14, figure 14). Use a good quality silicon-base lubricant. Do not lubricate packing used in oxygen service or in processes with temperatures over 260°C (500°F). To operate the lubricator, simply turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except open the isolating valve before turning the cap screw and then close the isolating valve after lubrication is completed.



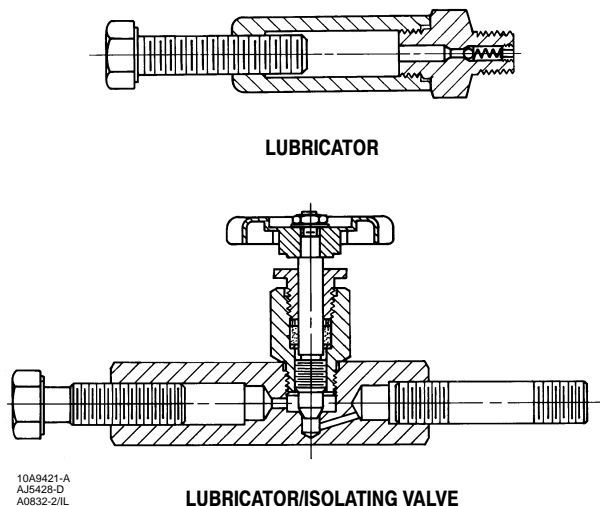


Figure 2. Lubricator and Lubricator/Isolating Valve (Optional)

## Packing Maintenance

### Note

**For valves with ENVIRO-SEAL packing, see the Fisher instruction manual, ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306, for packing instructions.**

**For valves with HIGH-SEAL packing, see the Fisher instruction manual, HIGH-SEAL Live-Loaded Packing System, Form 5263, for packing instructions.**

Key numbers refer to figure 3 for PTFE V-ring packing and to figure 4 for PTFE/composition packing, unless otherwise indicated.

For spring-loaded single PTFE V-ring packing, the spring (key 8) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5, figure 14) until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed to the Replacing Packing procedure.

If there is undesirable packing leakage with other than spring-loaded packing, first try to limit the

leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, the valve stem may be worn or nicked so that a seal cannot be made. The surface finish of a new valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, the leakage may be caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.

## Replacing Packing

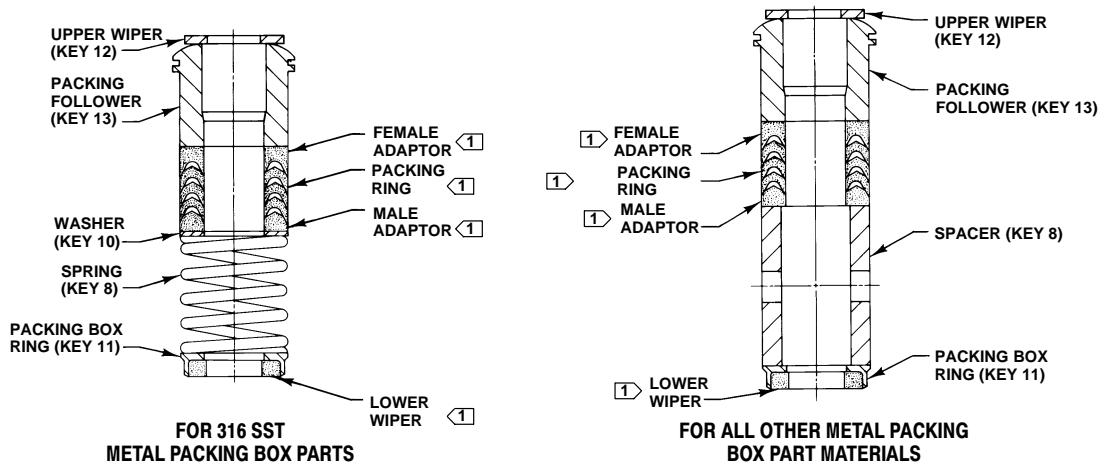
1. Isolate the control valve from the line pressure, release pressure from both sides of the valve, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector, then remove the actuator from the valve by unscrewing the yoke locknut (key 15, figure 14) or the hex nuts (key 26, figure 14).
3. Loosen the packing flange nuts (key 5, figure 14) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

## WARNING

**To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet.**

### Note

**The following step also provides additional assurance that the valve body fluid pressure has been relieved.**

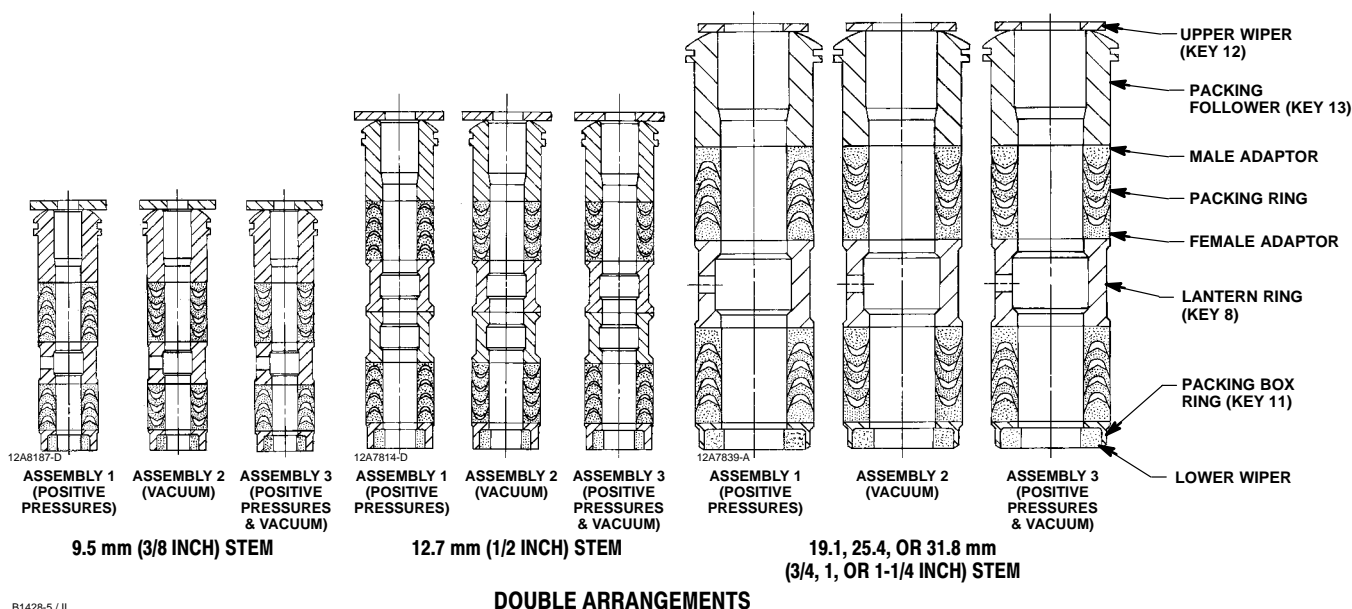


**NOTE:**

1 MALE ADAPTOR, PACKING RING, FEMALE ADAPTOR, AND LOWER WIPER ARE PART OF PACKING SET (KEY 6).  
2 REQ'D FOR DOUBLE ARRANGEMENTS, EXCEPT LOWER WIPER.

12A7837-A  
B1429-5 / IL

**SINGLE ARRANGEMENTS**



B1428-5 / IL

Figure 3. PTFE V-Ring Packing Arrangements for Plain and Extension Bonnets

### CAUTION

Avoid damaging the seating surface caused by the valve plug and stem assembly dropping from the bonnet (key 1, figure 14) after being lifted part way out. When lifting the bonnet, temporarily install a valve stem locknut on the valve stem. The locknut will prevent the valve plug and stem

assembly from dropping out of the bonnet.

4. Hex nuts (key 16, figure 16, 17, or 20) or cap screws (not shown) attach the bonnet (key 1, figure 14) to the valve body (key 1, figure 16, 17, or 20). Loosen these nuts or cap screws approximately 3 mm (1/8 inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve. Work the prying tool around the bonnet until the bonnet loosens. If no fluid leaks from the joint, remove the nuts or cap

Table 3. Body-to-Bonnet Bolt Torque Guidelines

VALVE SIZE, INCHES		BOLT TORQUES <sup>(1)</sup>			
Design ET	Design EAT	SA193-B7, SA193-B8M <sup>(3)</sup>		SA193-B8M <sup>(2)</sup>	
		N•m	Lbf•ft	N•m	Lbf•ft
1-1/4 or less	1	129	95	64	47
1-1/2, 1-1/2 x 1, 2, or 2 x 1	2 or 2 x 1	96	71	45	33
2-1/2 or 2-1/2 x 1-1/2	3 or 3 x 1-1/2	129	95	64	47
3, 3 x 2, or 3 x 2-1/2	4 or 4 x 2	169	125	88	65
4, 4 x 2-1/2, or 4 x 3	6 or 6 x 2-1/2	271	200	156	115
6	---	549	405	366	270
8	---	746	550	529	390

1. Determined from laboratory tests.  
2. SA193-B8M annealed.  
3. SA193-B8M strain hardened.

screws completely and carefully lift the bonnet off the valve.

5. Remove the locknut and separate the valve plug and stem from the bonnet. Set the parts on a protective surface to prevent damage to gasket or seating surfaces.

6. Remove the bonnet gasket (key 10, figure 16, 17, or 20) and cover the opening in the valve to protect the gasket surface and prevent foreign material from getting into the valve body cavity.

7. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 14). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.

8. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts by following the appropriate steps in the Trim Maintenance procedure.

9. Remove the covering protecting the valve body cavity and install a new bonnet gasket (key 10, figure 16, 17, or 20), making sure the gasket seating surfaces are clean and smooth. Then slide the bonnet over the stem and onto the stud bolts (key 15, figure 16, 17, or 20) or onto the valve body cavity if cap screws (not shown) will be used instead.

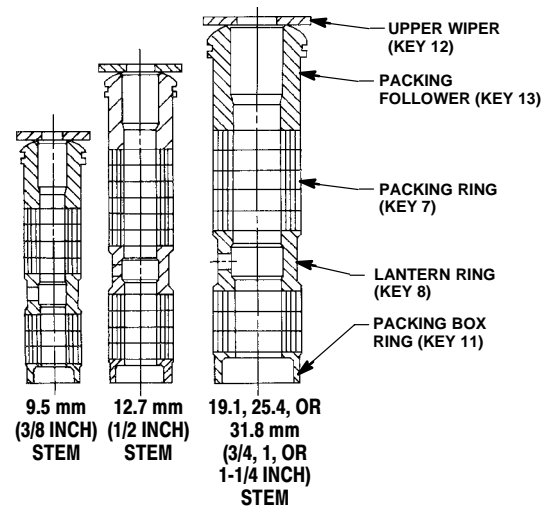


Figure 4. Detail of PTFE/Composition Packing Arrangements for Plain and Extension Bonnets

**Note**

Proper performance of the bolting procedures in step 10 compresses the spiral wound gasket (key 12, figure 16 or 17) or load ring (key 26, figure 20) enough to both load and seal the seat ring gasket (key 13, figure 16, 17 or 20). It also compresses the outer edge of the bonnet gasket (key 10, figure 16 through 20) enough to seal the body-to-bonnet joint.

The proper bolting procedures in step 10 include—but are not limited to—ensuring that bolting threads are clean, and evenly tightening the cap screws, or the nuts onto the studs, in a crisscross pattern. Tightening one cap screw or nut may loosen an adjacent

Table 4. Recommended Torque for Packing Flange Nuts

VALVE STEM DIAMETER		CLASS	GRAPHITE TYPE PACKING				PTFE TYPE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inches		N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in
9.5	3/8	125, 150	3	27	5	40	1	13	2	19
		250, 300	4	36	6	53	2	17	3	26
		600	6	49	8	73	3	23	4	35
12.7	1/2	125, 150	5	44	8	66	2	21	4	31
		250, 300	7	59	10	88	3	28	5	42
		600	9	81	14	122	4	39	7	58
19.1	3/4	125, 150	11	99	17	149	5	47	8	70
		250, 300	15	133	23	199	7	64	11	95
		600	21	182	31	274	10	87	15	131
25.4	1	300	26	226	38	339	12	108	18	162
		600	35	310	53	466	17	149	25	223
31.8	1-1/4	300	36	318	54	477	17	152	26	228
		600	49	437	74	655	24	209	36	314

cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made. When the operating temperature has been reached, perform this torquing procedure once again.

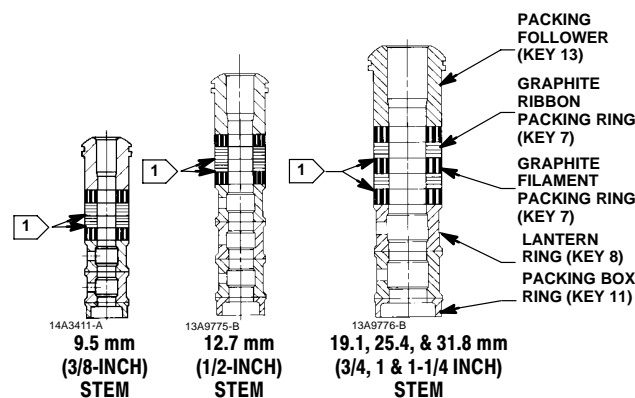
10. Lubricate the bolting (not necessary if factory pre-lubricated stud bolt nuts are used) and install it, using accepted bolting procedures during tightening, so that the body-to-bonnet joint will withstand test pressures and application service conditions. Use the bolt torques in table 3 as guidelines.

11. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3, 4, or 5. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box.

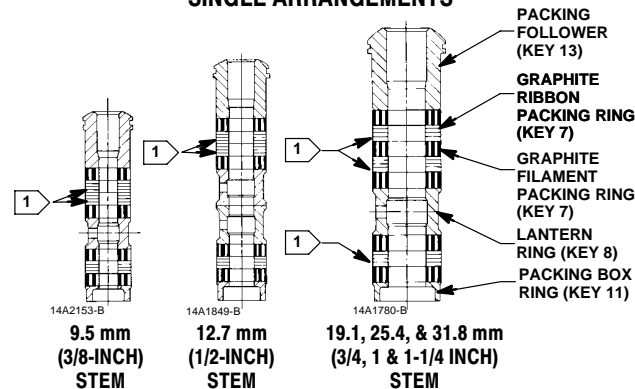
12. Slide the packing follower, upper wiper, and packing flange (keys 13, 12, and 3, figure 14) into position. Lubricate the packing flange studs (key 4, figure 14) and the faces of the packing flange nuts (key 5, figure 14). Install the packing flange nuts.

13. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts until the shoulder on the packing follower (key 13, figure 14) contacts the bonnet.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 4. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 4.



### SINGLE ARRANGEMENTS



### DOUBLE ARRANGEMENTS

NOTE:  
 1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS;  
 USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.

Figure 5. Detail of Graphite Ribbon/Filament Packing for Plain and Extension Bonnets

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended

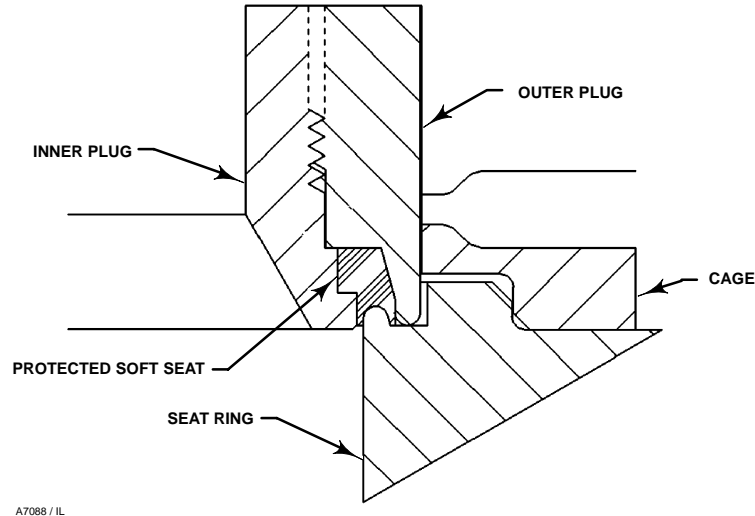


Figure 6. TSO (Tight Shutoff Trim), Detail of Protected Soft Seat

torque shown in table 4. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

**For ENVIRO-SEAL or HIGH-SEAL live-loaded packing**, refer to the note at the beginning of Packing Maintenance.

14. Mount the actuator on the valve assembly and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

### Trim Maintenance

Except where indicated, key numbers in this section are referenced in figure 16 for standard 1- through 6-inch constructions, figure 17 for Whisper Trim III detail, figures 18 and 19 for WhisperFlo trim, and figure 20 for Cavitrol III detail and the 8-inch Design ET valve.

### Disassembly

1. Remove the actuator and the bonnet according to steps 1 through 6 of the Replacing Packing procedure in the Maintenance section.

### WARNING

**Any damage to the gasket sealing surfaces could cause the valve to leak. The surface finish of the valve stem**

**(key 7) is critical for making a good packing seal. The inside surface of the cage or cage/baffle assembly (key 3), or cage retainer (key 31), is critical for smooth operation of the valve plug. The seating surfaces of the valve plug (key 2) and seat ring (key 9) are critical for proper shutoff. Unless inspection reveals otherwise, assume all these parts are in good condition and protect them accordingly.**

2. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13 in figure 14). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.

3. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.

4. Remove the load ring (key 26) from an 8-inch Design ET valve, or the cage adaptor (key 4) from any restricted-trim valve through 4 inches, and wrap it for protection.

5. On a 6-inch Design ET valve with Whisper Trim III or WhisperFlo cage, also remove the bonnet spacer (key 32) and bonnet gasket (key 10) on top of the spacer. Then on any construction with a cage retainer (key 31), remove the cage retainer and its associated

# ET Valve

gaskets. A Whisper Trim III and WhisperFlo cage retainer has two 3/8-inch-16 NPT tappings in which screws or bolts can be installed for lifting.

6. Remove the cage or cage/baffle assembly (key 3), the associated gaskets (keys 10, 11, and 12), and shim (key 51). If the cage is stuck in the valve, use a rubber mallet to strike the exposed portion of the cage at several points around its circumference.

7. **For constructions other than TSO (tight shutoff) trim**, remove the seat ring or liner (key 9) or disk seat (key 22), seat ring gasket (key 13), and the seat ring adaptor (key 5) and adaptor gasket (key 14) where used in a restricted-trim seat ring construction. PTFE-seat constructions use a disk (key 23) sandwiched between the disk seat and disk retainer (key 21).

8. **For TSO (tight shutoff) trim constructions**, perform the following steps (refer to figures 6 and 7):

- Remove the retainer, backup ring, anti-extrusion rings, and piston ring.
- Remove the set screws that lock the outer plug to the inner plug.
- Using a strap wrench or similar tool, unscrew the outer plug from the inner plug. Do not damage the outer plug guide surfaces.
- Remove the protected soft seat seal.
- Inspect the parts for damage and replace if needed.

9. **For all constructions**, inspect parts for wear or damage which would prevent proper operation of the valve. Replace or repair trim parts according to the following procedure for Lapping Metal Seats or other valve plug maintenance procedures as appropriate.

## Lapping Metal Seats

### CAUTION

**To avoid damaging the ENVIRO-SEAL Bellows Seal Bonnet assembly, do not attempt to lap the metal seating surfaces. The design of the assembly prevents rotation of the stem and any forced lapping rotation will damage internal components of the ENVIRO-SEAL Bellows Seal bonnet.**

With metal-seat constructions, lapping seating surfaces of the valve plug and seat ring or liner (keys 2 and 9, figure 16, 17, or 20) can improve shutoff. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Assemble the valve to the extent that the cage and the cage retainer and bonnet spacer (if used) are in place and the bonnet is bolted to the valve body. A simple handle can be made from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction to lap the seats. After lapping, remove the bonnet and clean the seat surfaces. Completely assemble as described in the Assembly portion of the Trim Maintenance procedure and test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

## Valve Plug Maintenance

Except where indicated, key numbers in this section are referenced in figure 16 for standard 1- through 6-inch constructions, figure 17 for Whisper Trim III, figures 18 and 19 for WhisperFlo trim, and figure 20 for Cavitrol III detail and the 8-inch Design ET valve.

### CAUTION

**To avoid the valve plug seal ring (key 28) not sealing properly, be careful not to scratch the surfaces of the ring groove in the valve plug or any of the surfaces of the replacement ring.**

1. With the valve plug (key 2) removed according to the Disassembly portion of the Trim Maintenance procedure, proceed as appropriate:

**For the two-piece seal ring**, The ring cannot be reused because it is a closed ring which must be pried and/or cut from the groove. Once the seal ring is removed, the elastomeric backup ring (key 29), which is also a closed ring, can be pried from the groove.

To install a new two-piece seal ring, apply a general purpose silicone-base lubricant to both the backup ring and seal ring (keys 29 and 28). Place the backup ring over the stem (key 7) and into the groove. Place the seal ring over the top edge of the valve plug (key 2) so that it enters the groove on one side of the valve plug. Slowly and gently stretch the seal ring and work it over the top edge of the valve

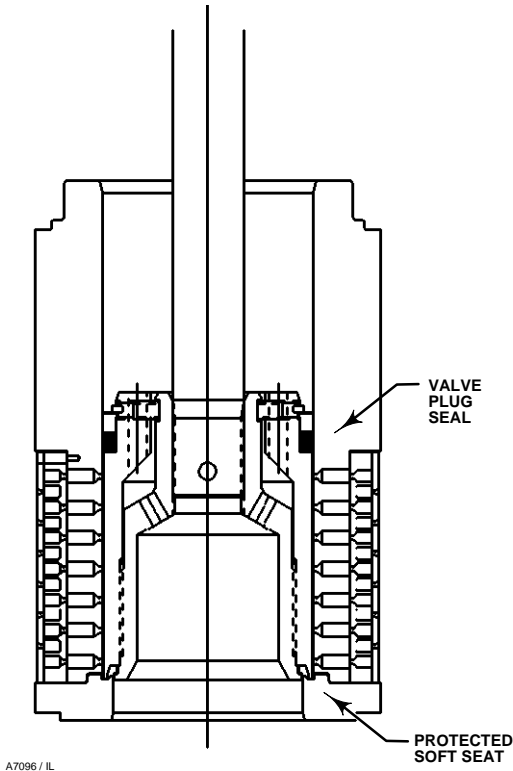


Figure 7. Typical Balanced TSO Trim

plug. The PTFE material in the seal ring must be permitted time to cold-flow during the stretching procedure, so avoid jerking sharply on this ring. Stretching the seal ring over the valve plug may make it seem unduly loose when in the groove, but it will contract to its original size after insertion into the cage.

**For the spring-loaded seal ring**, the ring used on a valve plug having a 136.5 mm (5-3/8 inch) or less port diameter may be removed undamaged by first working the retaining ring (key 27) off with a screwdriver. Then carefully slide the metal backup ring (key 29) and seal ring (key 28) off the valve plug (key 2). The spring-loaded seal ring used on a valve plug having a 178 mm (7-inch) or greater port diameter must be carefully pried and/or cut from its groove. Therefore, it cannot be reused.

A spring-loaded seal ring must be installed so that its open side faces toward the valve stem, or toward the seat of the plug depending on flow direction, as shown in view A of figure 16 or 20. To install a spring-loaded seal ring on a valve plug with a 136.5 mm (5-3/8 inch) or less port diameter, slide the seal ring (key 28) onto the valve plug followed by the metal backup ring (key 29). Then install the retaining

ring (key 27) by inserting one end in the groove and, while turning the plug, press the ring into the groove. Again, be careful not to scratch any surfaces of the ring or plug.

To install the seal ring on a valve plug with 178 mm (7-inch) or greater port diameter, lubricate it with a general purpose silicone-base lubricant. Then gently stretch the seal ring and work it over the top edge of the valve plug. The PTFE material in the seal ring must be permitted time to cold-flow during the stretching procedure, so avoid jerking sharply on the ring. Stretching the seal ring over the valve plug may make it seem unduly loose when in the groove, but it will contract to its original size after insertion into the cage.

## CAUTION

Never reuse an old stem or adaptor with a new valve plug. Using an old stem or adaptor with a new plug requires drilling a new pin hole in the stem (or adaptor, in case an ENVIRO-SEAL bellows seal bonnet is being used). This drilling weakens the stem or adaptor and may cause failure in service. However, a used valve plug may be reused with a new stem or adaptor, except with Cavitrol III trim.

### Note

The valve plug and valve plug stem for 2-stage Cavitrol III trim are a matched set and must be ordered together. If the 2-stage Cavitrol III valve plug or valve plug stem is damaged, replace the entire assembly (key 2, figure 20).

### Note

For plain bonnets and style 1 extension bonnets, the valve plug (key 2), valve stem (key 7), and pin (key 8) are available completely assembled. Refer to the Key 2, 7, and 8 Valve Plug and Stem Assembly tables in the Parts List.

2. To replace the valve stem (key 7), drive out the pin (key 8). Unscrew the valve plug from the stem or adaptor.

Table 5. Valve Stem Connection Assembly Torque and Pin Replacement

VALVE STEM DIAMETER		TORQUE, MINIMUM TO MAXIMUM		HOLE SIZE	
mm	Inches	N•m	Lbf•ft	mm	Inch
9.5	3/8	40-47	25-35	2.41 - 2.46	0.095 - 0.097
12.7	1/2	81-115	60-85	3.20 - 3.25	0.126 - 0.128
19.1	3/4	237-339	175-250	4.80 - 4.88	0.189 - 0.192
25.4	1	420-481	310-355	6.38 - 6.45	0.251 - 0.254
31.8	1-1/4	827-908	610-670	6.38 - 6.45	0.251 - 0.254

3. To replace the adaptor (key 24, figure 14) on ENVIRO-SEAL bellows seal bonnets, place the plug stem assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out the pin (key 36, figure 14). Reverse the plug stem assembly in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the valve plug/adaptor assembly (key 24, figure 14) from the valve stem assembly (key 20, figure 14).

4. Screw the new stem or adaptor into the valve plug. Tighten to the torque value given in table 5. Refer to table 5 to select the proper hole size. Drill through the stem or adaptor, using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin to lock the assembly.

5. For ENVIRO-SEAL bellows seal bonnets, grip the flats of the stem extending out of the top of the bellows shroud with a soft-jaw chuck or other type of vise. Screw the valve plug/adaptor assembly onto the valve stem. Tighten as necessary to align the pin hole in the stem with one of the holes in the adaptor. Secure the adaptor to the stem with a new pin.

### Assembly

Except where indicated, key numbers are referenced in figure 16 for standard 1- through 6-inch constructions, figure 17 for Whisper Trim III detail, figures 18 and 19 for WhisperFlo detail, and figure 20 for Cavitrol III detail and the 8-inch Design ET valve.

1. With a restricted-trim seat ring construction, install the adaptor gasket (key 14) and seat ring adaptor (key 5).

2. Install the seat ring gasket (key 13), seat ring or liner (key 9), or disk seat (key 22). With a PTFE-seat construction, install the disk and disk retainer (keys 21 and 23).

3. Install the cage or cage/baffle assembly (key 3). Any rotational orientation of the cage or assembly

with respect to the valve body is acceptable. A Whisper Trim III cage designated by level A3, B3, or C3 may be installed with either end up. The level D3 cage/baffle assembly or Cavitrol III cage assembly, however, must be installed with the hole pattern end next to the seat ring. If a cage retainer (key 31) is to be used, place it on top of the cage.

4. **For constructions other than TSO (tight shutoff) trim**, slide the valve plug (key 2) and stem assembly, or valve plug and ENVIRO-SEAL bellows seal assembly, into the cage. Make sure the seal ring (key 28) is evenly engaged in the entrance chamfer at the top of the cage (key 3) or cage retainer (key 31) to avoid damaging the ring.

5. **For TSO (tight shutoff) trim constructions**, perform the following steps (refer to figures 6 and 7).

- Thread the outer plug onto the inner plug until the parts seat metal to metal, using a strap wrench or similar tool that will not damage the outer plug guide surfaces.

- Mark the top of the inner plug and outer plug with alignment marks in the assembled position.

- Disassemble the outer plug from the inner plug and install the seal over the inner plug, so that the seal rests below the threaded area.

- Thread the outer plug onto the inner plug and tighten with a strap wrench or similar tool until the alignment marks line up. This will ensure that the plug parts are metal to metal and the seal is compressed properly. Do not damage the outer plug guide surfaces.

- Install set screws centering the inner plug in the outer plug and torque to 11 N•m (8 lbf•ft).

- Assemble the piston ring, anti-extrusion rings, backup ring, and retainer.

6. **For all constructions**, place the gaskets (keys 12, 11 or 14 if used, and 10) and the shim (key 51) on top of the cage or cage retainer. If there is a cage adaptor (key 4) or a bonnet spacer (key 32), set it on



the cage or cage retainer gaskets and place another flat sheet gasket (key 10) on top of the adaptor or spacer. If there is only a cage retainer, place another flat sheet gasket on the retainer.

7. With an 8-inch Design ET valve, install the load ring (key 26).
8. Mount the bonnet on the valve body and complete assembly according to steps 10 through 14 of the Replacing Packing procedure. Be sure to observe the note prior to step 10.

### ENVIRO-SEAL Bellows Seal Bonnet

#### **Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)**

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure in the *Maintenance* section.
2. With care, remove the valve plug and stem assembly from the valve body. If necessary, also lift out the cage.
3. Remove and discard the existing bonnet gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

**Note**

**The ENVIRO-SEAL stem/bellows assembly for Design E valves is available only with a threaded and drilled plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed.**

4. Inspect the existing valve plug. If the plug is in good condition, it can be reused with the new ENVIRO-SEAL stem/bellows assembly. To remove the existing valve plug from the stem, first, place the existing plug stem assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8).
5. Reverse the plug stem assembly in the soft-jaw chuck or vise. Grip the valve stem in an appropriate place and unscrew the existing plug from the valve stem.

Table 6. Recommended Torque for ENVIRO-SEAL Bellows Seal Packing Flange Nuts

VALVE SIZE, INCHES	VALVE STEM DIAMETER THROUGH PACKING	MINIMUM TORQUE		MAXIMUM TORQUE	
		N•m	Lbf•in	N•m	Lbf•in
1 - 2	1/2	2	22	4	33
3 - 8	1	5	44	8	67

**CAUTION**

**When installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.**

**Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.**

**Note**

**The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.**

6. To attach the valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, first attach the plug to the adaptor (key 24). Locate the adaptor. Notice that a hole has not been drilled in the threads where the plug screws onto the adaptor. Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the appropriate torque value.
7. Select the proper size of drill bit and drill through the adaptor using the hole in the valve plug as a guide. Remove any metal chips or burrs and drive in a new pin to lock the plug/adaptor assembly together.
8. Attach the plug/adaptor assembly to the ENVIRO-SEAL stem/bellows assembly by first securing the stem/bellows assembly in a soft-jaw chuck or other type of vise so that the jaws of the chuck or vise grip the flats of the stem extending out of the top of the bellows shroud. Screw the valve plug/adaptor assembly onto the valve stem. Tighten as necessary to align the pin hole in the stem with one of the holes in the adaptor. Secure the adaptor to the stem with a new pin.
9. Inspect the seat ring (key 9) and soft seat parts (keys 21, 22, and 23); replace, if necessary.

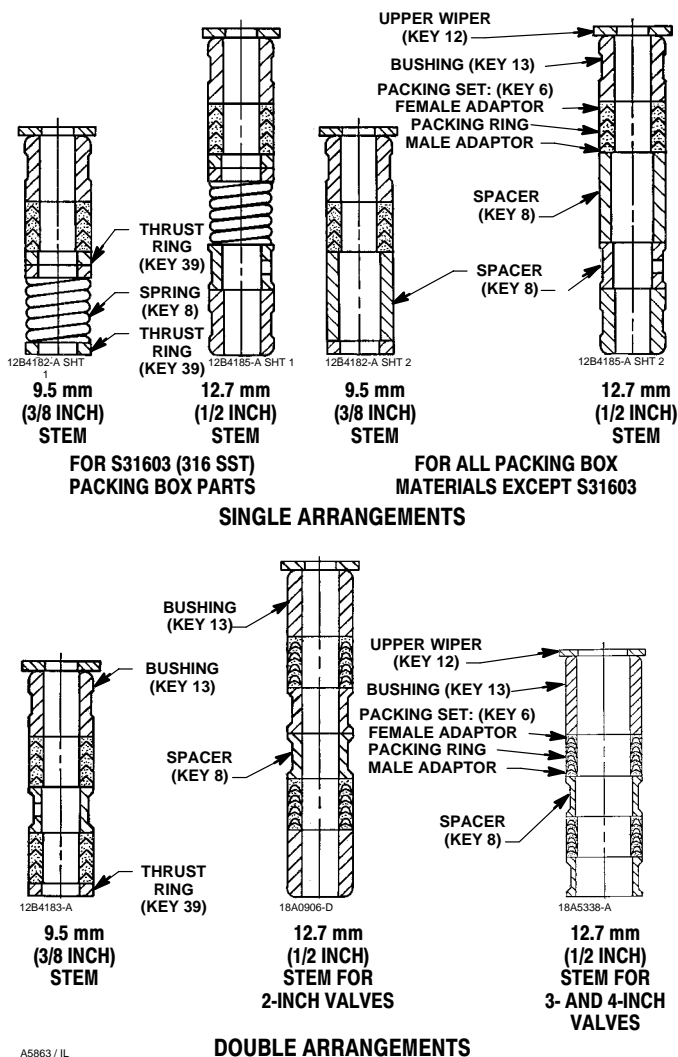


Figure 8. PTFE Packing Arrangements for Use in ENVIRO-SEAL Bellows Seal Bonnets

10. Place a new gasket (key 10) into the valve body in place of the bonnet gasket. Install the new stem/bellows assembly with valve plug/adaptor by placing it into the valve body on top of the new bellows gasket.

11. Place a new gasket (key 22) over the stem/bellows assembly. Place the new ENVIRO-SEAL bonnet over the stem/bellows assembly.

12. Properly lubricate the bonnet stud bolts. Install and tighten the bonnet hex nuts to the proper torque.

13. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 8 or 9.

14. Install the packing flange. Properly lubricate the packing flange stud bolts and the faces of the packing flange nuts.

**For graphite packing**, tighten the packing flange nuts to the maximum recommended torque shown in table 6. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 6.

**For other packing types**, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended

torque shown in table 6. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

15. Install travel indicator parts and stem locknuts; mount the actuator on the valve body according to the procedure in the appropriate actuator instruction manual.

### **Replacement of an Installed ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)**

1. Remove the actuator and bonnet according to steps 1 through 5 of the *Replacing Packing* procedure in the *Maintenance* section.

2. Carefully remove the ENVIRO-SEAL stem/bellows assembly. If necessary, also lift out the cage. Remove and discard the existing bonnet gasket and bellows gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

#### **Note**

**The ENVIRO-SEAL stem/bellows assembly for Design E valves is available only with a threaded and drilled plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed. If the existing valve plug is reused, and the adaptor is in good condition, it may be also reused. However, never reuse an old adaptor with a new valve plug. Using an old adaptor with a new valve plug requires drilling a new pin hole in the adaptor. This drilling weakens the adaptor and may cause failure in service. However, a used valve plug may be reused with a new adaptor.**

3. Inspect the existing valve plug and adaptor. If they are in good condition, they can be reused with the new stem/bellows assembly and they do not need to be separated.

## **CAUTION**

**When removing/installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.**

**Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.**

#### **Note**

**The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.**

4. If the valve plug and adaptor are not in good condition and must be replaced, first remove the valve plug/adaptor assembly from the stem/bellows assembly; then remove the valve plug from the adaptor. First, place the stem/bellows assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8, figure 16, 17, or 20). Drive out the pin (key 36, figure 14).

5. Reverse the stem/bellows and plug/adaptor assembly in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the plug/adaptor assembly from the stem/bellows assembly. Unscrew the valve plug from the adaptor.

6. To attach either the existing valve plug or a new one to the stem of the new ENVIRO-SEAL stem/bellows assembly, first attach the plug to the adaptor (if the valve plug was removed from the adaptor) as follows:

- Locate the adaptor. Notice that a hole has not been drilled in the threads where the plug screws onto the adaptor.

- Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor.

- Thread the adaptor into the valve plug and tighten to the appropriate torque value.

Table 7. Standard Material Designations

Standard Designation	Common Name or Tradename
CoCr-A Hardfacing Alloy R30006 S17400 SST S31600 SST	CoCr-A Alloy 6 Casting 17-4PH Stainless Steel 316 Stainless Steel
S41000 SST S41600 SST WCC Carbon Steel Casting	410 Stainless Steel 416 Stainless Steel WCC

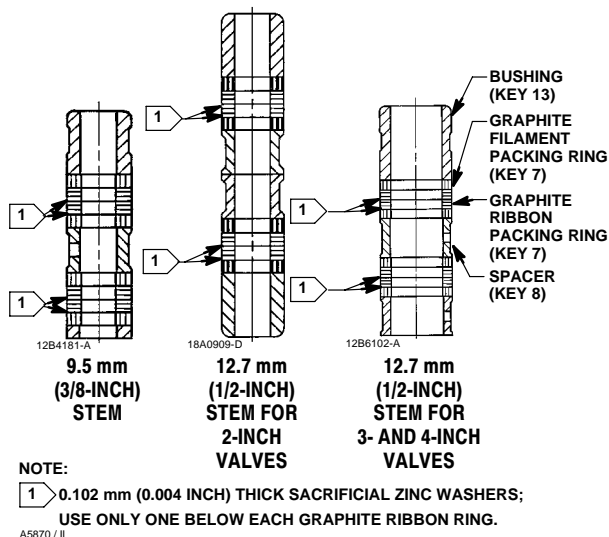


Figure 9. Double Graphite Ribbon/Filament Arrangements for Use in ENVIRO-SEAL Bellows Seal Bonnets

7. Complete the installation by following steps 7 through 9 and steps 12 through 15 of the ENVIRO-SEAL Bellows Seal Bonnet installation instructions found on pages 12 and 13.

### Purging the ENVIRO-SEAL Bellows Seal Bonnet

The ENVIRO-SEAL bellows seal bonnet can be purged or leak tested. Refer to figure 14 for an illustration of an ENVIRO-SEAL bellows seal bonnet, and perform the following steps for purging or leak testing.

1. Remove the two diametrically opposed pipe plugs (key 16).
2. Connect a purging fluid to one of the pipe plug connections.

3. Install appropriate piping or tubing in the other pipe plug connection to pipe away the purging fluid or to make a connection to an analyzer for leak testing.

4. When purging or leak testing has been completed, remove the piping or tubing and reinstall the pipe plugs (key 16).

#### Note

**Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.**

### Parts Ordering

Each body-bonnet assembly is assigned a serial number which can be found on the valve. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly. Refer to the serial number when contacting your Fisher representative for technical assistance. When ordering replacement parts, refer to the serial number and to the eleven-character part number for each part required from the following parts kit or parts list information.

Components that are not manufactured by Fisher should not, under any circumstances, be used in any Fisher valve. The use of parts not manufactured by Fisher may adversely affect the performance of the valve as well as worker and workplace safety.

Refer to table 7 for standard and common material designations.

## Parts Kits

### Gasket Kits

Gasket Kits (includes keys 10, 11, 12, 13, and 51; plus 14 and 20 on some restricted capacity valves)

DESCRIPTION	PART NUMBER
<b>Full Capacity Valves</b>	<b>-198° to 593°C (-325° to 1100°F)</b>
1 & 1-1/4 inch 1-1/2 inch (2-inch EAT) 2-inch 2-1/2 inch (3-inch EAT) 3-inch (4-inch EAT) 4-inch (6-inch EAT) 6-inch 8-inch	RGASKETX162 RGASKETX172 RGASKETX182 RGASKETX192 RGASKETX202 RGASKETX212 RGASKETX222 RGASKETX232
<b>Restricted Capacity Valves w/ Metal Seating</b>	
1-1/2 x 1-inch (2 x 1-inch EAT) 2 x 1-inch 2-1/2 x 1-1/2 inch (3 x 1-1/2 inch EAT) 3 x 2-inch (4 x 2-inch EAT) 4 x 2-1/2 inch (6 x 2-1/2 inch EAT)	RGASKETX242 RGASKETX252 RGASKETX262 RGASKETX272 RGASKETX282

## Packing Kits

### Standard Packing Repair Kits (Non Live-Loaded)

Standard Packing Repair Kits (non live-loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032
Double PTFE (Contains keys 6, 8, 11, 12)	RPACKX00042	RPACKX00052	RPACKX00062
PTFE/Composition (Contains keys 7, 8, 11, and 12)	RPACKX00072	RPACKX00082	RPACKX00092
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00102	RPACKX00112	RPACKX00122
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring])	RPACKX00132	RPACKX00142	RPACKX00152
Double Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00162	RPACKX00172	RPACKX00182

# ET Valve

## ENVIRO-SEAL Packing Retrofit Kits

Retrofit kits include parts to convert valves with existing standard bonnets to the ENVIRO-SEAL packing box construction. Refer to figure 11 for key numbers for PTFE packing, to figure 12 for key numbers for Graphite ULF packing, and to figure 13 for key numbers for duplex packing. PTFE kits include keys 200, 201, 211, 212, 214, 215, 216, 217, 218, tag, and cable tie. Graphite ULF kits include keys 200, 201, 207, 208, 209, 210, 211, 212, 214, 217, tag, and cable tie. Duplex kits include keys 200,

201, 207, 209, 211, 212, 214, 215, 216, 217, tag, and cable tie.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components in the ENVIRO-SEAL packing kits, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306.

ENVIRO-SEAL Packing Retrofit Kits

PACKING MATERIAL	STEM DIAMETER AND YOKE BOSS DIAMETER, mm (INCH)				
	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE	RPACKXRT012	RPACKXRT022	RPACKXRT032	RPACKXRT042	RPACKXRT052
Graphite ULF	RPACKXRT262	RPACKXRT272	RPACKXRT282	RPACKXRT292	RPACKXRT302
Duplex	RPACKXRT212	RPACKXRT222	RPACKXRT232	RPACKXRT242	RPACKXRT252

## ENVIRO-SEAL Packing Repair Kits

Repair kits include parts to replace the “soft” packing materials in valves that already have ENVIRO-SEAL packing arrangements installed or in valves that have been upgraded with ENVIRO-SEAL retrofit kits. Refer to figure 11 for key numbers for PTFE packing, to figure 12 for key numbers for Graphite ULF packing, and to figure 13 for key numbers for duplex packing. PTFE repair kits include keys 214, 215, and 218. Graphite ULF repair kits include keys 207, 208, 209, 210, and 214.

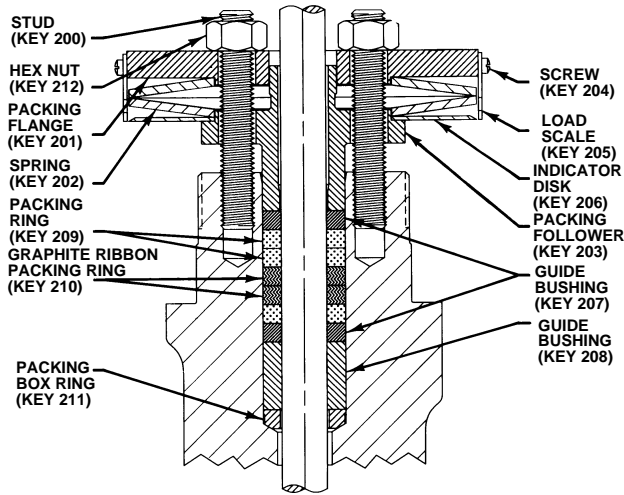
Duplex repair kits include keys 207, 209, 214, and 215.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components in the ENVIRO-SEAL packing kits, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306.

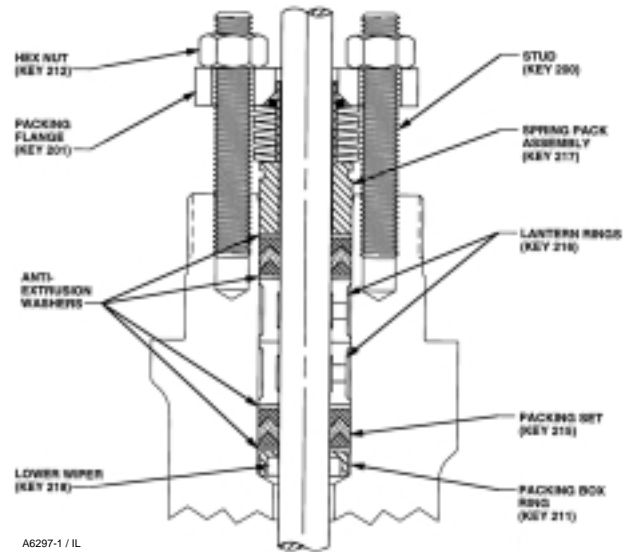
ENVIRO-SEAL Packing Repair Kits

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE (contains keys 214, 215, & 218)	RPACKX00192	RPACKX00202	RPACKX00212	RPACKX00222	RPACKX00232
Graphite ULF (contains keys 207, 208, 209, 210, and 214)	RPACKX00592	RPACKX00602	RPACKX00612	RPACKX00622	RPACKX00632
Duplex (contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312	RPACKX00322	RPACKX00332



A6138 / IL

Figure 10. Typical HIGH-SEAL Packing System



A6297-1 / IL

Figure 11. Typical ENVIRO-SEAL Packing System with PTFE Packing

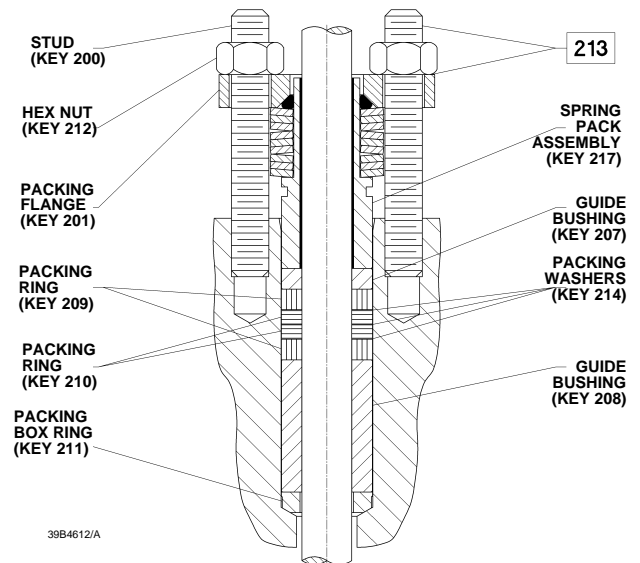
## Parts List

**Note**

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

### Bonnet (figures 3 through 9 and figure 14)

Key	Description	Part Number
1	Bonnet/ENVIRO-SEAL bellows seal bonnet If you need a bonnet or an ENVIRO-SEAL bellows seal bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Extension Bonnet Baffle	
3	Packing Flange	
3	ENVIRO-SEAL bellows seal packing flange	
4	Packing Flange Stud	
4	ENVIRO-SEAL bellows seal stud bolt	
5	Packing Flange Nut	
5	ENVIRO-SEAL bellows seal hex nut	
6*	Packing set, PTFE	see following table

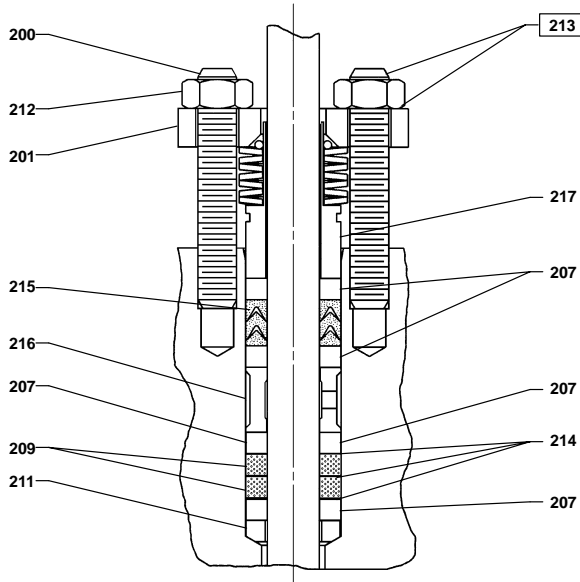


39B4612/A

Figure 12. Typical ENVIRO-SEAL Packing System with Graphite ULF Packing

Key	Description	Part Number
6*	ENVIRO-SEAL bellows seal packing set PTFE for 9.5 mm (3/8 inch) stem (1 req'd for single packing, 2 req'd for double packing)	12A9016X012
	PTFE for size 2 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A9016X012
	PTFE for size 3 and 4 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A8832X012

\*Recommended spare parts



A6722 / IL

Figure 13. Typical ENVIRO-SEAL Packing System with Duplex Packing

Key	Description	Part Number
7*	Packing ring, PTFE composition	see following table
7*	ENVIRO-SEAL bellows seal packing ring for low chloride graphite ribbon/filament packing arrangement	
	Ribbon packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0908X012
	Filament packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	1P3905X0172
	Ribbon packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0918X012
	Filament packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	14A0915X042
8	Spring	
8	Lantern ring	
8	ENVIRO-SEAL bellows seal spring	
8	ENVIRO-SEAL bellows seal spacer	
10	Special washer	
11*	Packing Box Ring, S31600	
	9.5 mm (3/8-inch) stem,	1J873135072
	12.7 mm (1/2-inch) stem,	1J873235072
	19.1 mm (3/4-inch) stem,	1J873335072
	25.4 mm (1-inch) stem,	1J873435072
	31.8 mm (1-1/4 inch) stem,	1J873535072
12*	Upper Wiper, felt	
	9.5 mm (3/8-inch) stem	1J872606332
	12.7 mm (1/2-inch) stem	1J872706332
	19.1 mm (3/4-inch) stem	1J872806332
	25.4 mm (1-inch) stem	1J872906332
	31.8 mm (1-1/4 inch) stem	1J873006332
12*	ENVIRO-SEAL bellows seal upper wiper	
	For 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem	18A0868X012
	For size 3 and 4 with 12.7 mm (1/2 inch) stem	18A0870X012
13	Packing Follower	

Key	Description	Part Number
13*	ENVIRO-SEAL bellows seal bushing	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	S31600/PTFE	18A0820X012
	R30006	18A0819X012
	S31600/Cr Coated	11B1155X012
	For size 3 and 4 with 12.7 mm (1/2 inch) stem (1 req'd)	
	S31600/PTFE	18A0824X012
	R30006	18A0823X012
	S31600/Cr Coated	11B1157X012
13*	ENVIRO-SEAL bellows seal bushing/liner	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	N10276 bushing, PTFE/glass liner	12B2713X012
	N10276 bushing, PTFE/carbon liner	12B2713X042
	For size 3 and 4 with 12.7 mm (1/2 inch) stem (1 req'd)	
	N10276 bushing, PTFE/glass liner	12B2715X012
	N10276 bushing, PTFE/carbon liner	12B2715X042
14	Pipe Plug	
14	Lubricator	
14	Lubricator/Isolating Valve	
15	Yoke Locknut	
15	ENVIRO-SEAL bellows seal Locknut	
16	Pipe Plug	
16	ENVIRO-SEAL bellows seal pipe plug	
20*	ENVIRO-SEAL bellows seal stem/bellows assembly	
	1 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X012
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X012
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X012
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X012
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X012
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X022
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X022
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X022
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X022
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X022
	2 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X032
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X032
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X032
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X032
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X032
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X042
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X042
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X042
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X042
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X042
22*	ENVIRO-SEAL bellows seal bonnet gasket (graphite/S31600)	
	Size 1/2 through 1-1/4	12B6316X022
	Size 1-1/2	12B6317X022
	Size 2	12B6318X022
	Size 3	12B6319X022
	Size 4	12B6320X022
24	ENVIRO-SEAL bellows seal adaptor	



# Instruction Manual

Form 5081  
June 2002

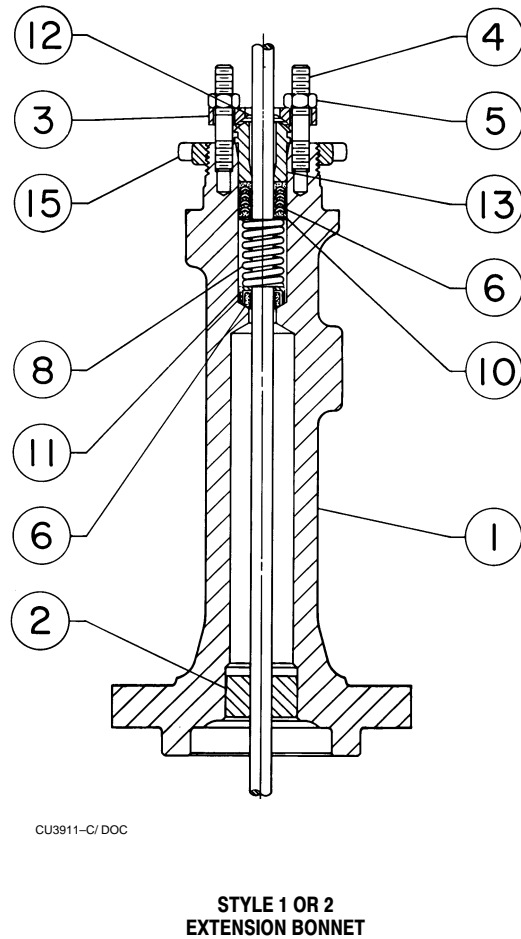
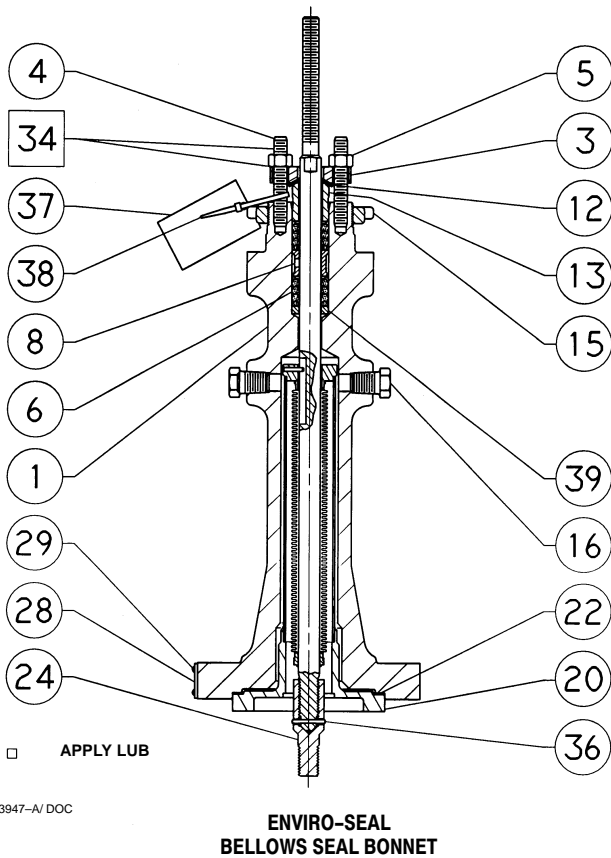
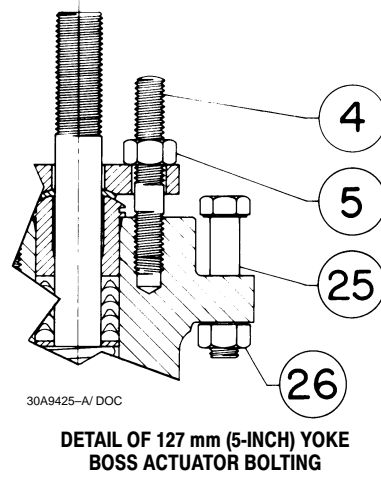
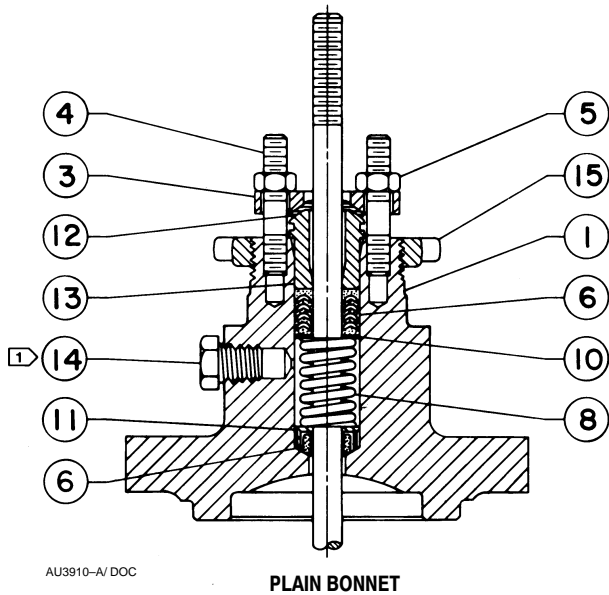
# ET Valve

Keys 6\*, 7\*, 8, and 10 Packing Box Parts<sup>(1)</sup>

DESCRIPTION		KEY NO.	STEM DIAMETER, mm (INCHES)					
			9.5 (3/8)	12.7 (1/2)	19.1 (3/4)	25.4 (1)	31.8 (1-1/4)	
PTFE V-Ring Packing	Packing Set, PTFE (1 req'd for single, 2 req'd for double) <sup>(2)</sup>	6	1R290001012	1R290201012	1R290401012	1R290601012	1R290801012	
	Spring, Stainless Steel (for single only)	8	1F125437012	1F125537012	1F125637012	1D582937012	1D387437012	
	Lantern Ring, Stainless Steel (for double only)	8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072	
	Quantity required	Double	---	1	2	1	1	1
	Special Washer, Stainless Steel (for single only)	10	1F125236042	1F125136042	1F125036042	1H982236042	1H995936042	
PTFE/Composition Packing	Packing Ring, PTFE composition	7	1F3370X0012	1E319001042	1E319101012	1D7518X0012	1D7520X0012	
	Quantity required	Double	---	7	10	8	8	8
	Lantern Ring, Stainless Steel (1 required)	8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072	
Graphite Ribbon/Filament	Graphite Ribbon Ring	7	1V3160X0022	1V3802X0022	1V2396X0022	1U6768X0022	1V5666X0022	
	Quantity required	Single	---	2	2	2	2	2
		Double	---	3	3	3	3	3
	Graphite Filament Ring	7	1F3370X0322	1E3190X0222	1E3191X0282	1D7518X0132	1D7520X0162	
	Quantity required	Single	---	2	2	3	3	3
		Double	---	4	4	5	5	5
	Lantern Ring	8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072	
	Quantity required	Single	---	2	3	2	2	2
	Double	---	1	2	1	1	1	
	Warning Tag		11B9513X012	11B9513X012	11B9513X012	11B9513X012	11B9513X012	

1. For ENVIRO-SEAL or HIGH-SEAL packing box parts, see instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306 or HIGH-SEAL Live-Loaded Packing System, Form 5263.  
2. Key 6 for double construction contains one extra packing ring for the 9.5 mm (3/8-inch) stem and one extra lower wiper for all sizes. Discard upon assembly.

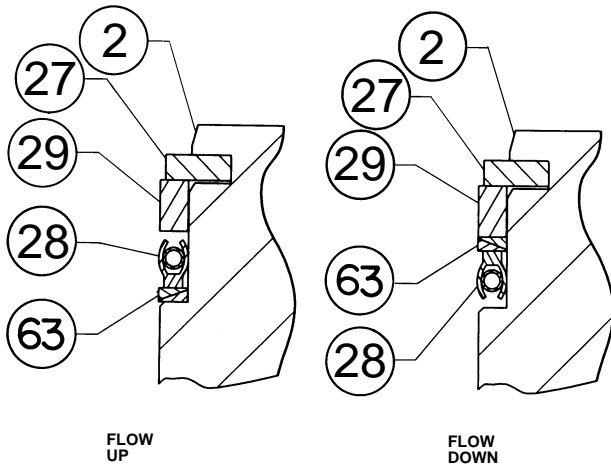
Key	Description	Part Number	Key	Description	Part Number
25	Cap Screw		34	Lubricant, Never-Seez Nickel Special (not included with valve)	
26	Hex Nut		36*	ENVIRO-SEAL bellows seal pin	12B3951X012
27	Pipe Nipple for lubricator/isolating valve		37	ENVIRO-SEAL bellows seal warning tag	
28	ENVIRO-SEAL bellows seal nameplate, warning		38	ENVIRO-SEAL bellows seal tie	
29	ENVIRO-SEAL bellows seal drive screw		39	ENVIRO-SEAL bellows seal thrust ring	



**NOTE:**

1 PIPE PLUG (KEY 14) INCLUDED ONLY IF BONNET IS DRILLED AND TAPPED FOR PACKING LUBRICATOR AND LUBRICATOR IS NOT INSTALLED.

Figure 14. Typical Bonnets



21B2120-A  
A6137 / IL

**1- TO 8-INCH DESIGN ET USING PEEK ANTI-EXTRUSION RINGS**

Figure 15. Alternate Configurations

Key	Description	Part Number
19	Drive Screw, Stainless Steel	
20*	Adaptor Gasket	see following table
21*	Seat Disk Retainer	see following table
22*	Disk Seat	see following table
23*	Disk	see following table
24*	Seal Ring (Design EAT)	see following table
25*	Backup Ring (Design EAT)	see following table
26	Load Ring (for 8 inch Design ET only)	
27*	Retaining Ring	see following table
27*	Shim (Design EAT)	see following table
28*	Seal Ring (Design ET)	see following table
29*	Backup Ring (Design ET)	see following table
31*	Whisper Trim III Cage Retainer for Levels A3, B3 & C3 (6 inch Design ET only)	
	410 Stainless steel	22A3255X012
	WCC steel (ENC)	22A3256X012
	316 Stainless Steel (ENC)	22A3256X022
	316 Stainless Steel w/CoCr-A bore	22A3257X012
	316 Stainless Steel (electrolized)	31A9792X012
31*	Whisper Trim III Cage Retainer & Baffle Ass'y for Level D3 (6 inch Design ET only)	
	410 Stainless Steel retainer & steel baffle	22A3258X012
	WCC steel (ENC) retainer & steel baffle	22A3258X022
	316 Stainless Steel (ENC) retainer & steel baffle	22A3258X052
	316 Stainless Steel w/CoCr-A retainer & steel baffle	22A3258X032
	316 Stainless steel (ENC) retainer & 316 stainless steel baffle	22A3258X042
	316 Stainless Steel (electrolized) retainer & 316 Stainless Steel baffle	22A3258X062
31*	Cavitrol III Cage Retainer, 316 Stainless Steel Design ET only)	
	1 inch valve (required w/2-stage cage only)	24A4258X012
	1-1/2 inch valve	24A4259X012
	2 inch valve	24A3040X012
	2-1/2 inch valve	24A4260X012
	3 inch valve	23A9451X012
	4 inch valve	23A5814X012
	6 inch valve	23A5801X012
	8 inch valve	23A9447X012
32	Whisper Trim III Bonnet Spacer (6 inch Design ET only)	
51*	Shim	see following table
54	Wire	
63*	Anti-Extrusion Ring	see following table

Key	Description	Part Number
-----	-------------	-------------

**Valve Body (figures 16 through 21)**

1	Valve Body If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve plug	see following table
3*	Cage	see following table
4	Trim adaptor	
5	Trim adaptor	
7*	Valve plug stem	see following table
8*	Pin, 316 Stainless Steel	
	9.5 mm (3/8 inches) stem	1V322635072
	12.7 mm (1/2 inch) stem	1V322735072
	19.1 mm (3/4 inch) stem	1V326035072
	25.4 mm (1 inch) or 31.8 mm (1-1/4 inch) stem	1V334035072
9*	Liner	see following table
9*	Seat Ring	see following table
10*	Bonnet Gasket	see following table
11*	Cage Gasket	see following table
12*	Spiral-Wound Gasket	see following table
13*	Seat Ring or Liner Gasket	see following table
14*	Adaptor Gasket	see following table
15	Cap Screw	
15	Stud	
16	Nut	
17	Pipe Plug, for use in valves with drain tapping only	
18	Flow Direction Arrow	

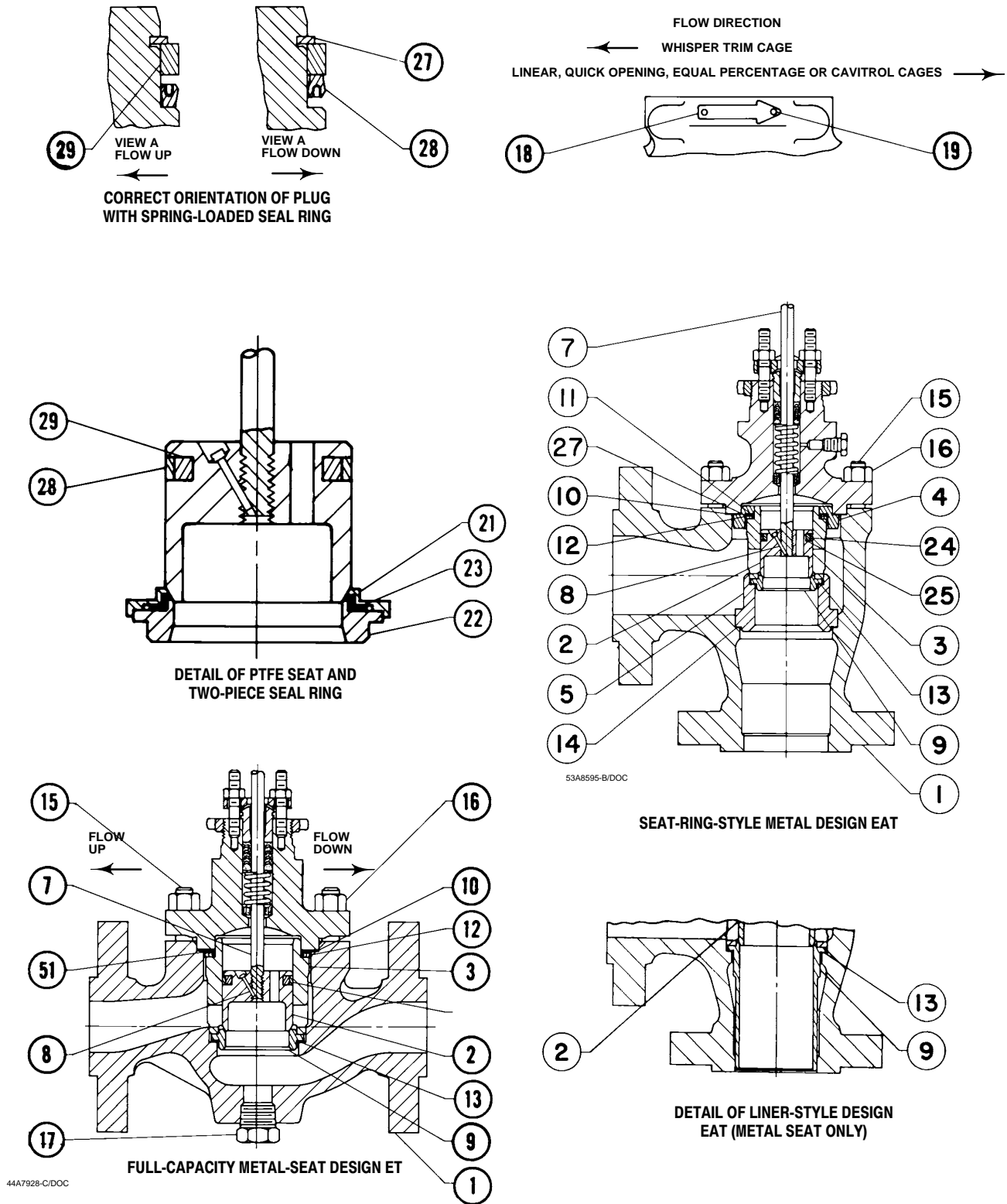
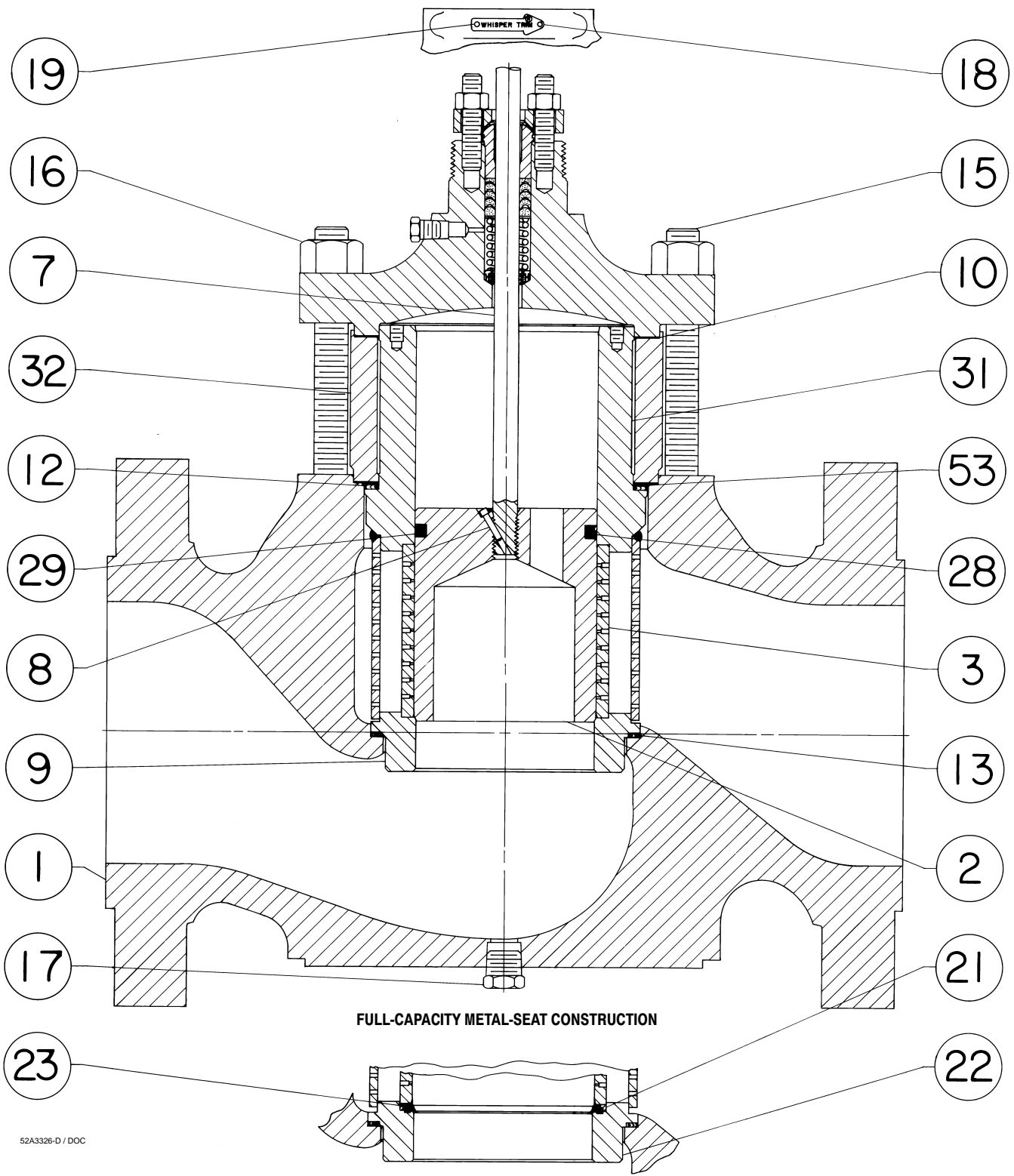
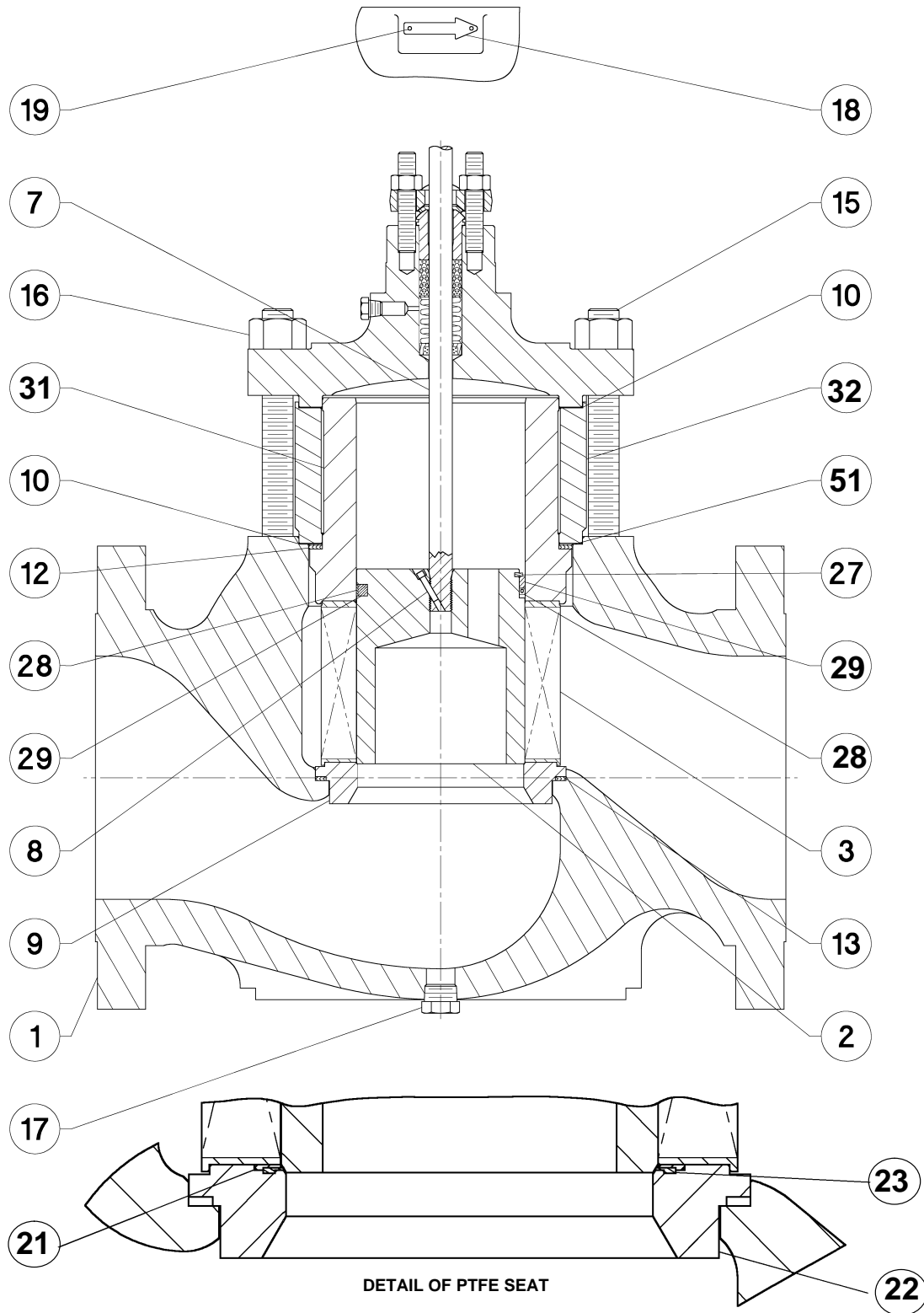


Figure 16. 1- Through 6-Inch Design ET and EAT Valves



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Figure 17. Design ET Valve Assembly with Whisper Trim III Cage



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DETAIL OF PTFE SEAT

Figure 18. Design ET Valve Assembly with WhisperFlo Cage

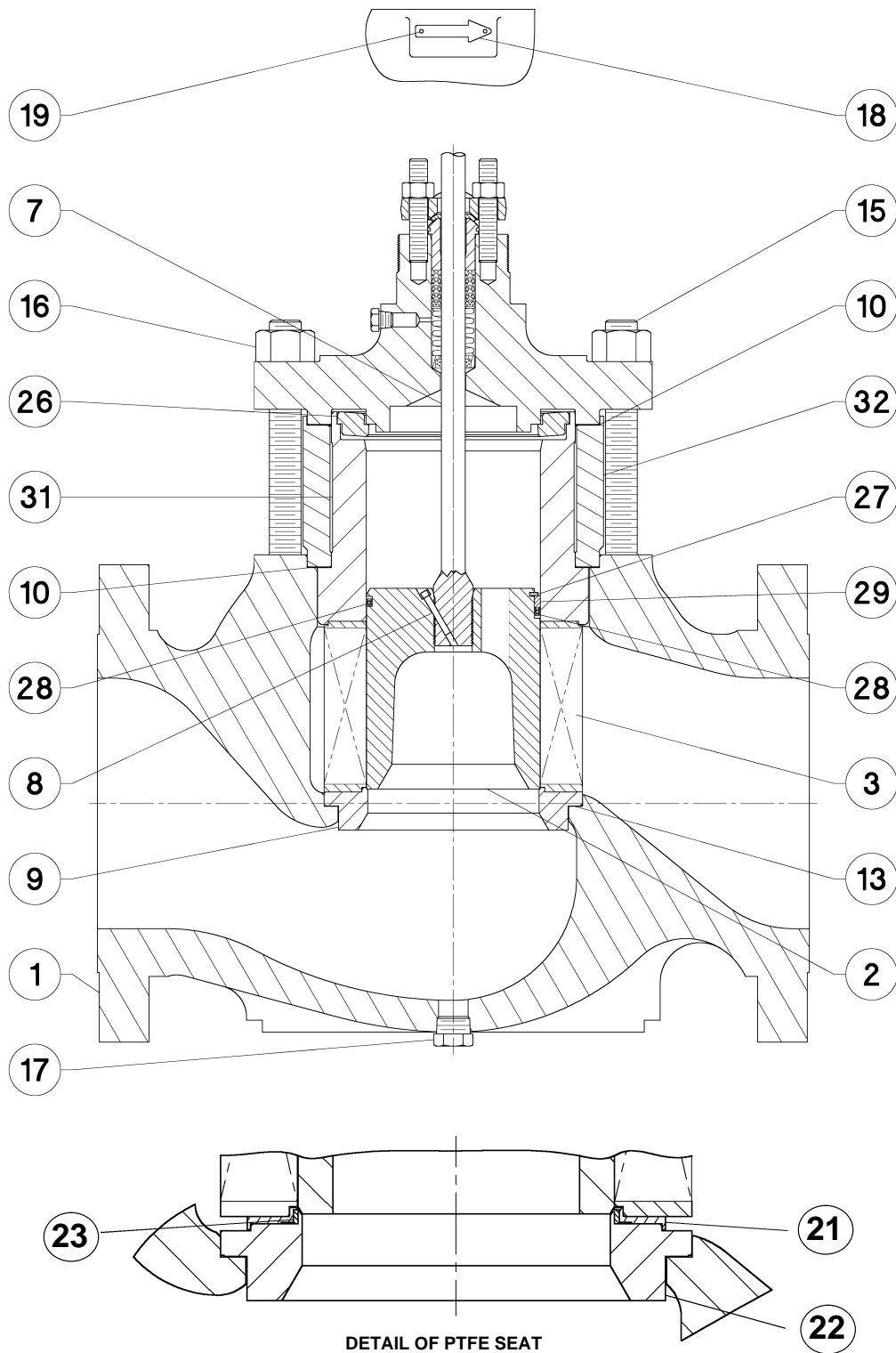
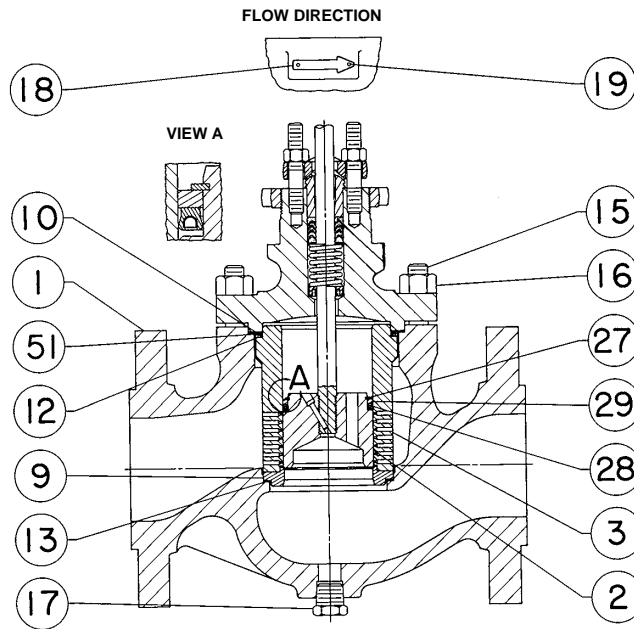
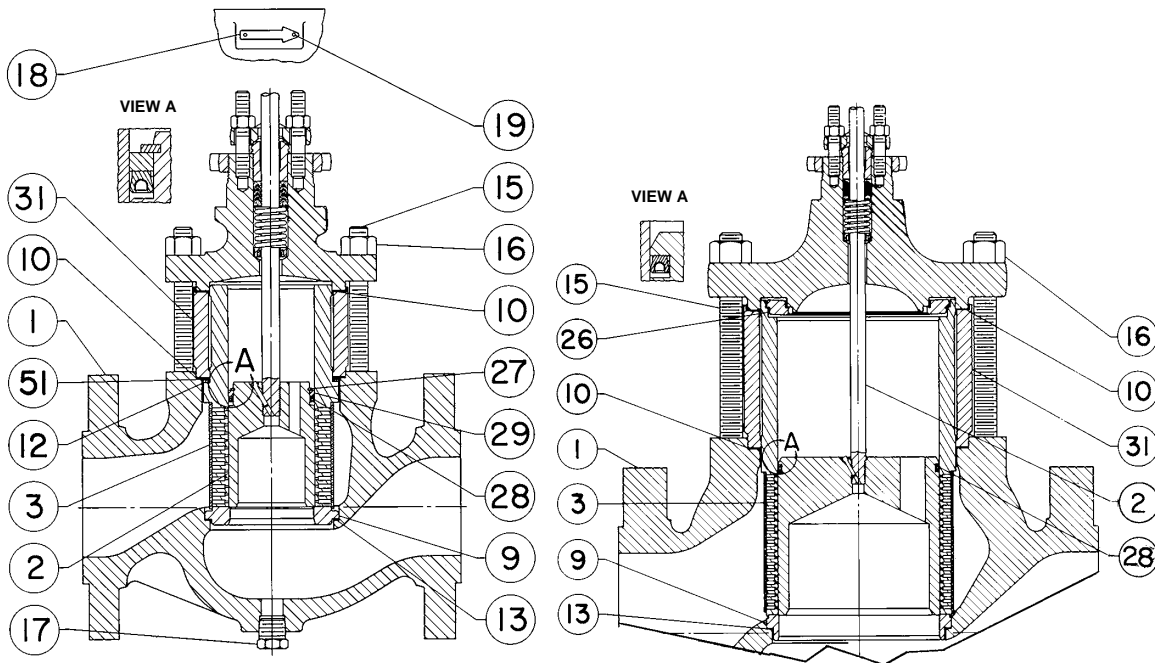


Figure 19. 8-Inch Design ET Valve Assembly with WhisperFlo Cage



54A8144-B/DOC

**1-STAGE CAVITROL III CONSTRUCTIONS THRU 6 INCHES SHOWING CORRECT ORIENTATION OF PLUG WITH SPRING-LOADED SEAL RING**



54A7268-B/DOC

**1 THROUGH 6-INCH VALVE SIZE**

54A8132-A/DOC

**8-INCH VALVE SIZE**

**PLUG AND SEAL RING WITH SPRING LOADING SHOWN IN CORRECT ORIENTATION FOR 2-STAGE CAVITROL III CAGE**

*Figure 20. Details of Cavitrol III and 8-Inch Design ET Valves*



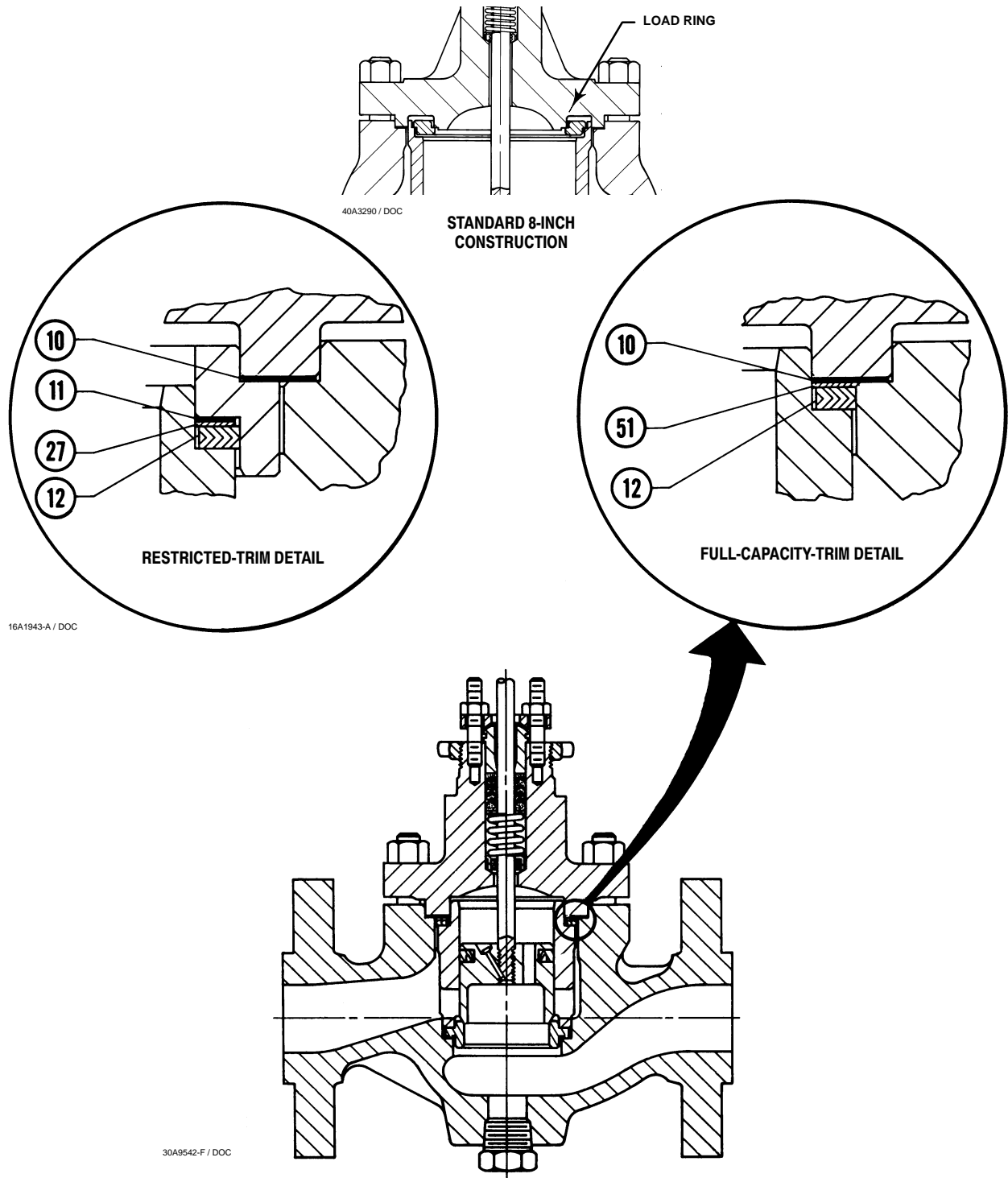


Figure 21. Gasket Set Detail

# ET Valve

Actuator Groups (by type number)

<p><b>Group 1</b> 54 mm (2-1/8 inches), 71 mm (2-13/16 inches), or 90 mm (3-9/16 inches) Yoke Boss</p> <p>350—71.4 mm (2-13/16 inches) Yoke Boss</p> <p>585 &amp; 585R (size 100)</p> <p>585C &amp; 585CR</p> <p>603 &amp; 1B</p> <p>618</p> <p>644 &amp; 645</p> <p>657 &amp; 667—76.2 mm (3 inches) maximum travel</p> <p>1008—71.4 mm (2-13/16 inches) Yoke Boss</p>	<p><b>Group 100</b> 127 mm (5 inches) Yoke Boss 3 inches maximum travel</p>	<p><b>Group 401</b> 90.5 mm (3-9/16 inches) Yoke Boss 3-1/4 to 4 inches maximum travel</p>	<p><b>Group 404</b> 127 mm (5 inches) Yoke Boss 4 inches maximum travel</p>	
	<p>350 585C 657 1008</p>	<p>657 657 MO 657-4 657-4 MO 667 667 MO 667-4 667-4 MO</p>	<p>667 667-4</p>	
	<p><b>Group 405</b> 127 mm (5 inches) Yoke Boss 4 inches maximum travel</p>	<p>657 MO 657-4 MO</p>	<p><b>Group 406</b> 127 mm (5 inches) Yoke Boss 4 inches maximum travel</p>	
	<p><b>Group 402</b> 90.5 mm (3-9/16 inches) Yoke Boss 4 inches maximum travel</p>	<p>457-7 585C</p>	<p>585 &amp; 585R (size 100) 667 MO 667-4 MO</p>	
	<p><b>Group 101</b> 127 mm (5 inches) Yoke Boss 3 inches maximum travel</p>	<p>667</p>	<p><b>Group 403</b> 90.5 mm (3-9/16 inches) Yoke Boss 4 inches maximum travel</p>	
	<p><b>Group 400</b> 71.4 mm (2-13/16 inches) Yoke Boss 4 inches maximum travel</p>	<p>585C 1008</p>	<p>585C 657</p>	
	<p>585C</p>	<p><b>Group 801</b> 90.5 mm (3-9/16 inches) Yoke Boss 8 inches maximum travel</p>	<p><b>Group 802</b> 127 mm (5 inches) Yoke Boss 8 inches maximum travel</p>	
		<p>585C</p>	<p>585C</p>	

Key 2\* Valve Plug for Constructions with Two-Piece Seal Ring

VALVE SIZE, INCHES		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>
Design ET	Design EAT	mm	Inches				
1, 1-1/4, or 1-1/2 x 1	1 or 2 x 1	9.5	3/8	1V657146172	1V657135072	11A5315X012	11A5317X012
		12.7	1/2	1V657246172	1V657235072	11A5316X012	11A5318X012
1-1/2	2	9.5	3/8	1V657346172	1V657335072	11A5321X012	10A4438X012
		12.7	1/2	1V657446172	1V657435072	10A4439X012	10A4611X012
2 or 3 x 2	4 x 2	12.7	1/2	1V657546172	1V657535072	11A5324X012	11A5326X012
		19.1	3/4	1V657646172	1V657635072	11A5325X012	11A5327X012
2 x 1	---	12.7	1/2	1V657246172	1V657235072	11A5316X012	11A5318X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V657746172	1V657735072	11A5330X012	11A5332X012
		19.1	3/4	1V657846172	1V657835072	11A5331X012	11A5333X012
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V657446172	1V657435072	10A4439X012	10A4611X012
3	4	12.7	1/2	1V657946172	1V657935072	11A5336X012	11A5337X012
		19.1	3/4	1V658046172	1V658035072	11A5014X012	11A5338X012
4	6	12.7	1/2	1V658146172	1V658135072	11A5341X012	11A5344X012
		19.1	3/4	1V6582X0022	1V6582X0072	11A5342X012	11A5345X042
		25.4	1	1V658346172	1V658335072	11A5343X012	11A5346X012
6	---	19.1	3/4	1V658446172	1V658435072	11A5350X012	11A5351X012
		25.4	1	1V658546172	1V658535072	10A5107X012	20A0103X012
		31.8	1-1/4	1V658646172	1V658635072	10A5108X012	20A4608X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

# Instruction Manual

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June 2002

# ET Valve

Keys 2\*, 7\*, and 8\* Valve Plug and Stem Assembly for Plain Bonnet with Two-Piece Seal Ring

VALVE SIZE, INCHES		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>
Design ET	Design EAT	mm	Inches				
1 or 1-1/4	1	9.5	3/8	1V6571X0032	1V6571X0052	11A5315X032	11A5317X042
		12.7	1/2	1V6572X0022	1V6572X0062	11A5316X022	11A5318X042
1-1/2	2	9.5	3/8	1V6573X0042	1V6573X0052	11A5321X022	10A4438X022
		12.7	1/2	1V6574X0012	1V6574X0032	---	10A4611X042
1-1/2 x 1	2 x 1	9.5	3/8	1V6571X0042	1V6571X0092	---	11A5317X072
		12.7	1/2	1V6572X0042	---	---	11A5318X032
2 or 3 x 2	4 x 2	12.7	1/2	1V6575X0052	1V6575X0062	11A5324X022	11A5326X022
		19.1	3/4	1V6576X0012	---	---	11A5327X032
2 x 1	---	12.7	1/2	1V6572X0022	1V6572X0062	11A5316X022	11A5318X042
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V6577X0042	1V6577X0062	11A5330X022	11A5332X022
		19.1	3/4	1V6578X0012	1V6578X0022	11A5331X022	---
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0012	1V6574X0032	---	10A4611X112
3	4	12.7	1/2	1V6579X0092	1V6579X0112	11A5336X032	11A5337X082
4	6	12.7	1/2	1V6581X0042	1V6581X0052	11A5341X032	11A5344X022
		19.1	3/4	1V6582X0022	1V6582X0072	---	11A5345X042
6	---	19.1	3/4	1V6584X0042	1V6584X0062	11A5350X032	21A5351X062

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Keys 2\*, 7\*, and 8\* Valve Plug and Stem Assembly for Style 1 Extension Bonnet with Two-Piece Seal Ring

VALVE SIZE, INCHES		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>
Design ET	Design EAT	mm	Inches				
1 or 1-1/4	1	9.5	3/8	1V6571X0072	1V6571X0062	---	11A5317X082
		12.7	1/2	1V6572X0032	---	11A5316X032	---
1-1/2	2	9.5	3/8	1V6573X0072	---	11A5321X042	10A4438X032
		12.7	1/2	1V6574X0052	---	---	10A4611X112
1-1/2 x 1	2 x 1	9.5	3/8	1V6571X0102	---	---	11A5317X052
		12.7	1/2	1V6572X0152	---	---	---
2 or 3 x 2	4 x 2	12.7	1/2	1V6575X0182	1V6575X0122	11A5324X042	11A5326X062
2 x 1	---	12.7	1/2	1V6572X0032	---	11A5316X032	---
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V6577X0052	---	---	11A5332X202
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0052	---	---	10A4611X112
3	4	12.7	1/2	1V6579X0082	1V6579X0072	---	11A5337X062
4	6	12.7	1/2	1V6581X0072	1V6581X0062	---	11A5344X052
6	---	19.1	3/4	1V6584X0052	1V6584X0112	---	21A5351X052

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

# ET Valve

Key 2\* Valve Plug for Spring-Loaded Seal Ring Constructions

VALVE SIZE, INCHES		STEM DIAMETER		416 STAINLESS STEEL HARDENED	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A SEAT & GUIDE <sup>(1)</sup>
Design ET	Design EAT	mm	Inches			
1, 1-1/4, or 1-1/2 x 1	1	9.5	3/8	20A4103X012	20A4103X022	20A4104X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	9.5	3/8	20A6711X012	20A6711X022	22A5941X012
		12.7	1/2	20A4150X012	20A4150X022	20A4151X012
2 or 3 x 2	4 x 2	12.7	1/2	20A4097X012	20A4097X022	20A4099X012
		19.1	3/4	20A4098X012	20A4098X022	20A4100X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	20A9533X012	20A9533X022	20A9534X012
		19.1	3/4	20A4144X012	20A4144X022	20A4146X012
3	4	12.7	1/2	20A5414X012	20A5414X022	22A3458X012
		19.1	3/4	20A5342X012	20A5342X022	20A5344X012
4	6	12.7	1/2	20A2641X012	20A2641X022	21A0187X012
		19.1	3/4	20A4194X012	20A4194X0A2	20A4197X012
		25.4	1	20A4195X012	20A4195X032	20A4198X012
6	---	19.1	3/4	20A2642X012	20A2642X022	21A8443X012
		25.4	1	20A5621X012	20A5621X022	20A6706X012
8	---	19.1	3/4	21A5356X012	21A5356X022	21A5362X012
		25.4	1	21A5357X012	21A5357X022	21A5363X012
		31.8	1-1/4	21A5358X012	21A5358X022	21A5364X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Keys 2\*, 7\*, and 8\* Valve Plug and Stem Assembly for Plain Bonnet for Spring-Loaded Seal Ring Constructions

VALVE SIZE, INCHES		STEM DIAMETER		416 STAINLESS STEEL HARDENED	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A SEAT & GUIDE <sup>(1)</sup>
Design ET	Design EAT	mm	Inches			
1, 1-1/4	1	9.5	3/8	20A4103X052	---	---
1-1/2	2	9.5	3/8	20A6711X032	20A6711X042	22A5941X022
		12.7	1/2	20A4150X062	---	---
1-1/2 x 1	2 x 1	9.5	3/8	20A4103X042	---	---
2 or 3 x 2	4 x 2	12.7	1/2	20A4097X062	20A4097X182	20A4099X102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	20A9533X052	20A9533X062	20A9534X092
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	20A4150X062	---	---
3	4	12.7	1/2	20A5414X062	20A5414X052	22A3458X022
		19.1	3/4	20A5342X082	---	20A5344X042
4	6	12.7	1/2	20A2641X042	20A2641X162	---
		19.1	3/4	20A4194X052	---	---
6	---	19.1	3/4	20A2642X052	20A2642X062	21A8443X032
8	---	19.1	3/4	21A5356X052	21A5356X132	21A5362X062

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Key 2\* 1-Stage Cavtrol III Valve Plug (Design ET only)

VALVE SIZE, INCHES	STEM DIAMETER		420 STAINLESS STEEL	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>
	mm	Inches		
1	12.7	1/2	28A1001X012	28A2226X012
1-1/2	12.7	1/2	28A1002X012	28A2227X012
	19.1	3/4	28A1003X012	28A2228X012
2	12.7	1/2	28A1004X012	28A2229X012
	19.1	3/4	28A1005X012	28A2230X012
2-1/2	12.7	1/2	28A1006X012	28A2231X012
	19.1	3/4	28A1007X012	28A2232X012
3	12.7	1/2	28A1008X012	28A2233X012
	19.1	3/4	28A1010X012	28A2234X012
4	19.1	3/4	28A1011X012	28A2235X012
	25.4	1	28A1013X012	28A2236X012
6	25.4	1	28A1014X012	28A2237X012
	31.8	1-1/4	28A1016X012	28A2238X012
8	25.4	1	28A1017X012	28A2239X012
	31.8	1-1/4		

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

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# ET Valve

Key 2\* 2-Stage Cavitol III Valve Plug & Stem Ass'y (Design ET only)

VALVE SIZE, INCHES	TRAVEL		ACTUATOR GROUP (FROM PRECEDING TABLE)	STEM DIAMETER		316 STAINLESS STEEL STEM		17-4PH STAINLESS STEEL STEM	
	mm	Inches		mm	Inches	420 HT Valve Plug	316 Stainless Steel Valve Plug w/CoCr-A Seat & Guide	420 HT Valve Plug	316 Stainless Steel Valve Plug w/CoCr-A Seat & Guide
1	25	1	1	12.7	1/2	24A5265X022	24A5519X022	----	----
1-1/2	38	1-1/2	1	12.7	1/2	24A5266X022	24A5286X022	----	----
2	51	2	1	12.7 19.1	1/2 3/4	24A3038X022 24A5550X022	24A5287X022 24A5551X022	24A3038X032 ----	24A5287X032 ----
2-1/2	64	2-1/2	1 400 1, 402, 403	12.7 12.7 19.1	1/2 1/2 3/4	24A5267X022 24A5267X032 24A5268X022	24A5288X022 24A5288X032 24A5289X022	24A5267X042 24A5267X052 ----	24A5288X042 24A5288X052 ----
3	76	3	1, 400 1, 402, 403	12.7 19.1	1/2 3/4	24A5269X022 23A9452X012	24A5290X022 24A5291X022	24A5269X032 ----	24A5290X032 ----
4	76	3	1, 402, 403	19.1	3/4	23A5818X022	24A5292X022	----	----
	102	4	401, 402, 403	19.1	3/4	23A5818X032	24A5292X032	----	----
	76	3	100, 101	25.4	1	24A5270X022	24A5293X022	----	----
	102	4	404	25.4	1	24A5270X022	24A5293X022	----	----
6	102	4	405, 406	25.4	1	24A5270X042	24A5293X042	----	----
	102	4	407	25.4	1	24A5270X032	24A5293X032	----	----
	76	3	1	19.1	3/4	23A5803X022	24A5294X022	23A5803X032	24A5294X032
	102	4	401, 403	19.1	3/4	23A5803X022	24A5294X022	23A5803X032	24A5294X032
8	102	4	402	19.1	3/4	23A5803X042	24A5294X042	23A5803X052	24A5294X052
	76	3	100, 101	25.4	1	24A3028X042	24A5295X022	----	----
	102	4	405, 406	25.4	1	24A3028X052	24A5295X032	----	----
	102	4	407	25.4	1	24A3028X062	24A5295X042	----	----
8	76	3	1	19.1	3/4	24A1141X092	34A4269X042	24A1141X072	34A4269X052
	102	4	401, 403	19.1	3/4	24A1141X092	34A4269X042	24A1141X072	34A4269X052
	102	4	402	19.1	3/4	24A1141X042	34A4269X062	24A1141X082	34A4269X072
	153	6	801	19.1	3/4	24A1141X032	34A4269X022	24A1141X062	34A4269X032
	76	3	100, 101	25.4	1	24A5273X022	34A4270X022	24A5273X032	34A5270X032
	102	4	404	25.4	1	24A5273X022	34A4270X022	24A5273X032	34A4270X032
	153	6	802	25.4	1	24A5273X022	34A4270X022	24A5273X032	34A4270X032
	102	4	407	25.4	1	24A5273X042	34A4270X042	24A5273X052	34A4270X052
	102	4	405, 406	25.4	1	24A5273X062	34A4270X062	24A5273X072	34A4270X072
	76	3	100, 101	31.8	1-1/4	24A7259X022	34A7260X022	----	----
	102	4	404	31.8	1-1/4	24A7259X022	34A7260X022	----	----
	153	6	802	31.8	1-1/4	24A7259X022	34A7260X022	----	----
102	4	407	31.8	1-1/4	24A7259X032	34A7260X032	----	----	
102	4	405, 406	31.8	1-1/4	24A7259X042	34A7260X042	----	----	

Key 2\* Whisper Trim III Valve Plug with Two-Piece Seal Ring (6-inch Design ET only)

STEM DIAMETER		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL	316 STAINLESS STEEL W/CoCr-A ON SEAT	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE <sup>(1)</sup>
mm	Inches					
19.1	3/4	22A3259X012	22A3259X022	22A3260X012	22A3261X012	22A3267X012
25.4	1	22A3262X012	22A3262X022	22A3263X012	22A3264X012	22A3268X012

1. High temperature.

Key 2\* Whisper Trim III Valve Plug for Spring Loaded Seal Ring (6-inch Design ET only)

STEM DIAMETER		17-4PH (HARDENED)	316 STAINLESS STEEL	316 STAINLESS STEEL W/CoCr-A ON SEAT	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE
mm	Inches				
19.1	3/4	22A3269X012	22A3269X022	22A3270X012	22A3271X012
25.4	1	22A3272X012	22A3272X022	22A3273X012	22A3274X012

\*Recommended spare parts

# ET Valve

Key 3\* Quick Opening Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		ALLOY 6
Design ET	Design EAT		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215033272	2U691146102	2U740348932	2U215039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219233272	2U691846102	2U725448932	2U219239102
2 or 3 x 2	4 x 2	2U223433272	2U692146102	2U740448932	2U223439102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227633272	2U692446102	2U740548932	2U227639102
3	4	2U231833272	2U692746102	2U740648932	2U231839102
4	6	2U236033272	2U693046102	2U740748932	2U236039102
6	---	2U506333272	2U693546102	2U806948932	2U506339102
8	---	20A3249X012	20A4350X012	20A5469X012	20A3249X092

Key 3\* Linear Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		ALLOY 6
Design ET	Design EAT		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215633272	2U691746102	2U741448932	2U215639102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219833272	2U692046102	2U741548932	2U219839102
2 or 3 x 2	4 x 2	2U224033272	2U692346102	2U741648932	2U224039102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U228233272	2U692646102	2U741748932	2U228239102
3	4	2U232433272	2U692946102	2U741848932	2U232439102
4	6	2U236633272	2U693346102	2U741948932	2U236639102
6	---	2U506133272	2U693846102	2U806848932	2U506139102
8	---	20A3247X012	20A4349X012	20A5468X012	20A3247X092

Key 3\* Equal Percentage Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		ALLOY 6
Design ET	Design EAT		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215333272	2U691346102	2U740848932	2U215339102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219533272	2U691946102	2U740948932	2U219539102
2 or 3 x 2	4 x 2	2U223733272	2U692246102	2U741048932	2U223739102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227933272	2U692546102	2U741148932	2U227939102
3	4	2U232133272	2U692846102	2U741248932	2U232139102
4	6	2U236333272	2U693146102	2U741348932	2U236339102
6	---	2U505933272	2U693746102	2U806748932	2U505939102
8	---	20A3245X012	20A4348X012	20A5467X012	20A3245X092

Key 3\* Whisper Trim I Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)
Design ET	Design EAT	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2V502333272
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2V502433272
2 or 3 x 2	4 x 2	2V502533272
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2V502633272
3	4	2V502733272
4	6	23A8915X032
6	---	23A8913X032

Key 3\* Whisper Trim III Cage (6-Inch Design ET only)

LEVEL	416 STAINLESS STEEL	316 STAINLESS STEEL (NICKEL COATED)	316 STAINLESS STEEL (ELECTROLIZED)
A3	32A3248X012	32A3251X012	32A3336X012
B3	32A3249X012	32A3252X012	32A3337X012
C3	32A3250X012	32A3253X012	32A3338X012
D3	32A6217X012	32A6220X012	32A6741X012

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# ET Valve

Key 3\* Cavitrol III Cage Assembly, 17-4PH stainless steel (hardened)

DESIGN ET VALVE SIZE, INCHES	STAGE		
	1	2	Characterized 2
1	38A1018X012	24A5558X012	24A5558X022
1-1/2	38A1019X012	24A5559X012	24A5559X022
2	38A1020X012	24A3031X032	24A3031X022
2-1/2	38A1021X012	24A5560X012	24A5560X022
3	38A1023X012	23A9453X022	23A9453X012
4	38A1025X012	23A5817X032	23A5817X022
6	38A1027X012	23A5804X012	23A5804X022
8	38A1029X012	24A3020X032	24A3020X042

Key 7\* Design ET Valve Plug Stem, 316 stainless steel (not for Cavitrol III or Whisper Trim III cage)

VALVE SIZE, INCHES	STEM DIAMETER & VSC <sup>(1)</sup> SIZE		PLAIN BONNET <sup>(3)</sup>				EXTENSION BONNET					
			Stem Length		Part Number	Style 1 <sup>(4)</sup>		Style 2				
						Stem Length		Part Number	Stem Length		Part Number	
			mm	Inches	mm	Inches	mm		Inches	mm		Inches
Full Capacity	1, 1-1/4, or 1-1/2	9.5	3/8	225	8-7/8	1U388835162	311	12-1/4	1U217735162	405	15-15/16	10A8823X022
		12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	473	18-5/8	1U218035162
	2	12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	614	24-3/16	1U226435162
		19.1	3/4	372	14-5/8	1U226535162	483	19	1L400135162	---	---	---
	2-1/2 or 3	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	---	---	---
	4	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	394	15-1/2	1K587735162	502	19-3/4	1U444635162	694	27-5/16	1U240035162
		25.4 <sup>(1)</sup>	1 <sup>(1)</sup>	464	18-1/4	1K759035162	---	---	---	---	---	---
		25.4 <sup>(2)</sup>	1 <sup>(2)</sup>	489	19-1/4	1U217535162	---	---	---	---	---	---
	6	19.1	3/4	403	15-7/8	1L996435162	511	20-1/8	1U507135162	699	27-1/2	1U524435162
		25.4	1	499	19-5/8	1N704735162	630	24-13/16	1K785135162	---	---	---
	31.8	1-1/4	508	20	1K415435162	656	25-13/16	1R562435162	---	---	---	
8	19.1	3/4	492	19-3/8	1K588035162	533	21	1U928235162	---	---	---	
	25.4	1	614	24-3/16	1K7891X0012	614	24-3/16	1K7891X0012	---	---	---	
	31.8	1-1/4	705	27-7/16	1L268835162	705	29-7/16	1L268835162	---	---	---	
Restricted Capacity	1-1/2 x 1	9.5	3/8	241	9-3/8	1U223635162	324	12-3/4	1U227035162	418	16-7/16	1U227235162
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	486	19-1/8	1U227335162
	2 x 1 or 2-1/2 x 1-1/2	12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	605	23-13/16	1U3893X0012
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	614	24-3/16	1U226435162
3 x 2	19.1	3/4	372	14-5/8	1U226535162	483	19	1L400135162	---	---	---	
	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162	
4 x 2-1/2	19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	681	26-13/16	1U232335162	

1. Type 667 actuator.  
2. Type 657 or 470 Series actuator.  
3. Plain bonnet is standard for 8-inch cast iron and WCC valve bodies.  
4. Style 1 extension bonnet is standard for 8-inch 316 SST valve bodies.

Key 7\* Whisper Trim III Valve Plug Stem, 316 stainless steel (6-inch Design ET only)

STEM DIAMETER		PLAIN BONNET	EXTENSION BONNET	
mm	Inches		Style 1	Style 2
19.1	3/4	1U294135162	1U928235162	1U6276X0012
25.4	1	1P847635162	1U627735162	---

# ET Valve

Key 7\* 1-Stage Cavitrol III Valve Plug Stem (Design ET only)

VALVE SIZE, INCHES	TRAVEL		ACTUATOR GROUP (FROM PRECEDING TABLE)	STEM DIAMETER		316 STAINLESS STEEL	17-4PH STAINLESS STEEL STEM
	mm	Inches		mm	Inches		
1	19, 25	3/4, 1	1	12.7	1/2	1U389035162	1U3890X0062
1-1/2	19, 22	3/4, 7/8	1	12.7	1/2	1U389035162	1U3890X0062
2	26	1-1/8	1 1	12.7 19.1	1/2 3/4	1K586935162 1U226535162	10A8840XC82 1U226535382
2-1/2	38	1-1/2	1 1	12.7 19.1	1/2 3/4	1U230535162 1U230835162	1U2305X0012 1U2308X0082
3	38, 41	1-1/2, 1-5/8	1 1	12.7 19.1	1/2 3/4	1U230535162 1U230835162	1U2305X0012 1U2308X0082
4	51, 54 54 54	2, 2-1/8 2-1/8 2-1/8	1 402 403	19.1 19.1 19.1	3/4 3/4 3/4	1K587735162 1V142235162 1U293835162	1K5877X0022 1V1422X0042 1U2938X0062
	51, 54	2, 2-1/8	100 101	25.4 25.4	1 1	1U217535162 1K759035162	1U217550372 1K7590X0012
6	51 57 51 57	2 2-1/4 2 2-1/4	100 100 100 100	25.4 25.4 31.8 31.8	1 1 1-1/4 1-1/4	1P847635162 1N704735162 1K415435162 1N920935162	11A3429X252 1N7047X0012 1K415435382 1N9209X0052
	51, 57	2, 2-1/4	101 101	25.4 31.8	1 1-1/4	1P405135072 1K775335162	1P4051X0032 1K7753X0012
8	76, 86	3, 3-3/8	100, 101, 404 100, 101, 404	25.4 31.8	1 1-1/4	10A3282X012 1R489535162	10A3282X012 1R4895X0022
	86	3-3/8	407 407	25.4 31.8	1 1-1/4	11A3429X012 1U9886X0012	1K7783X0052 1U9886X0152

Key 7\* Valve Plug Stem for Bellows Seal Bonnet, 316 Stainless Steel

VALVE SIZE, INCHES		STEM DIAMETER		STEM LENGTH		PART NUMBER
Design ET	Design EAT	mm	Inches	mm	Inches	
1, 1-1/4, 1-1/2, or 1-1/2 X 1	1, 2, or 2 x 1	9.5	3/8	222	8-3/4	1R288535162
		12.7	1/2	286	11-1/4	1R288835162
2, 2-1/2, 2-1/2 X 1-1/2, or 3	3 or 4	12.7	1/2	314	12-3/8	1U389235162
---	3 x 1-1/2	12.7	1/2	295	11-5/8	1U388935162
2 x 1 or 3 x 2	4 x 2	12.7	1/2	305	12	1U389135162
4	6	12.7	1/2	327	12-7/8	2R369335072
		19.1	3/4	387	15-1/4	1K587635162
4 x 2-1/2	6 x 2-1/2	12.7	1/2	327	12-7/8	2R369335072
		19.1	3/4	375	14-3/4	1U389435162
6	---	19.1	3/4	387	15-1/4	1K587635162



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# ET Valve

## Key 9\* Design EAT Liner

Liner Material	Valve Size, Inches	Class 150 Raised Face	Class 300 Raised Face	Class 600 Raised Face	Socket Weld	Schedule 40 or 80 Butt Weld
416 stainless steel (hardened)	1	1V560146172	1U384246172	1V560246172	1V560146172	1V560146172
	2	1V560346172	1U384346172	1V560546172	1V560346172	1V560346172
	2 x 1	1V560646172	1U385146172	1V387646172	1V560646172	1V560646172
	3	2V561346172	2U384546172	2V561646172	---	2V561346172
	3 x 1-1/2	2V560946172	2U385346172	2V545946172	---	2V560946172
	4	2V562246172	2U384746172	2V561946172	---	2V562246172
	4 x 2	2V561846172	2U385546172	2V561246172	---	2V561846172
	6	2V563146172	2U384946172	2V562846172	---	2U384946172
6 x 2-1/2	2V562646172	2U385746172	2V562346172	---	2U385746172	
316 stainless steel	1	1V560135072	1U384235072	1V560235072	1V560135072	1V560135072
	2	1V560335072	1U384335072	1V560535072	1V560335072	1V560335072
	2 x 1	1V560635072	1U385135072	1V387635072	1V560635072	1V560635072
	3	2V561335072	2U384535072	2V561635072	---	2V561335072
	3 x 1-1/2	2V560935072	2U385335072	2V545935072	---	2V560935072
	4	2V562235072	2U384735072	2V561935072	---	2V562235072
	4 x 2	2V561835072	2U385535072	2V561235072	---	2V561835072
	6	2V563135072	2U384935072	2V562835072	---	2U384935072
6 x 2-1/2	2V562635072	2U385735072	2V562335072	---	2U385735072	

## Key 9\* Metal-Seat Seat Ring (not for Whisper Trim III or Cavitrol III Cage)

VALVE SIZE, INCHES		416 STAINLESS STEEL (HARDENED) <sup>(1)</sup>	316 STAINLESS STEEL	R30006
Design ET	Design EAT			
1, 1-1/4, or 2 x 1	1	1U222546172	1U222535072	1U222539102
1-1/2 x 1	2 x 1	1U222046172	1U222035072	1U222039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1U221946172	1U221935072	1U221939102
2 or 3 x 2	4 x 2	1U222646172	1U222635072	1U222639102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	1U222746172	1U222735072	1U222739102
3	4	1U222846172	1U222835072	1U222839102
4	6	1U222946172	1U222933092	1U222939102
6	---	1U508046172	1U508033092	1U508039102
8	---	20A3260X012	20A3260X022	20A3260X152

1. 410 stainless steel (CA15) is used for 6- and 8-inch full-sized and restricted-trim valves.

## Key 9\* Cavitrol III Seat Ring (Design ET only)

VALVE SIZE, INCHES	1-STAGE CAGE		2-STAGE CAGE	
	17-4PH Stainless Steel	Alloy 6 (Cast)	17-4PH Stainless Steel	316 Stainless Steel w/CoCr-A Seat & Bore
1	23A7567X012	23A7567X022	24A5231X012	24A5239X012
1-1/2	23A7568X012	23A7568X022	24A5232X012	24A5240X012
2	23A7569X012	23A7569X022	24A3039X012	24A5241X012
2-1/2	24A1586X012	24A1586X022	24A5233X012	24A5242X012
3	24A3016X012	24A3016X022	23A9450X012	24A5243X012
4	24A1135X012	24A1135X022	23A5813X012	24A5244X012
6	23A5820X032	23A5820X012	23A5802X022	24A5245X012
8	23A9445X022	23A9445X032	24A3021X022	24A5246X012

## Key 9\* Whisper Trim III Seat Ring (6-Inch Design ET only)

410 Stainless Steel	316 Stainless Steel	316 Stainless Steel w/ CoCr-A Seat
21A9794X012	21A9794X022	21A9795X012

### Gasket Descriptions

KEY NUMBER	DESCRIPTION	MATERIAL
		FGM -198° to 593°C (-325° to 1100°F)
10 <sup>(1)</sup>	Bonnet Gasket	Graphite/S31600
11	Cage Gasket	
13	Seat Ring or Liner Gasket	
14 or 20	Adapter Gasket	
12	Spiral-Wound Gasket	N06600 (Inconel 600)/Graphite
27 or 51	Shim	S31600 (316 SST)

1. 2 req'd for 2-stage Cavitrol III cage.

### Keys 10\*, 11\*, 12\*, 13\*, 14\*, 20\*, 27\*, and 51\* Gaskets and Shims

VALVE SIZE, INCHES		KEY NUMBER	To 593°C (To 1100°F)	VALVE SIZE, INCHES		KEY NUMBER	To 593°C (To 1100°F)
Design ET	Design EAT			Design ET	Design EAT		
1 or 1-1/4	1	Set 10 12 13 27 or 51	RGASKETX162 1R2859X0042 1R286099442 1R2862X0062 16A1936X012	3	4	Set 10 12 13 27 or 51	RGASKETX202 1R3484X0042 1R348299442 1R3481X0052 16A1940X012
1-1/2	2	Set 10 12 13 27 or 51	RGASKETX172 1R3101X0032 1R309999442 1R3098X0052 16A1937X012	3 x 2	4 x 2	Set 10 11 12 13 14 27 or 51	RGASKETX272 1R3484X0042 1R3298X0032 1R329799442 1R3296X0042 1R3481X0052 16A1938X012
1-1/2 x 1	2 x 1	Set 10 11 12 13 20 27 or 51	RGASKETX242 1R3101X0032 1R2861X0042 1R286099442 1R3098X0052 1U2152X0042 16A1936X012	4	6	Set 10 12 13 27 or 51	RGASKETX212 1R3724X0042 1R372299442 1J5047X0062 16A1941X012
2	---	Set 10 12 13 51	RGASKETX182 1R3299X0042 1R329799442 1R3296X0042 16A1938X012	4 x 2-1/2	6 x 2-1/2	Set 10 11 12 13 14 27 or 51	RGASKETX282 1R3724X0042 1R3846X0042 1R384599442 1R3844X0052 1J5047X0062 16A1939X012
2 x 1	---	Set 10 11 12 13 14 51	RGASKETX252 1R3299X0042 1R2861X0042 1R286099442 1R2862X0062 1R3296X0042 16A1936X012	6	---	Set <sup>(2)</sup> 10 12 13 51	RGASKETX222 1U5081X0052 1U508599442 1U5086X0032 16A1942X012
2-1/2	3	Set 10 12 13 27 or 51	RGASKETX192 1R3847X0032 1R384599442 1R3844X0052 16A1939X012	8	---	Set 10 13	RGASKETX232 10A3265X112 10A3266X082
2-1/2 x 1-1/2	3 x 1-1/2	Set 10 11 12 13 14 27 or 51	RGASKETX262 1R3847X0032 1R3100X0032 1R309999442 1R3098X0052 1R3844X0052 16A1937X012				

1. -73°C to 149°C (-100° to 300°F) for temperature cycling service.  
2. Whisper Trim III construction requires 2 bonnet gaskets (key 10) so order a set plus 1 extra bonnet gasket for that construction.

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# ET Valve

Key 21\*, 22\*, and 23\* PTFE Seat Disk Retainer, Disk Seat, and Disk

VALVE SIZE, INCHES		KEY 21 DISK RETAINER, 316 STAINLESS STEEL	KEY 22 DISK SEAT		KEY 23 DISK, PTFE -73 TO 204°C (-100 TO 400°F)
Design ET	Design EAT		316 Stainless Steel	Alloy 6 (Cast)	
1, 1-1/4, or 2 x 1	1	1V710035072	1V710235072	1V710239102	1V710106242
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1V710335072	1V710535072	1V710539102	1V710406242
1-1/2 x 1	2 x 1	1V712135072	1V712235072	1V712239102	1V710106242
2 or 3 x 2	4 x 2	1V710835072	1V710635072	1V710639102	1V710706242
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	1V710935072	1V711135072	1V711139102	1V711006242
3	4	1V711235072	1V711435072	1V711439102	1V711306242
4	6	1V711533092	1V711733092	1V711739102	1V711606242
6	All except Whisper Trim III cage	1V711833092	1V712033092	1V7120X0012	1V711906242
	Whisper Trim III cage	23A4937X012	23A4938X012	---	13A4936X012
8	---	10A4466X012	20A4467X012	20A4467X022	20A4468X012

Key 27\* Retaining Ring for Spring-Loaded Seal Ring, 302 SST

VALVE SIZE, INCHES		PART NUMBER
Design ET	Design EAT	
1, 1-1/4 1-1/2 x 1, or 2 x 1	1 or 2 x 1	10A4211X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	10A4220X012
2 or 3 x 2	4 x 2	10A4210X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	10A4219X012
3	4	10A5350X012
4	6	10A4225X012
6 (Whisper Trim III only)	---	10A5410X012

Key 27\* Cavitrol III Retaining Ring for 1 through 6-inch  
Design ET only, 302 SST

VALVE SIZE, INCHES	1-STAGE CAGE	2-STAGE CAGE
1	10A4211X012	11A3405X012
1-1/2	10A4220X012	10A4211X012
2	10A4210X012	10A4220X012
2-1/2	10A4219X012	10A4210X012
3	10A5350X012	10A4219X012
4	10A4225X012	10A4219X012
6	None required	10A5410X012

Key 24\* Seal Ring (Design EAT)

Key 28\* Seal Ring (Design ET) (not for Cavitrol III or Whisper Trim III Construction)

VALVE SIZE, INCHES		STANDARD, CARBON FILLED PTFE	SPRING-LOADED
Design ET	Design EAT		PTFE -73 to 232°C (-100 to 450°F)
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	1V659105092	10A4207X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1V659305092	10A4216X012
2 or 3 x 2	4 x 2	1V550805092	10A4206X012
2-1/2 or 4 x 2-1/2	3 x 2 or 6 x 2-1/2	1V659505092	10A4215X012
3	4	1V659705092	10A5351X022
4	6	1V659905092	10A4223X012
6	---	1V660105092	10A2643X022
8	---	---	10A3261X012

Key 28\* Cavitrol III Seal Ring for Design ET only, spring loaded  
PTFE

VALVE SIZE, INCHES	1-STAGE CAGE	2-STAGE CAGE
1	10A4207X012	11A3407X042
1-1/2	10A4216X012	10A4207X012
2	10A4206X012	10A4216X012
2-1/2	10A4215X012	10A4206X012
3	10A5351X022	10A4215X012
4	10A4223X012	10A4215X012
6	10A2643X022	10A5411X022
8	10A3261X012	10A2643X022

Key 28\* Whisper Trim III Seal (6-inch Design ET only)

CARBON FILLED PTFE	SPRING LOADED PTFE
11A9729X012	10A5411X022

# ET Valve

Key 25\* Backup Ring (Design EAT)

Key 29\* Backup Ring (Design ET) (not for Cavitrol III or 8-inch Design ET)

VALVE SIZE, INCHES		STANDARD CONSTRUCTION			SPRING LOADED SEAL CONSTRUCTION	
Design ET	Design EAT	Nitrile -34 to 93°C (-30 to 200°F)	Fluoroelastomer <sup>(1)</sup> -18 to 204°C (-0 to 400°F)	Ethylene Propylene -40 to 232°C (-40 to 450°F)	416 Stainless Steel	316 Stainless Steel
1, 1-1/4, 1-1/2 x 1, or 2 x 1 1-1/2 or 2-1/2 x 1-1/2 2 or 3 x 2 2-1/2 or 4 x 2-1/2 3 4	1 or 2 x 1 2 or 3 x 1-1/2 4 x 2 3 or 6 x 2-1/2 4 6	1V659003052 1V659203052 1V550703052 1V659403052 1V659603052 1V659803052	1V659005292 1V659205292 1V550705292 1V659405292 1V659605292 1V659805292	1V6590X0042 1V6592X0032 1V5507X0042 1V6594X0032 1V6596X0032 1V6598X0022	10A4209X012 10A4218X022 10A4208X012 10A4217X012 10A5349X012 10A4224X012	10A4209X022 10A4218X012 10A4208X022 10A4217X022 10A5349X022 10A4224X022
6	All except Whisper Trim III cage	---	1V660003052	1V660005292	1V6600X0022	---
	Whisper Trim III cage	---	11A9728X022	11A9728X012	11A9728X042	12A3332X012

1. Not for use with steam or ammonia. Not recommended for water above 82°C (180°F).

Key 29\* Cavitrol III Backup Ring, 416 Stainless Steel  
(not for 8-inch Design ET)

VALVE SIZE, INCHES	1-STAGE CAGE	2-STAGE CAGE
1	10A4209X012	11A3404X012
1-1/2	10A4218X022	10A4209X022
2	10A4208X012	10A4218X022
2-1/2	10A4217X012	10A4208X012
3	10A5349X012	10A4217X012
4	10A4224X012	10A4217X012
6	None required	10A5409X012

Keys 3\*, 9\*, 2\*, 28\*, 63\*, 29\*, and 27\* TSO Trim Parts for Design ET Valves

VALVE SIZE, INCH	PORT, INCH	TRAVEL, INCH	TRIM	STEM DIAMETER		ACTUATOR GROUP	CHARACTERISTIC	KEY 3	KEY 3	KEY 9	KEY 2	
				mm	Inch			Cage Full 2-Stage	Cage Characterized 2-Stage	Seat Ring	Plug / Stem Assembly	
3	2-11/16	3	810	12.7	1/2	1 & 400	Cavitrol III	23A9453X022	23A9453X012	28B1302X012 28B1303X012	28B1306X012 28B1306X022	
			816	19.1	3/4							100 & 101
4	2-11/16	3	810	19.1	3/4	1, 402, 403	Cavitrol III	23A5817X032	23A5817X022	28B1307X012	28B1310X012	
		4										401, 403
		4										402
VALVE SIZE, INCH	PORT, INCH	TRAVEL, INCH	TRIM	STEM DIAMETER		ACTUATOR GROUP	CHARACTERISTIC	KEY 28	KEY 63	KEY 29	KEY 27	
				mm	Inch			Seal Ring	Anti-Extrusion Ring	Back-Up Ring	Retaining Ring	
3	2-11/16	3	810	12.7	1/2	1 & 400	Cavitrol III	10A4215X102	22B2617X012	10A4217X012 10A4217X022	10A4219X012 10A4219X082	
			816	19.1	3/4							100 & 101
4	2-11/16	3	810	19.1	3/4	1, 402, 403	Cavitrol III	10A4215X102	22B2617X012	10A4217X012	10A4219X012	
		4										401, 403
		4										402

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# ET Valve

Keys 3\*, 9\*, 2\*, 28\*, 63\*, 29\*, and 27\* TSO Trim Parts for Design ET and EAT Valves<sup>(1)</sup>

VALVE SIZE, INCH		PORT, INCH	TRAVEL, INCH	STEM DIAMETER		CHARACTERISTIC	KEY 3	KEY 7	KEY 24	KEY 63	KEY 25	KEY 26
ET	EAT			mm	Inch		Cage	Plug/Stem Assembly	Seal Ring	Anti-Extrusion Ring	Back-Up Ring	Retaining Ring
3	4	3-1/4	1-1/2	12.7	1/2	Linear Equal % Quick Open	2U232433272 2U232133272 2U231833272	27B9567X012	10A5351X112	23B6126X012	10A5349X012	10A5350X012
4	6	4-3/16	2	19.1	3/4	Linear Equal % Quick Open	2U236633272 2U236333272 2U236033272	38B0282X012	10A4223X142	21B9341X012	10A4224X012	10A4225X012

1. Trim is 812.

Key 9\* TSO Trim Parts for Design ET and EAT Valves<sup>(1)</sup>

VALVE SIZE, INCH		PORT, INCH	KEY 9				
ET	EAT		Seat Ring	Seat and Liner			
				Class 150 Raised Face	Class 300 Raised Face	Class 600 Raised Face	Schedule 40 or 80 ButtWeld
3	4	3-1/4	37B9563X012	38B0273X012	38B0273X022	38B0273X032	38B0273X012
4	6	4-3/16	38B0276X012	38B0277X012	38B0276X022	38B0276X032	38B0276X022

1. Trim is 812.

Keys 63\*, 28\*, 29\*, 27\*, 2\*, and 9\* Design ET Full Capacity Trim above 232°C (450°F) using PEEK Anti-Extrusion Rings

VALVE SIZE	PORT	Use w/ Cage/See Footnote	KEY 63	KEY 28	KEY 29	KEY 27	KEY 2	STEM CONN DIAMETER, INCHES	KEY 9
			Anti-Extrusion Ring	Seal Ring	Back-Up Ring	Retaining Ring	Plug <sup>(1)</sup>		Seat Ring <sup>(1)</sup>
1	1-5/16	A	23B6125X012	10A4207X032	10A4209X012	10A4211X012	33B6091X012	3/8	21B3686X012
1-1/2	1-7/8	A	22B4694X012	10A4216X032	10A4218X022	10A4220X012	33B6093X012 33B6094X012	3/8 1/2	21B6970X012
2	2-5/16	A	21B9340X012	10A4206X032	10A4208X012	10A4210X012	33B6097X012 33B6098X012	1/2 3/4	10B8254X012
2-1/2	2-7/8	A	22B2617X012	10A4215X032	10A4217X012	10A4219X012	33B6109X012 33B6110X012	1/2 3/4	21B3687X012
3	3-7/16	A	23B6126X012	10A5351X062	10A5349X012	10A5350X012	33B6105X012 33B6106X012	1/2 3/4	23B6127X012
4	4-3/8	A	21B9341X012	10A4223X032	10A4224X012	10A4225X012	33B6101X012 33B6102X012 33B6111X012	1/2 3/4 1	23B6128X012
6	7	A	22B5998X012	10A2643X032	12B5997X012	14A4652X012	33B6115X012 33B6116X012	3/4 1	29A9703X012
6	5-3/8	C	21B9342X012	10A5411X032	12A3332X012	10A5410X012	33B6134X012 33B6136X012	3/4 1	33B6146X012
8	8	B	22B9203X012	10A3261X032	11B8325X022	11B8322X012	33B6119X012 33B6120X012 33B6121X012	3/4 1 1-1/4	29A9704X012

A—Cages - Quick opening, equal percentage, linear, Whisper I.  
B—Cages - Equal percentage, linear - plug & seat ring material CA15 (cast 410).  
C—Cages - Whisper III - plug material 17-4PH H900 - seat ring material forged F6A (SST).  
1. Seat rings with wide bevel seat and plugs with radius seat.

Keys 63\*, 28\*, 29\*, 27\*, 2\*, and 9\* Design ET Restricted Trim above 232°C (450°F) using PEEK Anti-Extrusion Rings

VALVE SIZE	PORT	KEY 63	KEY 28	KEY 29	KEY 27	KEY 2	STEM CONN DIAMETER, INCHES	KEY 9
		Anti-Extrusion Ring	Seal Ring	Back-Up Ring	Retaining Ring	Plug <sup>(1)</sup>		Seat Ring <sup>(1)</sup>
1-1/2 x 1	1-5/16	23B6125X012	10A4207X032	10A4209X012	10A4211X012	33B6091X012	3/8	22B3550X012
2-1/2 x 1-1/2	1-7/8	22B4694X012	10A4216X032	10A4218X022	10A4220X012	33B6094X012	1/2	21B6970X012
3 x 2	2-5/16	21B9340X012	10A4206X032	10A4208X012	10A4210X012	33B6097X012 33B6098X012	1/2 3/4	10B8254X012
4 x 2-1/2	2-7/8	22B2617X012	10A4215X032	10A4217X012	10A4219X012	33B6109X012 33B6110X012	1/2 3/4	21B3687X012

Cages - Quick opening, equal percentage, linear, Whisper I.  
1. Seat rings with wide bevel seat and plugs with radius seat.





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# 3582 Series Valve Positioners, Type 3582i Valve Positioner, and 3583 Series Valve Stem Position Transmitters

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W5498-1

CONTROL VALVE WITH TYPE 3582 POSITIONER



W8424

CONTROL VALVE WITH TYPE 3582i POSITIONER



W5499-1

CONTROL VALVE WITH TYPE 3583 TRANSMITTER

Figure 1. Typical Mounting for the 3582 Series, Type 3582i, and 3583 Series Positioners and Transmitters



# 3582 and 3583 Series

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## Introduction

### Scope of Manual

This instruction manual includes installation, operation, calibration, maintenance, and parts ordering information for the 3582 Series pneumatic valve positioners, the Type 3582i electro-pneumatic valve positioner, and the 3583 Series pneumatic valve stem position transmitters. Refer to separate instruction manuals for information on the control valve, actuator, and accessories.

Only personnel qualified through training or experience should install, operate, or maintain the valve positioner or valve stem position transmitter. If there are any questions concerning the instructions in this manual, contact your Fisher sales office or representative before proceeding.

### Description

The 3582 Series pneumatic valve positioners and the Type 3582i electro-pneumatic valve positioner shown in figure 1 are used with diaphragm-actuated, sliding-stem control valve assemblies. The pneumatic valve positioners receive a pneumatic input signal from a control device and modulate the supply pressure to the control valve actuator. The positioner adjusts the actuator supply pressure to maintain a valve stem position proportional to the pneumatic input signal.

Type 3582NS positioners meet typical requirements of the nuclear power industry. The Type 3582NS

construction includes materials that provide superior performance at elevated temperature and radiation levels. The O-rings are EPDM (ethylene propylene) and the diaphragms are EPDM/Nomex. EPDM<sup>(1)</sup> demonstrates superior temperature capability and shelf life over nitrile. The Nomex diaphragm fabric demonstrates improved strength retention at elevated temperature and radiation conditions.

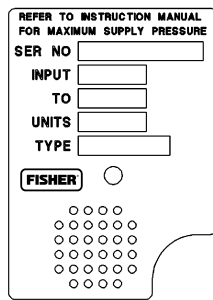
In addition, the Type 3582NS positioner is qualified "commercial grade dedicated" under Fisher's 10CFR50, Appendix B, quality assurance program. These can be supplied as 10CFR21 items.

The Type 3582i is an electro-pneumatic valve positioner, consisting of a Type 582i electro-pneumatic converter installed on a Type 3582 pneumatic valve positioner. The Type 3582i valve positioner provides an accurate valve stem position that is proportional to a dc current input signal.

The Type 582i electro-pneumatic converter is a modular unit that can be installed at the factory or in the field. However, do not plan to install a Type 582i converter on an existing positioner until you contact your Fisher sales office or representative for application assistance.

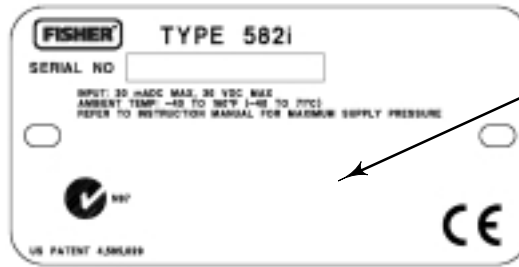
The Type 582i converter receives the dc current input signal and, through a nozzle/flapper arrangement, provides a proportional pneumatic output signal. This pneumatic output signal provides the input signal to the pneumatic valve positioner, eliminating the need for a remote-mounted transducer.

1. Use a clean, dry, oil-free air supply with instruments containing EPDM components. EPDM is subject to degradation when exposed to petroleum-based lubricants.



1388758-D SHT 1 / DOC

POSITIONER OR TRANSMITTER NAMEPLATE



1185625-F SHT B / DOC

TYPE 582i CONVERTER NAMEPLATE

INFORMATION IN THIS PORTION OF THE NAMEPLATE IDENTIFIES THE HAZARDOUS AREA CLASSIFICATION AND APPROVALS FOR THE PRODUCT SPECIFIED ON THE EQUIPMENT ORDER

Figure 2. Typical Nameplates

The 3583 Series pneumatic valve stem position transmitters are for use with sliding-stem diaphragm actuators. These units provide an output signal that is directly proportional to the valve stem position.

Refer to the type number description for a detailed explanation of type numbers.

### Type Number Descriptions

The following descriptions provide specific information on the different valve positioner or valve stem position transmitter constructions. If the type number is not known, refer to the nameplate on the positioner. For the location of the nameplate, refer to key 25 in figure 21.

**Type 3582**—Pneumatic valve positioner with bypass and instrument, supply, and output pressure gauges.

**Type 3582A**—Pneumatic valve positioner without bypass and without pressure gauges.

**Type 3582C**—Pneumatic valve positioner without bypass and with automotive tire valves instead of pressure gauges.

**Type 3582D**—Pneumatic valve positioner with bypass and with automotive tire valves instead of pressure gauges.

**Type 3582G**—Pneumatic valve positioner without bypass and with instrument, supply, and output pressure gauges.

**Type 3582NS**—Pneumatic valve positioner for nuclear service applications with or without bypass and with automotive tire valves instead of pressure gauges.

**Type 3582i**—Electro-pneumatic valve positioner without bypass; with Type 582i converter; and with:

supply and output pressure gauges, automotive tire valves, or pipe plugs.

**Type 582i**—Electro-pneumatic converter with: supply and output pressure gauges, automotive tire valves, or pipe plugs. Used for conversion of a 4 to 20 milliamper input signal to a 0.2 to 1.0 bar (3 to 15 psig) input signal for the pneumatic valve positioner.

**Type 3583**—Pneumatic valve stem position transmitter with supply and output pressure gauges.

**Type 3583C**—Similar to the Type 3583 valve stem position transmitter except with automotive tire valves in place of pressure gauges.

### Specifications

Specifications for the valve positioners are shown in table 1. Specifications for the valve stem position transmitters are shown in table 3.

Refer to the unit nameplate to determine the type of positioner or transmitter, supply pressure, etc. A typical nameplate is shown in figure 2.

# 3582 and 3583 Series

Table 1. Specifications for 3582 Series and Type 3582i Valve Positioners

<p><b>Input Signal<sup>(1)</sup>,</b>  <b>3582 Series:</b>          ■ 0.2 to 1.0 bar (3 to 15 psig), ■ 0.4 to 2.0 bar (6 to 30 psig), or ■ split range, see table 6  <b>Type 3582i:</b>          4 to 20 mA dc constant current with 30 V dc maximum compliance voltage, can be split range, see table 6</p> <p><b>Equivalent Circuit for Type 3582i</b>          The Type 582i converter equivalent circuit is 120 ohms, shunted by three 5.6-volt zener diodes (see figure 11)</p> <p><b>Output Signal<sup>(1)</sup></b>  <b>Type:</b> Pneumatic pressure as required by actuator up to 95 percent of maximum supply  <b>Action<sup>(1)</sup>:</b> Field-reversible between ■ direct and ■ reverse within the pneumatic valve positioner</p> <p><b>Supply Pressure<sup>(1)</sup></b>  <b>Recommended:</b> 0.3 bar (5 psi) above actuator requirement  <b>Maximum:</b> 3.4 bar (50 psig) or pressure rating of actuator, whichever is lower</p> <p><b>Input Bellows Pressure Rating<sup>(2)</sup></b>          See table 5 for minimum and maximum pressure ratings (allowable input signal) for each available range spring</p> <p><b>Maximum Steady-State Air Consumption<sup>(1)(3)</sup></b>  <b>For 3582 Series</b>          1.4 bar (20 psig) Supply: 0.38 normal m<sup>3</sup>/hr (14.0 scfh)          2.0 bar (30 psig) Supply: 0.48 normal m<sup>3</sup>/hr (18.0 scfh)          2.4 bar (35 psig) Supply: 0.54 normal m<sup>3</sup>/hr (20.0 scfh)  <b>For Type 3582i Only</b>          1.4 bar (20 psig) Supply: 0.46 normal m<sup>3</sup>/hr (17.2 scfh)          2.0 bar (30 psig) Supply: 0.58 normal m<sup>3</sup>/hr (21.4 scfh)          2.4 bar (35 psig) Supply: 0.64 normal m<sup>3</sup>/hr (23.8 scfh)</p> <p><b>Maximum Supply Air Demand<sup>(1)</sup></b>  <b>For 3582 Series and Type 3582i</b>          1.4 bar (20 psig) Supply: 4.7 normal m<sup>3</sup>/hr (164.5</p>	<p>scfh)          2.0 bar (30 psig) Supply: 7.0 normal m<sup>3</sup>/hr (248.5 scfh)          2.4 bar (35 psig) Supply: 8.1 normal m<sup>3</sup>/hr (285.5 scfh)</p> <p><b>Performance</b>  <b>For 3582 Series</b>  <i>Independent Linearity<sup>(1)</sup>:</i> ±1 percent of output signal span  <i>Hysteresis<sup>(1)</sup>:</i> 0.5 percent of span  <b>For Type 3582i Only</b>  <i>Independent Linearity<sup>(1)</sup>:</i> ±2 percent of output signal span  <i>Hysteresis<sup>(1)</sup>:</i> 0.6 percent of span</p> <p><i>EMC Effects:</i> These instruments have the CE mark in accordance with the European Electromagnetic Compatibility (EMC) Directive. They meet the emissions requirements of IEC 61326-1 (Edition 1.1) for Class A equipment for use in industrial locations and Class B equipment for use in domestic locations. They also meet the immunity requirements listed in table 2. This table is in accordance with Annex A of IEC 61326-1 for equipment intended for use in industrial locations.</p> <p><b>For 3582 Series and Type 3582i</b>  <i>Open Loop Gain (Output Signal)<sup>(1)</sup>:</i>          ■ 100 in the range of 0.2 to 1.0 bar (3 to 15 psig)          ■ 55 in the range of 0.4 to 2.0 bar (6 to 30 psig)</p> <p><b>Operating Influences<sup>(1)</sup></b>  <b>Supply Pressure, For 3582 Series Units:</b> Valve travel changes less than 1.67 percent per bar (0.25 percent per 2 psi) change in supply pressure  <b>Supply Pressure, For Type 3582i Units:</b> Valve travel changes less than 3.62 percent per bar (1.5 percent per 2 psi) change in supply pressure</p> <p><b>Operative Temperature Limits<sup>(1)(2)</sup></b>  <b>Standard Construction, For 3582 Series and Type 3582i Units:</b> -40 to +71°C (-40 to +160°F)  <b>Type 3582NS Units:</b> -40 to +82°C (-40 to +180°F) with EPDM elastomers  <b>High-Temperature Construction, For Types 3582A and C only:</b> -18 to +104°C (0 to +220°F) without gauges</p>
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- Continued -

*Table 1. Specifications for 3582 Series and Type 3582i Valve Positioners (Continued)*

<p><b>Electrical Classification for Type 3582i</b></p> <p>Please refer to the Hazardous Area Classifications Bulletins for specific approvals. Also, refer to the nameplates shown in figure 2 for the location of positioner or transmitter classification information and approval descriptions.</p> <p><b>Housing Classification for Type 3582i</b></p> <p>NEMA 3, IEC 529 IP54: Mount instrument with vent on the side or bottom if weatherproofing is a concern.</p> <p><b>Pressure Gauges</b></p> <p>40 mm (1-1/2 inch) diameter with plastic case and brass connection ■ triple scale (PSI, MPa, and bar) or ■ dual scale (PSI and kg/cm<sup>2</sup>)</p>	<p><b>Pressure Connections</b></p> <p>1/4-inch NPT female</p> <p><b>Electrical Connection for Type 3582i</b></p> <p>1/2-14 NPT conduit connection</p> <p><b>Maximum Valve Stem Travel</b></p> <p>105 mm (4-1/8 inches); adjustable to obtain lesser travels with standard input signals</p> <p><b>Characterized Cams</b></p> <p>See characterized cams section</p> <p><b>Approximate Weight</b></p> <p><b>3582 Series Units:</b> 2.5 kg (5-1/2 pounds) <b>Type 3582i:</b> 3.6 kg (8 pounds)</p>
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1. This term is defined in ISA Standard S51.1-1979.  
 2. Do not exceed any of the pressure or temperature limits in this instruction manual. Also, any applicable standard or code should not be exceeded.  
 3. Normal m<sup>3</sup>/hr—normal cubic meters per hour (0°C and 1.01325 bar, absolute); Scfh—Standard cubic feet per hour (60°F and 14.7 psia).

*Table 2. EMC Immunity Performance Criteria*

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria
Enclosure	Electrostatic Discharge (ESD)	IEC 61000-4-2	4 KV contact 8 KV air	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz, 10 V/m 1 KHz AM at 80%	A
	Rated power frequency magnetic field	IEC 61000-4-8	60 A/m at 50 Hz	A
I/O signal/control	Burst (fast transients)	IEC 61000-4-4	1 KV	A
	Surge	IEC 61000-4-5	1 KV (line to ground only)	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 volts	A

Specification limit = ±1% of span

**Note**

**Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.**

# 3582 and 3583 Series

Table 3. Specifications for 3583 Series Valve Stem Position Transmitters

<p><b>Input Signal<sup>(1)</sup></b> 105 mm (4-1/8 inches) of valve stem travel; adjustable to obtain full output signal with lesser stem travels</p> <p><b>Output Signal<sup>(1)</sup></b> <b>Type:</b> ■ 0.2 to 1.0 bar (3 to 15 psig) or ■ 0.4 to 2.0 bar (6 to 30 psig) pneumatic pressure <b>Action:</b> Field-reversible between direct and reverse</p> <p><b>Output Bellows Pressure Rating<sup>(2)</sup></b> See table 5 for minimum and maximum pressure ratings (allowable input signal) for each available range spring</p> <p><b>Supply Pressure<sup>(1)</sup></b> <b>Recommended:</b> 0.3 bar (5 psi) above upper limit of output signal range <b>Maximum:</b> 2.4 bar (35 psig) or pressure rating of connected equipment, whichever is lower</p> <p><b>Maximum Steady-State Air Consumption<sup>(1)(3)</sup></b> 1.4 bar (20 psig) Supply: 0.38 normal m<sup>3</sup>/hr (14.0 scfh) 2.0 bar (30 psig) Supply: 0.48 normal m<sup>3</sup>/hr (18.0 scfh) 2.4 bar (35 psig) Supply: 0.54 normal m<sup>3</sup>/hr (20.0 scfh)</p>	<p><b>Reference Accuracy<sup>(1)</sup></b> ±1 percent of output signal span</p> <p><b>Operating Influence<sup>(1)</sup></b> Output signal changes 1.67 percent per bar (0.23 percent per 2 psig) change in supply pressure</p> <p><b>Operative Ambient Temperature Limits<sup>(1)(2)</sup></b> <b>Standard Construction, 3583 Series:</b> -40 to +71°C (-40 to +160°F) <b>High-Temperature Construction, Type 3583C only:</b> -18 to +104°C (0 to +220°F)</p> <p><b>Pressure Connections</b> Supply and output pressure connections are 1/4-inch NPT female</p> <p><b>Maximum Valve Stem Travel</b> 105 mm (4-1/8 inches); adjustable to obtain full output signal with lesser stem travels</p> <p><b>Cam</b> Linear</p> <p><b>Approximate Weight</b> 2.5 kg (5-1/2 pounds)</p>
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1. This term is defined in ISA Standard S51.1-1979.

2. Do not exceed any of the pressure or temperature limits in this instruction manual. Also, any applicable standard or code should not be exceeded.

3. Normal m<sup>3</sup>/hr—normal cubic meters per hour (0°C and 1.01325 bar, absolute); Scfh—Standard cubic feet per hour (60°F and 14.7 psia).

## Installation

### Note

**All valve positioners and valve stem position transmitters are shipped with foam rubber packing material inside the case. Remove the cover (key 33, figure 21) and the packing material before attempting to operate the unit. Make sure all vent openings are clear before installation of the unit and that they remain clear during use.**

Typically, the positioner or transmitter is ordered with the actuator. If so, the factory mounts the valve positioner or valve stem position transmitter and connects the valve positioner output to the actuator. If a Type 67CFR filter-regulator is specified, it may be integrally mounted to the valve positioner or valve

stem position transmitter, except for the Type 3582NS positioner. For the Type 3582NS, the Type 67CFR is separately mounted, not integrally mounted to the positioner.

### Note

**In some cases, alignment and calibration of the valve positioner or valve stem position transmitter at the factory may not be possible, and field alignment and calibration is required. Before putting the valve positioner or valve stem position transmitter into service, check the operation of the unit to be sure it is calibrated. If the valve positioner or valve stem position transmitter requires alignment or calibration, refer to the appropriate calibration instructions in this manual.**

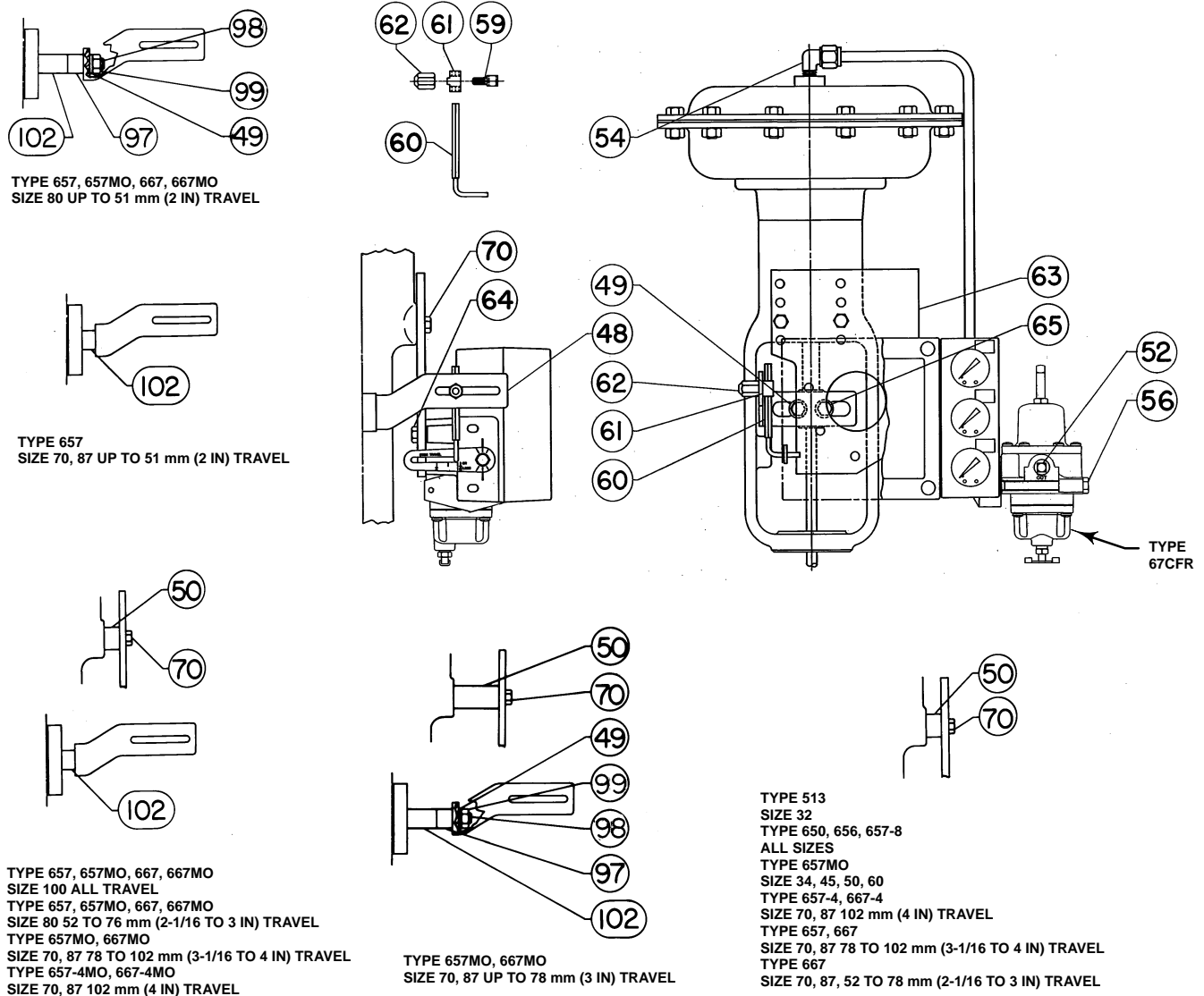


Figure 3. Mounting Assembly

If the valve positioner or valve stem position transmitter is ordered separately, disconnected, or removed from the actuator, refer to the appropriate sections of this manual for installation information.

**Mounting**

Key numbers used in this procedure are shown in figure 3 except where indicated.

1. Figure 3 shows the various mounting parts required for mounting on Fisher actuators. Mounting parts for Fisher actuators that require spacers have

the spacers (key 50) included. Type 657 and 667 actuators, sizes 70 through 100, with or without a side-mounted handwheel, use spacers (keys 97 and 102) between the stem connector and the connector arm (key 48). On all other actuators that use spacers, place the spacers (key 50) between the mounting plate (key 63) and the actuator mounting boss.

When mounting the valve positioner or valve stem position transmitter on an actuator by another manufacturer, provide spacers, if necessary, by cutting sections from 1/2- or 3/8-inch pipe so that the "X" dimension matches the value given in figure 6.

# 3582 and 3583 Series

Table 4. 3582 and 3583 Series Mounting Information

ACTUATOR TYPE	ACTUATOR SIZE	MAXIMUM TRAVEL		MOUNTING HOLES SET NO.(1)	TRAVEL PIN POSITION(2)	ACTUATOR TYPE	ACTUATOR SIZE	MAXIMUM TRAVEL		MOUNTING HOLES SET NO.(1)		TRAVEL PIN POSITION(2)	
		mm	Inch					mm	Inch	657	667		
513 & 513R	20	19	3/4	2	Normal	657 & 667 Without Side-Mounted Handwheel	30	19	3/4	3	4	Normal	
	32	19	3/4	2	Normal		34	19	1-1/8	3	2	Normal	
656	30	51	2	4	Inverted		40	38	1-1/2	2	3	Normal	
	40	89	3-1/2	4	Inverted		45	19	3/4	1	4	Inverted(3)	
	60	102	4	4	Inverted		45	51	2	1	1	Normal	
							50	51	2	1	2	Normal	
657-4 Without Side-Mounted Handwheel	70	102	4	3	Inverted		60	51	2	1	2	Normal	
							70	51	2	2	1	Normal	
657-4 With Side-Mounted Handwheel	70	102	4	2	Inverted		52-76	2-1/16-3	3	2	Normal		
	87	102	4	1	Inverted		78-102	3-1/16-4	3	1	Inverted(4)		
657-8	30	54	2-1/8	3	Normal		657 & 667 With Side-Mounted Handwheel	34	19	3/4	2	2	Normal
	34	54	2-1/8	3	Normal			40	38	1-1/2	1	2	Normal
	40	79	3-1/8	3	Normal	45		51	2	1	4	Normal	
	40	89	3-1/2	3	Normal	50		51	2	4	1	Inverted(4)	
	46	79	3-1/8	2	Normal	60		51	2	3	1	Inverted(4)	
	46	105	4-1/8	2	Normal	70		105	4-1/8	2	2	Inverted	
	47	79	3-1/8	2	Inverted	80		76	3	2	2	Normal	
47	105	4-1/8	1	Inverted	87	76		3	2	2	Normal		
657-8	60	105	4-1/8	4	Inverted	78-102		3-1/16-4	2	1	Inverted		
	70	105	4-1/8	2	Inverted								
667-4 Without Side-Mounted Handwheel	70	102	4	1	Normal	34		19	3/4	2	2	Normal	
	87	102	4	1	Normal	40	38	1-1/2	1	2	Normal		
						45	51	2	1	4	Normal		
						50	51	2	4	1	Inverted(4)		
						60	51	2	3	1	Inverted(4)		
						70	102	4	2	2	Inverted		
						80	76	3	2	2	Normal		
						87	76	3	2	2	Normal		
						78-102	3-1/16-4	2	1	Inverted			

1. The indicated set number should be considered a reference point only, due to the variables related to making up the stem connection.  
 2. Normal position is shown in figure 4.  
 3. Travel pin position for Type 657 is normal.  
 4. Travel pin position for Type 667 is normal.

2. As shown in figures 3 and 4, attach the connector arm (key 48) to the stem connector so that the connector arm extends through the yoke legs on the side of the lower mounting boss.

3. Attach the valve positioner or valve stem position transmitter to the mounting plate (key 63) using the holes shown in figure 5.

4. Mount the Type 67CFR regulator:

- **3582 Series valve positioners (except Type 3582NS) and 3583 Series valve stem position transmitters**, mount the regulator on the integral boss on the bypass block.

- **Type 3582NS valve positioners**, use the mounting plate with provision for separately mounting the Type 67CFR regulator. Separately mount the positioner and the regulator on the mounting plate.

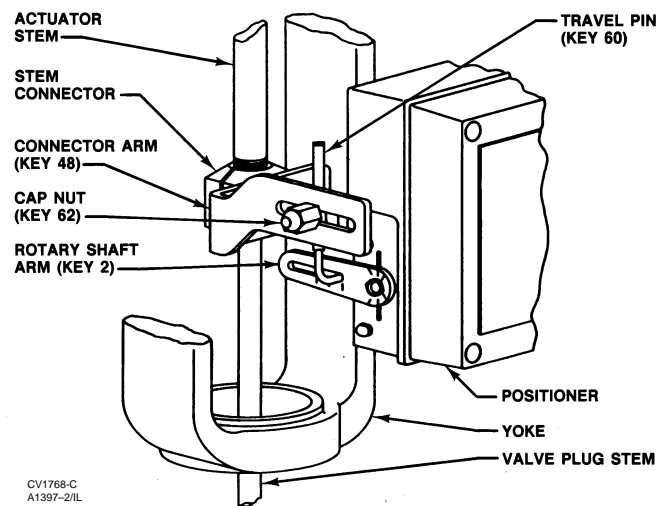
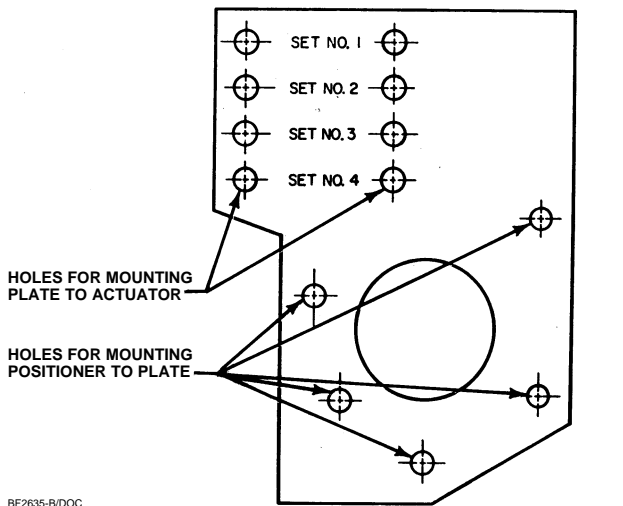
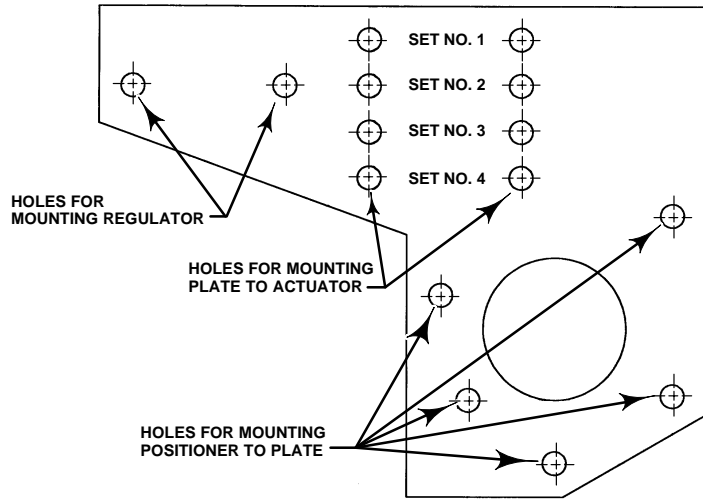


Figure 4. Isometric View Showing Motion Feedback Arrangement and Typical Stem Connection





MOUNTING PLATE FOR MOUNTING POSITIONER WITH INTEGRALLY MOUNTED FILTER REGULATOR



MOUNTING PLATE FOR MOUNTING POSITIONER WITH SEPARATELY MOUNTED FILTER REGULATOR

Figure 5. Mounting Plates Used with 3582 Series Valve Positioners and 3583 Series Valve Stem Position Transmitters

- **Type 3582i valve positioners**, mount the regulator on the integral boss that is part of the Type 582i converter housing.

5. As shown in figure 5, the mounting bracket has four sets of holes for mounting the assembly to the actuator. Refer to table 4 to determine which set of mounting holes to use, then attach the assembly to the lower mounting pad on the actuator.

### CAUTION

**To avoid equipment damage, be certain the connector arm clears the valve positioner or valve stem position transmitter case as the actuator moves through its complete stroke.**

6. Position the actuator to its mid-travel position using a handwheel or manual loading regulator.
7. Slip the round end of the travel pin (key 60) into the rotary shaft arm (key 2) slot as shown in figure 4.
8. Slide the square end of the travel pin into the pin holder and pin lock (keys 61 and 59). Place the pin lock and holder into the slot in the connector arm (key 48). Screw the cap nut (key 62) onto the pin lock (key 59), but do not tighten.
9. With the actuator at its mid-travel position, lift the rotary shaft arm so that the 0-degree index marks on

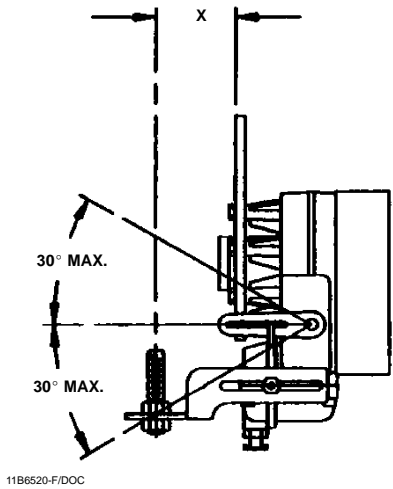
the rotary shaft arm are aligned with the case index marks as shown in figure 7.

### CAUTION

**Never set the travel pin at a setting that is less than the actual actuator stroke. Setting the travel pin at a setting that is less than the actual actuator stroke will cause the cam to rotate more than 60 degrees, causing damage to the cam or other parts.**

10. Position the travel pin so that it is perpendicular to the connector arm and aligns with the correct actuator stem travel index on the rotary shaft arm. Tighten the cap nut (key 62 in figure 4).
11. Check the travel pin setting using the following procedures:

- **For standard travel pin setting** (that is, with the travel pin setting equal to total actuator travel). Stroke the actuator to each end of its travel. At each end of travel, the 30-degree index marks on the rotary shaft arm should align with the case index marks. If the index marks are not in line, loosen the cap nut (key 62) and slide the travel pin (key 60) in the rotary shaft arm slot until the 30-degree index marks align with the case index marks. Be sure the



STEM TRAVEL	X		
	9.5 mm (3/8-Inch) Stem	12.7 mm (1/2-Inch) Stem	19.1 mm (3/4-Inch) Stem
Millimeters			
29 or less	81	87	100
38	90	97	109
51	102	108	121
64	113	119	132
76	124	130	143
89	135	141	154
102	146	152	165
Inches			
1-1/8 or less	3.19	3.44	3.94
1-1/2	3.56	3.81	4.31
2	4.00	4.25	4.75
2-1/2	4.44	4.69	5.19
3	4.88	5.12	5.62
3-1/2	5.31	5.56	6.06
4	5.75	6.00	6.50

Figure 6. Spacing for Mounting on Other Than Fisher Actuators

travel pin remains perpendicular to the connector arm. After making this adjustment, tighten the cap nut and re-check the arm at the mid-travel position. If the 0-degree index marks do not align, repeat this procedure.

- **For special travel pin setting** (that is, with the travel pin setting greater than total actuator travel). Check the index marks using a procedure similar to the standard settings procedure. The arm will not rotate a full 60 degrees as the actuator is stroked, and the 30-degree index marks on the cam will be short of aligning with the case index marks. If necessary, adjust the travel pin position so that the 30-degree marks are the same distance from the respective case index mark at each end of actuator travel.

### Changing Cam Position

Refer to figure 21 for a typical cam illustration and key number locations.

#### Note

- **For Valve Positioners: The small arrow on the cam must point in the direction of stem movement with increasing actuator diaphragm pressure.**

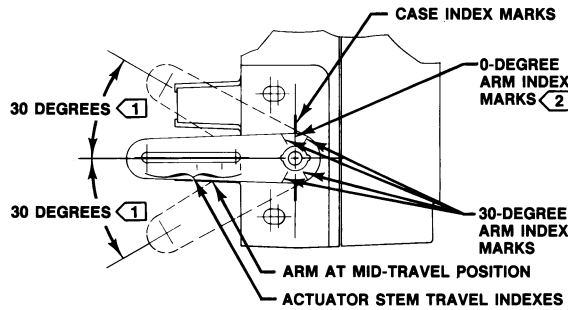
- **For Valve Stem Position Transmitters: If the arrow on the cam points up toward the nozzle, output pressure increases with downward stem movement. If the arrow points down, output pressure decreases with downward stem movement.**

**If the arrow is pointing in the wrong direction, use the following procedure to remove, reverse, and re-install the cam.**

When mounting a valve positioner or valve stem position transmitter, check to see if the correct cam (key 4) and cam position has been selected. To change the cam or cam position, unhook the extension spring (key 38), and remove the cam bolt and locking nut (keys 6 and 45). Remove the cam and spring retainer bracket (key 43).

To install the cam, screw the locking nut all the way onto the cam bolt. Attach the cam and spring retainer bracket to the shaft assembly with the cam bolt. Tighten the bolt to secure the cam. Then, tighten the locking nut against the spring retainer bracket. Hook the spring into the spring retainer bracket.

Details on cam characteristics can be found in the cam information portion of the operating information section.



- NOTES:
- ① MAXIMUM ROTATION FROM MID-TRAVEL POSITION.
  - ② ALIGN INDEX MARKS AS SHOWN FOR MID-TRAVEL POSITION.

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A2452-2/IL

Figure 7. Rotary Shaft Arm and Case Index Marks

the level of filtration equipment required to prevent performance degradation of pneumatic equipment. A filter or filter regulator capable of removing particles 40 microns in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.

Supply pressure must be clean, dry, oil-free<sup>(2)</sup> air or noncorrosive gas. Use a Fisher Type 67CFR Filter Regulator, or equivalent, to filter and regulate supply air. Except for the Type 3582NS, the filter regulator can be mounted on the positioner. For the Type 3582NS the regulator can be mounted on the mounting plate with the positioner but not on the positioner. The supply pressure should be high enough to permit setting the regulator 0.3 bar (5 psi) above the upper limit of the appropriate pressure range, for example: 1.4 bar (20 psig) for a 0.2 to 1.0 bar (3 to 15 psig) range. However, do not exceed the maximum allowable supply pressure of 3.4 bar (50 psig) nor the pressure rating of any connected equipment.

Connect the nearest suitable supply source to the 1/4-inch NPT IN connection on the filter regulator (if furnished) or to the 1/4-inch NPT SUPPLY connection on the positioner block assembly.

### Output Connection

A factory mounted valve positioner has the valve positioner output piped to the supply connection on the actuator. If mounting the valve positioner in the field, connect 3/8-inch tubing between the 1/4-inch NPT valve positioner connection marked OUTPUT and the actuator supply pressure connection. Connect the valve stem position transmitter connection marked OUTPUT to an instrument that indicates valve stem position.

### Instrument Connection

For a 3582 Series pneumatic valve positioner connect 3/8-inch tubing from the control device to the 1/4-inch NPT INSTRUMENT connection. If the control device is mounted on the control valve assembly by the factory, this connection is made.

The Type 3582i electro-pneumatic valve positioner requires a 4 to 20 milliampere dc current input signal from the control device. A 1/2-inch NPT conduit connection is provided for properly wiring electrical installations. For more information, see the electrical connections section.

## Pressure Connections



Valve positioners and valve stem position transmitters are capable of providing full supply pressure to connected equipment. To avoid personal injury and equipment damage, make sure the supply pressure never exceeds the maximum safe working pressure of any connected equipment.

Pressure connections are shown in figure 8. All pressure connections are 1/4-inch NPT female. Use 3/8-inch tubing for all pressure connections. After making pressure connections, turn on the supply pressure and check all connections for leaks.

### Supply Connection



Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free air, or non-corrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend

2. Use a clean, dry, oil-free air supply with instruments containing EPDM components. EPDM is subject to degradation when exposed to petroleum-based lubricants.

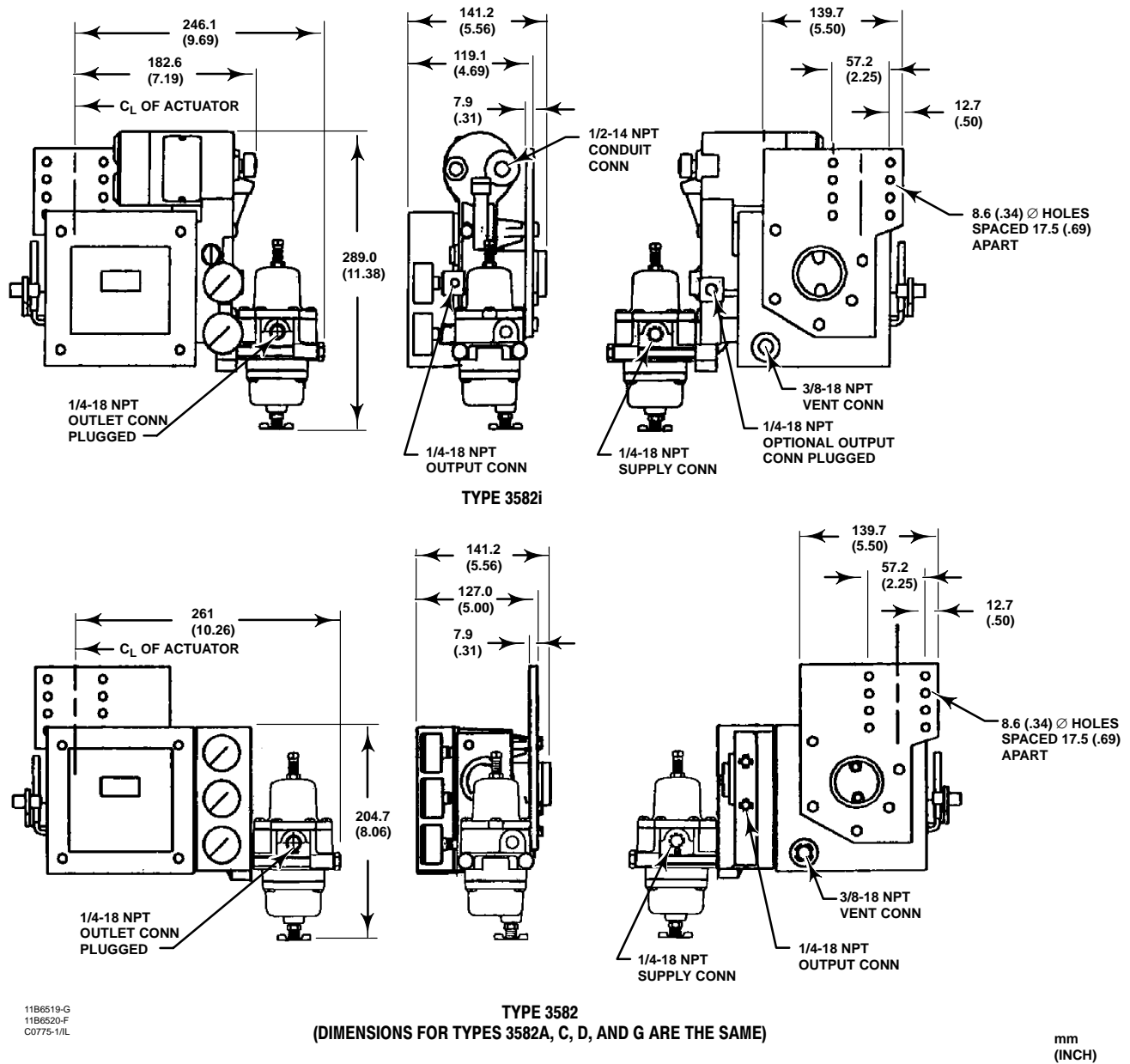


Figure 8. Typical Dimensions and Connections

### Diagnostic Connections

To support diagnostic testing of valve/actuator/positioner/accessory packages, special connectors and hardware are available. The hardware used includes 1/8-inch NPT connector bodies and body protectors. If the diagnostic

connectors are ordered for a positioner with gauges, 1/8-inch stems are also included.

Install the connectors on the 3582 block assembly or Type 582i housing as shown in figure 9. Before installing the connectors on the positioner, apply sealant to the threads. Sealant is provided with the diagnostic connections and hardware.

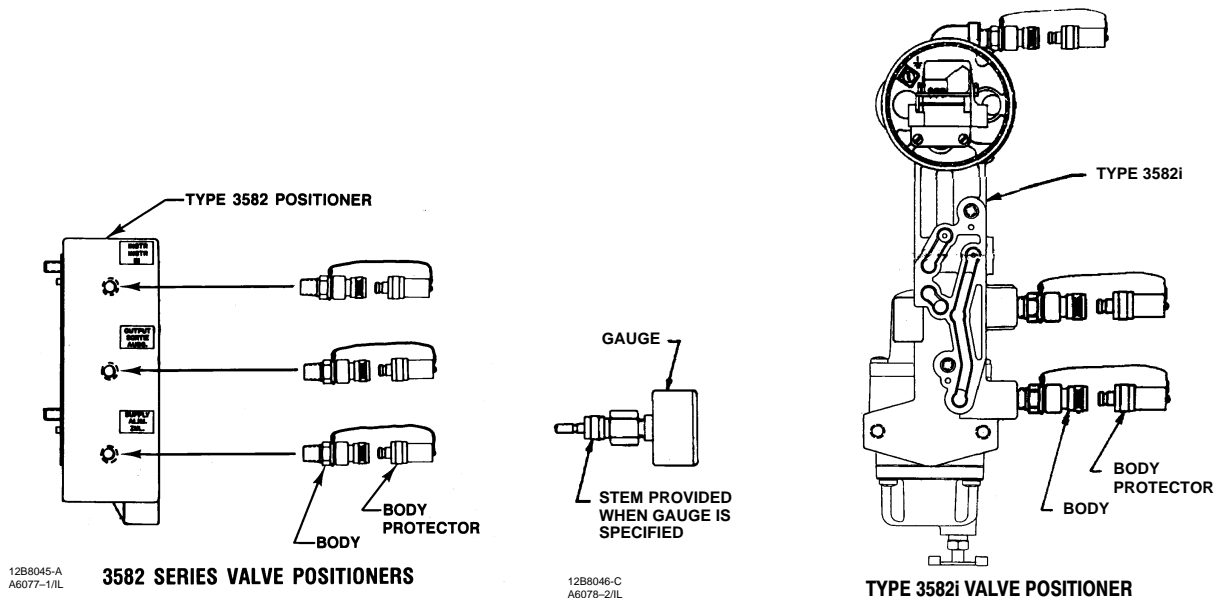


Figure 9. Diagnostic Connections

Vent

**WARNING**

If a flammable or hazardous gas is to be used as the supply pressure medium, personal injury or property damage could result from fire or explosion of accumulated gas or from contact with a hazardous gas. The positioner/actuator assembly does not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used. For leakage rates, see the Maximum Steady-State Air Consumption specification. A remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

**CAUTION**

When installing a remote vent pipe, take care not to overtighten the pipe in

the vent connection. Excessive torque will damage the threads in the connection.

The vent opening at the back of the case marked VENT should be left open to prevent pressure buildup inside the case and to provide a drain hole for any moisture that might collect inside the case. The perforated section of the nameplate normally covers this opening to prevent blockage from debris or insects.

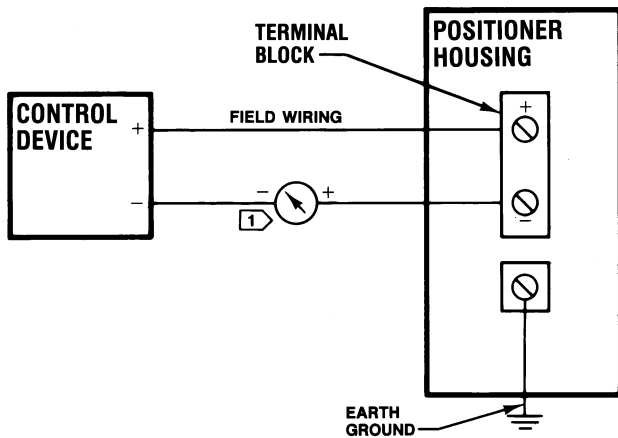
If a remote vent is required, the vent line must be as short as possible with a minimum number of bends and elbows. The vent connection is 3/8-inch NPT female. Use 3/8-inch or larger tubing to provide a remote vent. The 582i has a 1/4-inch NPT female vent connection.

Also, be certain that the exhaust holes in the relay (key 32 in figure 21) are kept open.

**Electrical Connections for Type 3582i Valve Positioner**

**WARNING**

For explosion-proof applications, disconnect power before removing the converter housing cap.



**NOTE:**  
1 FOR TROUBLESHOOTING OR MONITORING OPERATION, AN INDICATING DEVICE CAN BE A VOLTMETER ACROSS A 250 OHM RESISTOR OR A CURRENT METER.

A3875/IL

Figure 10. Typical Field Wiring Diagram

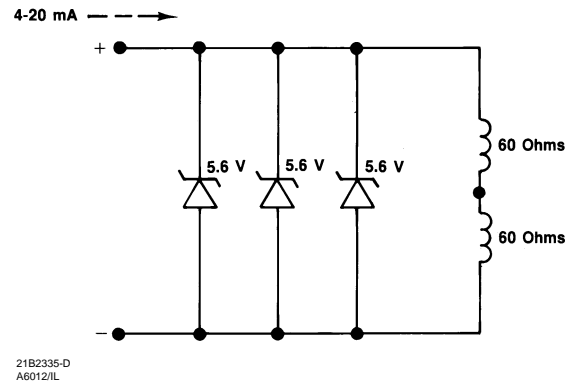
**For explosion-proof applications, install rigid metal conduit and a conduit seal no more than 18 inches (457 mm) from the converter. Personal injury or property damage might result from explosion if the seal is not installed.**

**For intrinsically safe installations, refer to the loop schematics at the end of this manual, factory drawings, or to instructions provided by the barrier manufacturer for proper wiring and installation.**

Use the 1/2-inch NPT conduit connection on the Type 582i converter housing for installation of field wiring. For Class I, Division I explosion-proof applications, install rigid metal conduit and a seal no more than 457 mm (18 inches) from the converter. Also, install conduit according to local and national electrical codes which apply to the application.

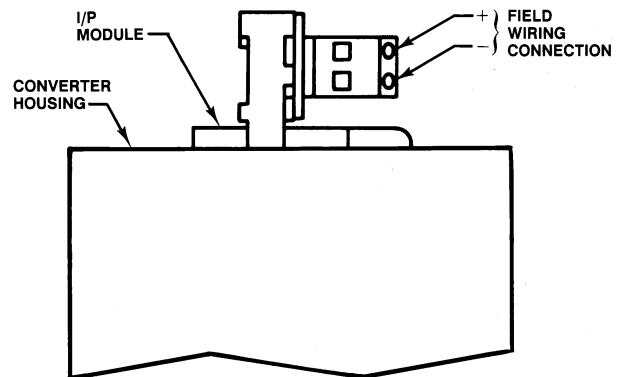
Refer to figures 10, 11 and 12 when connecting field wiring from the control device to the converter. Connect the positive wire from the control device to the converter positive (+) terminal, and the negative wire from the control device to the converter negative (-) terminal. Do not overtighten the terminal screws. Maximum torque is 0.45 N•m (4 lbf•in.). Connect the converter grounding terminal to an earth ground.

3. Please contact your Fisher sales office or representative before planning to upgrade any existing 3582 Series valve positioner by field installation of a Type 582i electro-pneumatic converter. Also, refer to this section of the instruction manual which describes field installation of a Type 582i converter.



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A6012/IL

Figure 11. Type 582i Input Equivalent Circuit



A7140/IL

Figure 12. Type 582i Converter Wiring Connections

## Installation Of Type 582i Converter<sup>(3)</sup>

### WARNING

**Avoid personal injury from sudden release of process pressure. Before mounting the Type 582i converter:**

- **Disconnect any operating lines providing air pressure or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**

- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**

- **Vent actuator loading pressure and relieve any actuator spring precompression.**

- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

**Note**

**Before planning to retrofit an installed 3582 Series positioner, refer to the positioner mounting plate illustrations shown in figure 5. Mounting plates with a three-hole mounting pattern (positioner to mounting plate) cannot support a Type 582i converter. Do not attempt to mount a Type 582i converter on an existing 3582 Series positioner which has a three-hole mounting pattern.**

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If a 3582 Series pneumatic valve positioner has previously been installed using a mounting plate with a five-hole mounting pattern (positioner to mounting plate), either at the factory or in the field, it can be upgraded to a Type 3582i electro-pneumatic valve positioner by installation of a Type 582i converter. To install a Type 582i converter, refer to the following instructions.

**Note**

**Inspect the existing valve positioner to determine the input signal range. If the input signal range is not 0.2 to 1.0 bar (3 to 15 psig), refer to the appropriate sections of this manual describing input signal ranges and how to change the range spring.**

1. Inspect the positioner mounting plate. Be certain that five screws fasten the positioner to the mounting plate. Two additional screws fasten the plate to the actuator.

When the positioner is correctly attached to the mounting plate, proceed with the installation by taking the control valve/actuator/positioner package out of service.

2. Properly vent the actuator loading pressure and the supply pressure. Disconnect the pressure tubing connections to the valve positioner.
3. Remove the two screws (key 105 in figures 25 or 26) holding the bypass block (key 34A in figures 25 or 26) to the valve positioner case and remove the bypass block. Save the screws to reattach the Type 582i converter.
4. Remove and discard the existing gasket (key 104 in figures 25 or 26) between the bypass block and valve positioner case.
5. Unpack the Type 582i converter to be installed.
6. Position the new gasket on the Type 582i converter as shown in figure 27. Insert the existing screws (key 105 in figures 25 or 26) through the appropriate holes in the Type 582i converter housing and new gasket.
7. Mate the converter and new gasket to the side of the valve positioner case using the alignment pins on the converter housing.
8. Tighten the screws.
9. Reconnect the pressure connections according to the instructions given in the pressure connections section of this manual.
10. Make the electrical connections according to the instructions given in the electrical connections section of this manual.
11. Complete the standard calibration procedure described in the calibration section of this manual.
12. Return the control valve package to service.

## Operating Information

Instructions for setting the zero and span are found in the calibration section.

## Valve Positioner Cam Information

**Note**

**The small arrow on the valve positioner cam must point in the direction of stem movement with increasing actuator diaphragm pressure. If the arrow is pointing in the wrong direction, remove, reverse, and re-install the cam.**

**Isolate the control valve and shut off pressure lines to the valve positioner.**

# 3582 and 3583 Series

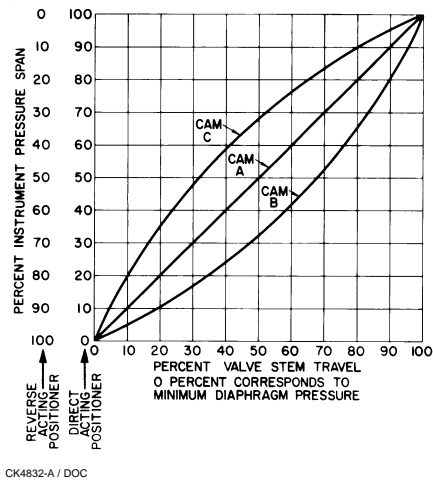


Figure 13. Cam Characteristic Curves

Refer to figure 21 for key number locations. Unhook the spring (key 38), and remove the cam bolt and locking nut (keys 6 and 45). Remove the cam (key 4) and spring retainer bracket (key 43). To install the cam, screw the locking nut all the way onto the cam bolt. Attach the cam and spring retainer bracket with the cam bolt. Tighten the bolt to secure the cam. Then, tighten the locking nut against the spring retainer bracket. Hook the spring into the spring retainer bracket.

When shipped from the factory, 3582 Series valve positioners and the Type 3582i valve positioner have a linear cam, Cam A, installed in the operating position. Two characterized cams, Cams B and C, are available. These characterized cams may be used to modify the valve flow characteristics.

Figure 13 shows resultant stem travel due to an incremental instrument pressure change for each cam. In figure 13, the curves are based on 60 degrees cam rotation for 100 percent stem travel. At 50 percent of the input signal span, for example, the stem will travel 50 percent with cam A, 68 percent with cam B, and 32 percent with cam C. Figure 14 shows how the flow characteristics change when using the cams with a valve that has equal percentage characteristics. Figure 15 shows how the flow characteristics change when using the cams with a valve that has linear characteristics.

When cam A is the operating cam, there is a linear relationship between an incremental instrument pressure change and the resultant valve stem travel.

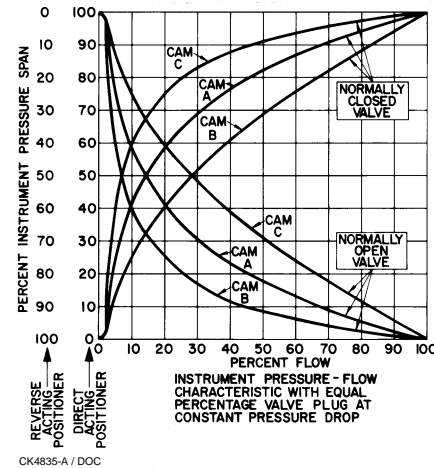


Figure 14. Flow Characteristics with Different Cams and Equal Percentage Valve Plug

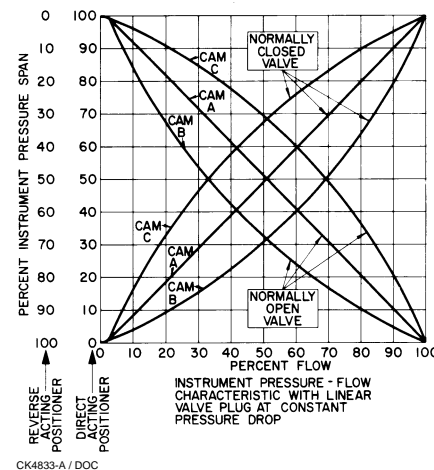


Figure 15. Flow Characteristics with Different Cams and Linear Valve Plug

The flow characteristic is that of the control valve. Installing either cam B or C as the operating cam, changes the relationship between the incremental instrument pressure change and valve stem travel, thereby modifying the valve flow characteristic.

## Valve Stem Position Transmitter Cam Information

### Note

If the small arrow on the valve stem position transmitter cam points up toward the nozzle, output pressure increases with downward stem movement. If the arrow points down,



**output pressure decreases with downward stem movement. If the arrow is pointing in the wrong direction, remove, reverse, and re-install the cam.**

**Isolate the control valve and shut off pressure lines to the valve positioner. Refer to figure 21 for key number locations. Unhook the spring (key 38), and remove the cam bolt and locking nut (keys 6 and 45). Remove the cam (key 4) and spring retainer bracket (key 43). To install the cam, screw the locking nut all the way onto the cam bolt. Attach the cam and spring retainer bracket with the cam bolt. Tighten the bolt to secure the cam. Then, tighten the locking nut against the spring retainer bracket. Hook the spring into the spring retainer bracket.**

The linear cam is the only cam available for the 3583 Series valve stem position transmitter. There is always a linear relationship between stem travel and the stem position transmitter output.

## Valve Positioner Bypass Operation

Type 3582 and 3582D valve positioners, and Type 3582NS positioners with bypass, are supplied with a bypass assembly. A handle on the bypass assembly permits selecting positioner or bypass operation. Refer to figure 25 for key number locations.

### CAUTION

**Do not use bypass when the valve positioner is reverse-acting or is in split-range operation. In these cases, bypassing the valve positioner sends the input signal directly to the actuator. Such a change will affect the desired operation and possibly upset the system. Use bypass only when the input signal range is the same as the valve positioner output range required for normal actuator operation.**

Labels on the bypass block (key 34A) and a pointer on the bypass handle (key 34D) indicate if the input signal from the instrument goes to the positioner or directly to the control valve actuator. Push the bypass handle toward the back of the positioner to move the pointer over the word POSITIONER. With

the bypass handle in this position, the input signal goes to the valve positioner bellows and the output pressure of the valve positioner goes to the actuator. Pull the bypass handle forward to move the pointer over the word BYPASS. In this position, the input signal goes directly to the actuator.

### Note

**A difference between the input signal pressure and the valve positioner output pressure could cause a transient bump in the controlled system when the bypass handle is moved to BYPASS.**

With a reverse-acting or split-range valve positioner, the bypass handle may be locked in the POSITIONER position so that bypass cannot be used. To lock the bypass handle in the POSITIONER position, first shut off the instrument and supply pressure to the valve positioner. Then, remove the hex head shoulder screw from the center of the handle. Remove the handle and rotate it 180 degrees and re-install it with the handle between the two lugs cast on the bypass block. Replace the shoulder screw.

## Input Signal Ranges

Standard input signal ranges for valve positioners and valve stem position transmitters are shown in table 5. Changing from one standard range to another requires changing the range spring. To change the range spring, refer to the instructions for changing the range spring in the maintenance section of this manual. Split-range operation of 3582 Series valve positioners or the Type 3582i valve positioner normally does not require changing the spring. Refer to the section below for split-range information.

## Valve Positioner Split-Range Operation

The 3582 Series valve positioners and the Type 3582i valve positioner are suitable for split-range operations. In split-range operation, the input signal, either pneumatic or dc current, from a single control device is split between two or more control valves. No additional parts are required to use an existing valve positioner for split-range operation.

Table 6 shows some typical split-ranges for the valve positioners.

# 3582 and 3583 Series

Table 5. Standard Instrument Input Signals and Range Springs

INSTRUMENT INPUT SIGNAL RANGE	STANDARD SPAN	ALLOWABLE INPUT SIGNAL <sup>(1)</sup>		RANGE SPRING COLOR	RANGE SPRING PART NUMBER
		Minimum	Maximum		
0.2–1.0 bar (3–15 psig)	0.8 bar (12 psig)	0.07 bar (1 psig)	1.4 bar (21 psig)	Silver	1V621727012
4–20 mA <sup>(2)</sup>	16 mA	2 mA	22 mA		
0.4–2.0 bar (6–30 psig)	1.6 bar (24 psig)	0.07 bar (1 psig)	2.4 bar (35 psig)	Red	1V621927012

1. Minimum and maximum allowable input signals ensure functional operation.  
2. For Type 3582i, only.

Table 6. Split-Range Capabilities

3582 SERIES POSITIONERS				
Split	0.2 to 1.0 Bar or 3 to 15 Psig Input Signal		0.4 to 2.0 Bar or 6 to 30 Psig Input Signal	
	Bar	Psig	Bar	Psig
Two-way	0.2 to 0.6 0.6 to 1.0	3 to 9 9 to 15	0.4 to 1.2 1.2 to 2.0	6 to 18 18 to 30
Three-way	0.2 to 0.5 0.5 to 0.7 0.7 to 1.0	3 to 7 7 to 11 11 to 15	0.4 to 0.9 0.9 to 1.5 1.5 to 2.0	6 to 14 14 to 22 22 to 30
TYPE 3582i POSITIONER				
Split	4 to 20 Milliampere Input Signal			
Two-way	4 to 12 12 to 20			
Three-way	4 to 9.3 9.3 to 14.7 14.7 to 20			

To change to split-range operation, perform the beam alignment procedures then perform the calibration procedure using the desired split range inputs that result in full valve travel. For example, for a 3582 Series positioner with a 0.2 to 1.0 bar (3 to 15 psig) input signal range in a two-way split, a 0.6 bar (9 psig) input signal should completely stroke the valve for a 0.2 to 0.6 bar (3 to 9 psig) signal range.

**Note**

The flapper must approach the nozzle squarely at the midpoint value of the input signal range for proper operation.

On some applications where the input signal span is comparatively small (as found with split-range applications), the nozzle adjustment may not be enough to set the proper starting point. Also, some difficulty may be experienced in keeping a valve positioner from unloading when the input signal continues to increase above the split-range.

For example, for a 0.2 to 0.6 bar (3 to 9 psig) input signal range, the input signal could increase to 1.0 bar (15 psig). Continued bellows travel due to the increased input signal over the split-range would drive the flapper into the nozzle. The impact could possibly cause misalignment between the flapper and nozzle. Such a misalignment, in turn, could affect split-range calibration.

In these cases, adjust the follower assembly screw in addition to the nozzle adjustment to obtain satisfactory results.

**Note**

The 3582 Series valve positioners require a relatively small percentage of the instrument pressure span to obtain full valve travel. With the travel pin set to equal the valve travel, the input signal change required to fully stroke the valve can be reduced to 33 percent of normal input signal change. With the travel pin set to a value greater than the valve travel, the input signal change required to fully stroke the valve can be reduced to a minimum of 20 percent of normal input signal change.

### Changing Valve Positioner Action

Converting a 3582 Series valve positioner or Type 3582i valve positioner from direct acting (an increasing input signal, either pneumatic or electrical, increases output pressure) to reverse acting (increasing input signal decreases output pressure) or vice versa requires no additional parts. The position of the flapper assembly on the beam determines the action. As shown in figure 16, the beam is divided into quadrants. The direct-acting quadrant of the beam is labeled DIRECT and the reverse-acting quadrant is labeled REVERSE. To

change the positioner action, simply move the flapper assembly to the opposite quadrant of the beam. Perform the calibration procedures in the valve positioner calibration section.

## Changing Valve Stem Position Transmitter Action

Refer to figure 21 for key number locations unless otherwise indicated.

The flapper of the 3583 Series valve stem position transmitter is always positioned in the reverse-acting quadrant as shown in figure 20. To reverse the signal, reverse the cam as follows:

1. Unhook the spring (key 38), and remove the cam bolt (key 6), cam (key 4), and spring retainer bracket (key 43).
2. Screw the locking nut (key 45) all the way onto the cam bolt.

### Note

**If the arrow stamped on the cam points toward the nozzle, output pressure increases with downward stem movement. If the arrow points down away from the nozzle, output pressure decreases with downward stem movement.**

3. Reverse the cam (key 4) from its original position. Attach the cam and spring retainer bracket with the cam bolt. Tighten the cam bolt to secure the cam. Then tighten the locking nut against the spring retainer bracket.
4. Hook the spring into the spring retainer bracket.
5. After reversing the cam, perform the calibration procedures in the calibration of valve positioners and transmitters section.

## Calibration Of Valve Positioner Or Valve Stem Position Transmitter

### Note

**The following beam alignment and calibration procedures are applicable for both the 3582 Series and the Type 3582i valve positioners and 3583 Series valve stem position transmitters.**

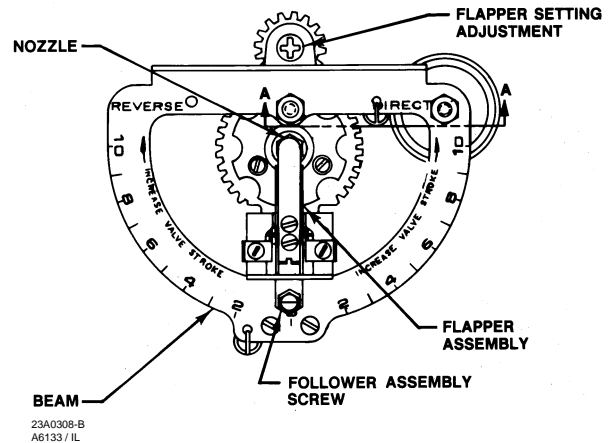
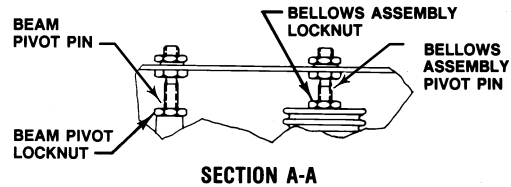


Figure 16. Partial View for Beam Leveling and Calibration

## Beam Alignment

### Note

**The beam is leveled at the factory prior to shipment. Once the beam is leveled, no additional leveling should be required unless the beam pivot pin or the bellows assembly pivot pin are changed, the bellows assembly or range spring are replaced, or the valve positioner is changed to split range operation.**

The purpose of beam alignment is to ensure the correct mechanical position of parts so the valve positioner can be calibrated. Provide the appropriate supply pressure. Also, provide an input signal to the positioner which can be manually set at the midpoint of the desired input signal range.

Refer to figure 16 for parts locations. Refer to figure 21 for key number locations unless otherwise indicated. Position the flapper assembly by hand to different settings on the beam assembly or by using a screwdriver in the slot of the flapper setting adjustment.

To level the beam, proceed as follows:

### Note

**In the following steps, if the required rotary shaft arm position cannot be attained when adjusting a pivot point, adjust one of the other pivot points slightly. Then, repeat the original pivot adjustment. Continue this process until the required arm position can be attained.**

1. Stroke the actuator to its mid-travel position with a handwheel or a manual loader. Refer to figures 4 and 7. Lift the rotary shaft arm (key 2) so that the 0-degree index marks on the rotary shaft arm align with the case index marks as shown in figure 7. Then, position the travel pin (key 60) so that it is perpendicular to the arm and aligns with the appropriate total actuator travel index mark on the rotary shaft arm. Tighten the locking nut (key 62).

### Note

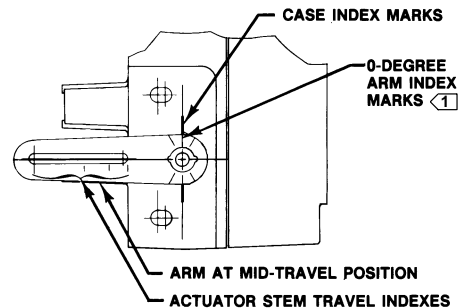
**Valve stem travels less than 29 mm (1-1/8 inches) require that the travel pin be set at the 1-1/8 inches travel index mark on the rotary shaft arm.**

2. Loosen the nozzle locknut and turn the nozzle clockwise to its lowest position. Then screw the nozzle out (counterclockwise) approximately 2 turns and tighten the locknut.

### Note

**For proper operation, the flapper must approach the nozzle squarely. Inspect the nozzle/flapper alignment. Be sure the flapper is not loose, bent, or twisted.**

3. Remove any loading pressure and/or disengage any handwheel used to position the actuator. Connect the necessary tubing from the valve positioner output to the actuator pressure connection.
4. Connect the input to the valve positioner and set the input signal value at midrange. For example, for a 3582 Series valve positioner with a 0.2 to 1.0 bar (3 to 15 psig) input signal range, set the input signal at 0.6 bar (9 psig). Then apply supply pressure to the valve positioner.
5. Move the flapper assembly to zero on the beam scale. The 0-degree index marks on the rotary shaft arm should align with the case index marks as



NOTE:  
 1 ALIGN INDEX MARKS AS SHOWN FOR MID-TRAVEL POSITION.  
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Figure 17. Rotary Shaft Arm 0-Degree and Case Index Marks, Location and Alignment

shown in figure 17. If not, loosen the follower assembly screw locknut and adjust the follower assembly screw until the 0-degree index marks on the rotary shaft arm align with the case index marks. Tighten the locknut.

6. Move the flapper assembly to position 10 on the direct-acting side of the beam scale. The 0-degree index marks on the rotary shaft arm should align with the case index marks as shown in figure 17. If not, loosen the bellows assembly locknut and adjust the bellows pivot pin until the 0-degree index marks on the rotary shaft arm align with the case index marks. Tighten the locknut.

7. Move the flapper assembly to the left to position 10 on the reverse-acting side of the beam. The 0-degree index marks on the rotary shaft arm should align with the case index marks as shown in figure 17. If not, loosen the beam pivot pin locknut and adjust the beam pivot pin until the 0-degree index marks on the rotary shaft arm align with the case index marks. Tighten the locknut.

8. Repeat steps 5, 6, and 7 to optimize alignment. Recheck to make sure the flapper approaches the nozzle squarely. If it does not, adjust the nozzle and re-level the beam. After alignment, the valve positioner is ready for calibration.

## Calibration

1. Shut off the supply pressure to the valve positioner. Connect or reconnect the necessary tubing from the valve positioner output to the actuator supply connection. Connect the input to the valve positioner and set the input signal value at midrange.
2. Move the flapper assembly to approximately position 6 in the proper operating quadrant of the

Table 7. Minimum Travel with Given Pin Position

TRAVEL PIN POSITION ALONG ROTARY SHAFT ARM	MINIMUM TRAVEL AVAILABLE	
	mm	Inch
1-1/8	6	1/4
1-1/2	8	5/16
2	11	7/16
2-1/2	13	1/2
3	16	5/8
4	22	7/8

beam (direct or reverse acting), and apply supply pressure to the valve positioner. The 0 degree index marks on the rotary shaft arm should align with the case index marks as shown in figure 17 and the actuator should be at its midtravel position. If not, first check for loose linkage or improper cam installation. A minor nozzle height adjustment might be necessary to make the desired input signal value correspond to the starting point of travel.

3. Apply an input signal equal to the low value of the input signal range. For example, for a 3582 Series valve positioner with a 0.2 to 1.0 bar (3 to 15 psig) input signal range, set the input signal at 0.2 bar (3 psig). Loosen the nozzle locknut and adjust the nozzle until the actuator moves to the proper end of its travel. Changing the nozzle position is intended only as a means of zero trim adjustment. Whenever nozzle position is changed, the zero reference point is changed.

4. Apply an input signal equal to the high value of the input signal range and observe the actuator stem travel. If the stem travel is short of its expected range, increase the travel by moving the flapper assembly to a higher number on the beam. If the desired stem travel occurs before the input signal reaches the high value of the input signal range, decrease the travel by moving the flapper assembly toward a lower number on the beam.

5. Repeat steps 3 and 4 until the correct travel is achieved. Each time the flapper position is changed in step 4, repeat step 3 to provide proper zero.

Moving the flapper assembly toward zero on the beam scale decreases stem travel. Table 7 lists the minimum stem travel available for different travel pin settings. For example, with a travel pin setting of 2 the minimum stem travel possible, for the full input signal range, would be 11 mm (7/16-inch).

**Note**

**The positioner will fully vent or pressurize the actuator to supply pressure at the ends of actuator travel**

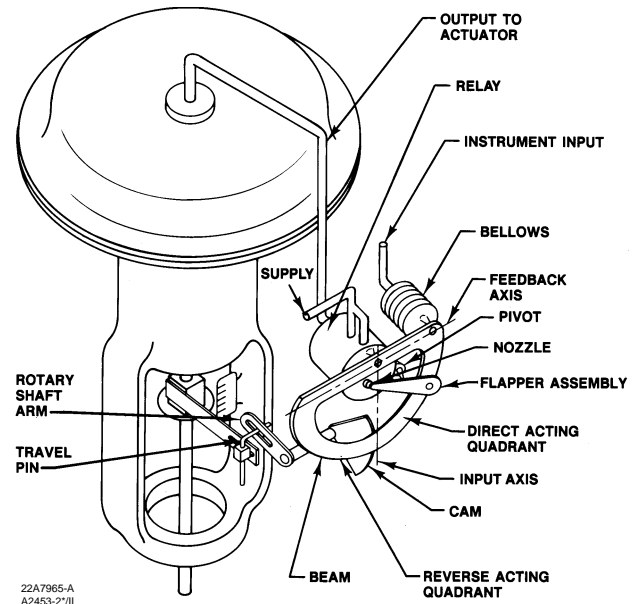


Figure 18. Schematic Illustration of 3582 Series Positioner

**when the positioner is calibrated correctly. Failure to properly calibrate the positioner may result in reduced seat loading.**

**Principle of Operation**

**3582 Series Valve Positioners**

The 3582 Series (the Type 3582, 3582NS and Types 3582A, C, D, and G pneumatic valve positioners) accept a pneumatic input signal from a control device. Figure 18 is an operational schematic for a direct-acting pneumatic valve positioner.

As shown in figure 18, in a diaphragm-actuated, sliding stem control valve package with a 3582 Series valve positioner, supply pressure is connected to the Type 83L relay. A fixed restriction in the relay limits flow to the nozzle so that when the flapper is not restricting the nozzle, air can bleed out faster than it is being supplied.

The input signal from the control device is connected to the bellows. When the input signal increases, the bellows expands and moves the beam. The beam pivots about the input axis moving the flapper closer to the nozzle. The nozzle pressure increases and, through relay action, increases the output pressure to the actuator. The increased output pressure to the

# 3582 and 3583 Series

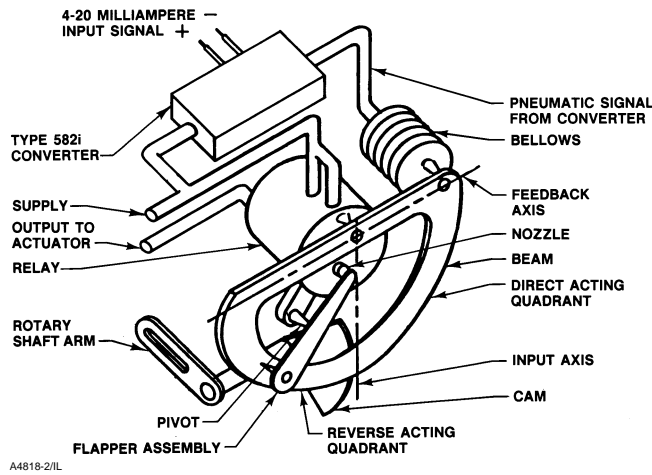


Figure 19. Schematic Illustration of Type 3582i Positioner

actuator causes the actuator stem to move downward. Stem movement is fed back to the beam by means of a cam. As the cam rotates, the beam pivots about the feedback axis to move the flapper slightly away from the nozzle. The nozzle pressure decreases and reduces the output pressure to the actuator. Stem movement continues, backing the flapper away from the nozzle, until equilibrium is reached.

When the input signal decreases, the bellows contracts (aided by an internal range spring) and the beam pivots about the input axis to move the flapper away from the nozzle. Nozzle pressure decreases and the relay permits the release of diaphragm casing pressure to atmosphere. The actuator stem moves upward. Through the cam, stem movement is fed back to the beam to reposition the flapper closer to the nozzle. When equilibrium conditions are obtained, stem movement stops and the flapper is positioned to prevent any further decrease in diaphragm case pressure.

The principle of operation for reverse acting units is similar except that as the input signal increases, the diaphragm casing pressure is decreased. Conversely, a decreasing input signal causes an increase in the pressure to the diaphragm casing.

## Type 3582i Valve Positioner

As shown in figure 19, the Type 3582i electro-pneumatic valve positioner has a Type 582i electro-pneumatic converter attached to the valve positioner. The 582i contains an I/P module which provides a pneumatic output proportional to a dc

current input signal. The dc current input operates coils in a force balanced beam system which in turn, control bleed air through an integral nozzle/flapper arrangement. The nozzle pressure provides the pneumatic input signal pressure used by the pneumatic valve positioner.

## 3583 Series Valve Stem Position Transmitters

3583 Series (Type 3583, 3583C) pneumatic valve stem position transmitters are mechanically linked to the valve stem in a diaphragm-actuated, sliding-stem control valve package. A change in the position of the valve stem changes the output pressure produced by the position transmitter. This signal is then piped to a reporting or recording device to indicate valve stem position.

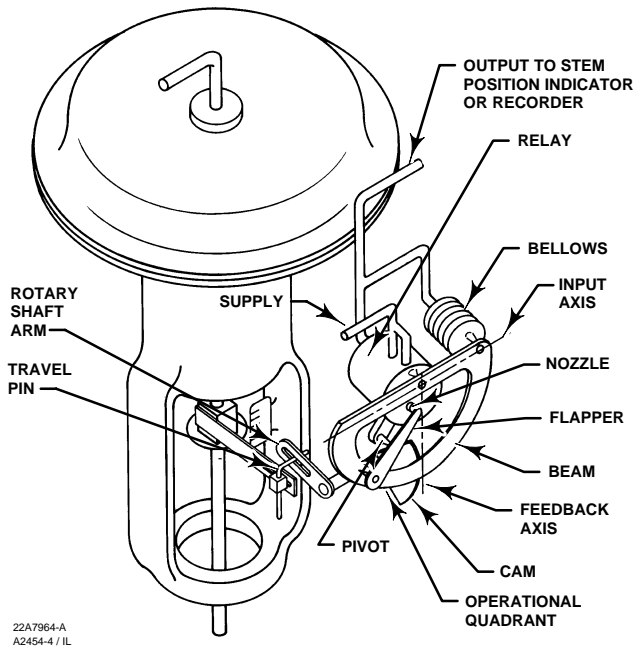
The action of a valve stem position transmitter can be changed by reversing the internal cam. The valve stem position transmitter cam is supplied with an arrow stamped on one side. The cam can be positioned to obtain either increasing or decreasing output pressure with downward stem motion. If the cam arrow points toward the nozzle, the output pressure increases; if the cam points away, the output pressure decreases with downward stem motion.

Figure 20 depicts a diaphragm actuator which produces downward stem motion for increasing actuator pressure. For a stem position transmitter, the flapper assembly is always positioned in the reverse-acting quadrant of the beam. Supply pressure is connected to the Type 83L relay. A fixed restriction in the relay limits flow to the nozzle so that when the flapper is not restricting the nozzle, air can bleed out faster than it is being supplied.

As the pressure to the diaphragm actuator increases, the valve stem moves downward, causing the internal cam to rotate. Cam rotation causes the beam to pivot about the input axis moving the flapper closer to the nozzle. The nozzle pressure increases which, through relay action, increases the output pressure.

The output pressure is also connected to the bellows. As the output pressure increases, the bellows expands, causing the beam to pivot about the feedback axis moving the flapper slightly away from the nozzle until equilibrium is reached. The position transmitter output pressure is now proportional to the valve stem position.

As the pressure to the diaphragm actuator decreases, the valve stem moves upward, causing



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Figure 20. Schematic Illustration of 3583 Series Transmitter

the internal cam to rotate. Cam rotation causes the beam to pivot about the input axis moving the flapper away from the nozzle. The nozzle pressure decreases which, through relay action, decreases the output pressure. The bellows contracts, causing the beam to pivot about the feedback axis and moving the flapper closer to the nozzle until equilibrium is reached. The position transmitter output pressure is again proportional to the valve stem position.

## Maintenance

### WARNING

**Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**

- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve.**

- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

**For explosion proof applications, disconnect power before removing the converter housing cap in an explosive atmosphere.**

Due to normal wear or damage from external sources (such as debris in the supply medium), periodic maintenance or repair of the valve positioner or valve stem position transmitter may be necessary. Maintenance of these units consists of troubleshooting, removal for inspection, and replacement of component parts.

### CAUTION

**When replacing components, use only components specified by Fisher Controls. Substitution with other components may result in the positioner or transmitter no longer meeting safety certification requirements. Also, always use proper component replacement techniques. Improper techniques and poor quality repairs can impair the safety features of the device.**

In case of operational difficulties, the valve positioner or valve stem position transmitter should first be checked to see that adjustments have been properly made. All pressure lines and connections should be checked for leaks.

The pneumatic relay and gaskets should also be inspected and replaced if necessary.

Instructions are given below for:

- changing the range spring;
- replacing gaskets, nozzle O-rings, and the relay;
- adjusting the flapper pivot;
- replacing the Type 582i converter primary O-ring and filter;

## 3582 and 3583 Series

- replacing the Type 582i converter cover O-ring;
- removing the Type 582i converter; and
- reassembling the Type 582i converter.

### Changing the Range Spring

Unless otherwise noted, key number locations are shown in figure 21.

The range spring is inside the bellows assembly. Standard range spring data is given in table 5. When an input signal range is split to operate two or more control valves, normally changing the range spring is not necessary. The input signal range for the range spring is stamped on the nameplate.

Perform the following procedure to change the range spring in a valve positioner or valve stem position transmitter.

1. Unhook the extension springs (keys 27, 77) from the beam (key 29).
2. Loosen and remove the two screws (key 13), and lock washers (key 12) that hold the bellows assembly (key 7) in place.
3. Lift out the beam and bellows assembly. Be careful not to lose the small O-ring (key 11).
4. Loosen the machine screw (key 10), and remove the range spring (key 8).
5. Install a new range spring, making sure the small end of the spring is against the spring seat (key 9). Replace the spring seat and tighten the screw.
6. If the O-ring (key 11) is worn or damaged, replace it with a new one after applying lubricant (key 94). Make sure the O-ring is in place, then install the bellows assembly, securing it with two mounting screws and lock washers.
7. Install the beam over the pivots and hook the springs to the beam.
8. Make any minor adjustments that may be necessary to re-level the beam as outlined in the beam alignment procedures of the valve positioners or the valve stem position transmitters calibration section. After leveling the beam, calibrate the unit according to the appropriate calibration instructions.

### Replacing Gaskets

Unless otherwise noted, key numbers used in this procedure are shown in figures 25 and 26.

A gasket (key 34C) is located behind the bypass handle (key 34D) of the 3582 Series valve positioners or manifold (key 34D) of the 3583 Series valve stem position transmitters.

1. Remove the screw (key 34G), and lift out the bypass handle or manifold.
2. Remove the gasket.
3. Apply lubricant (key 94) to both sides of the replacement gasket when used with the bypass assembly of the 3582 Series valve positioners. Do not apply lubricant to the gasket when the bypass assembly is not used.
4. Set the new gasket in place on the four locating pins and replace the bypass handle or manifold.

The case gasket (key 104) is located between the case (key 1 in figure 21) and the bypass block (key 34A) in a 3582 Series valve positioner or a 3583 Series valve stem position transmitter or the housing of the Type 582i converter (key 1 in figure 27).

5. Remove the two mounting screws (key 105 in figures 25 and 26; key 11 in figure 27) that hold the bypass block or converter housing to the case and remove the unit to expose the case gasket.
6. Install a new gasket and replace the bypass block or converter housing.

### Replacing the Nozzle O-Ring

Unless otherwise noted, key numbers are shown in figures 22 and 24.

1. Remove the two screws (key 19C) that hold the flapper and follower assembly (keys 19B and 19G) to the adjustment arm (key 19A).

### CAUTION

**For proper operation, be careful not to bend or twist the flapper or nick the nozzle orifice during reassembly.**

2. Carefully remove the flapper and follower assembly for access to the nozzle (key 18 in figure 21).
3. Loosen the locking nut (key 71), and unscrew the nozzle (key 18).



4. Remove the locking sleeve (key 72) from the nozzle adaptor (key 3). The nozzle adaptor is bonded to the positioner case with adhesive (key 96) and should not be removed.
5. Inspect the O-ring (key 73) on the nozzle adapter and replace the O-ring, if necessary. If replacing the O-ring, apply lubricant (key 94) to the O-ring before installing it on the nozzle adapter.
6. Reinstall the nozzle onto the nozzle adapter, leaving the locking nut loose.
7. Replace the flapper and follower assembly. Make sure the letter "T" on the flapper is visible from the front of the positioner or transmitter.
8. Perform the beam alignment and calibration procedures in the Calibration of Valve Positioner or Valve Stem Position Transmitter section.

## Replacing the Relay

### Note

**The relay is not field repairable. If the relay is defective, replace the relay.**

Use the following procedure to replace the relay assembly. Refer to figure 21 for key number locations, unless otherwise noted.

1. For valve positioners using a bypass, direct action, and a full-range input signal, place the positioner in bypass operation by moving the bypass handle to BYPASS. Then, shut off the supply pressure. For all other valve positioners and valve stem position transmitters, isolate the control valve from the system and shut off all pressure lines.

### Note

**A difference between input and valve positioner output pressure could cause a transient bump in the controlled system when the bypass handle is moved to BYPASS.**

2. Remove the Type 83L relay (key 32) from the back of the case by loosening the two mounting screws (key 10, figure 23).
3. Reinstall the new relay assembly on the case, making sure the O-rings (keys 13 and 15, figure 23) are in place. Secure with the two mounting screws (key 10, figure 23).
4. Resume operation by moving the bypass handle to the POSITIONER position or by connecting the

valve positioner or valve stem position transmitter and control valve to the system.

## Adjusting the Flapper Pivot

Key numbers used in this procedure are shown in figure 24.

1. Loosen the two screws (key 19C).
2. Tighten the pivot pin (key 19L) by compressing the upturned ears of the arm support (key 19K). Tighten the screws (key 19C) and make sure the flapper (key 19B) does not rub on the supports.
3. The flapper should be snug, but not constricting to pivot action.

## Replacing the Type 582i Converter Primary O-Ring and Filter

Key numbers used in this procedure are shown in figure 27.

1. Locate and remove the nozzle restriction adaptor assembly (key 4).
2. Inspect and replace, if necessary, the O-rings (keys 5 and 6). Apply lubricant (key 15) to the O-ring before replacing.
3. Inspect and replace the filter cartridge (key 23).

## Replacing the Type 582i Converter Housing Cap O-Ring

Key numbers used in this procedure are shown in figure 27.

1. Unscrew and remove the converter housing cap (key 2). Inspect and replace the O-ring (key 8), if necessary. Apply lubricant (key 15) to the O-ring before replacing.

## Removing the Type 582i Converter

During the following converter removal procedures, refer to figure 27 for key number locations.

## CAUTION

**The I/P module should never be disassembled because the magnetism in the coils will decrease permanently. If troubleshooting or alignment attempts indicate a faulty I/P module,**

## 3582 and 3583 Series

replace the module or return the converter to your Fisher sales representative or sales office for repair.

### Note

**To check the operation of the I/P module, remove the pipe plug (key 12), and connect a pressure gauge. Provide a 1.4 bar (20 psig) supply pressure to the converter. With a 4-milliampere input signal the pressure output should read 0.16 to 0.24 bar (2.3 to 3.5 psig). With a 20-milliampere input signal the pressure output should read 0.96 to 1.07 bar (14.0 to 15.5 psig).**

1. Turn off the input signal to the converter. Release all supply pressure from the valve positioner.
2. Remove the housing cap (key 2).
3. Note the location of the wires, disconnect the field wiring from the terminal block. Disconnect the grounding wire from the external ground screw (key 10).
4. To remove the I/P module, remove the two screws (key 9), and pull the module out of the housing. Inspect the O-ring (key 6) and replace it, if necessary. Apply lubricant (key 15) to the O-ring before replacing.
  - a. To remove the entire Type 582i converter from the Type 3582i valve positioner, continue with steps 5 through 7.
  - b. To replace the I/P module only, obtain a replacement I/P module listed in the parts list and refer to the procedures for reassembling the Type 582i converter.
5. Disconnect the supply tubing, output tubing, and electrical conduit from the converter.
6. If necessary, remove the Type 67CFR regulator by removing the two screws (key 13). Then, remove the regulator from the converter assembly. Inspect the O-ring (key 3) and replace it if necessary. Apply lubricant (key 15) to the O-ring before replacing.
7. Remove the two screws (key 11) holding the Type 582i converter to the valve positioner case. Remove the converter from the valve positioner case (key 1 in figure 21). Inspect the gasket (key 20) and replace it if necessary.

## Reassembling the Type 582i Converter

During the following converter reassembly procedures, refer to figure 27 for key number locations.

1. If the Type 582i converter was removed from the valve positioner, install a new gasket (key 20) between the converter housing and the valve positioner case. Attach the converter housing to the valve positioner case with the screws (key 11) and tighten the screws.
2. If the I/P module was removed from the Type 582i converter, reinstall the I/P module in the converter housing. Secure the I/P module with the two screws (key 9).
3. If other valve positioner components are removed, refer to the appropriate reassembly procedures and assemble the valve positioner completely.
4. Reconnect the supply tubing, output tubing, and conduit to the valve positioner.
5. Reconnect the wiring to the terminal block. Do not overtighten the terminal screws. Maximum torque is 0.45 N•m (4 lbf•in.). Reconnect the grounding wire to the housing ground screw (key 10) and replace the cap (key 2).

### Note

**To check the operation of the I/P module, remove the pipe plug (key 12), and connect a pressure gauge. Provide a 1.4 bar (20 psig) supply pressure to the converter. With a 4-milliampere input signal the pressure output should read 0.16 to 0.24 bar (2.3 to 3.5 psig). With a 20-milliampere input signal the pressure output should read 0.96 to 1.07 bar (14.0 to 15.5 psig).**

6. Plug the output connection and apply 2.4 bar (35 psig) to the supply pressure connection.

## CAUTION

**Do not apply a signal greater than 35 milliamperes to the I/P module. Higher signal values may damage the converter module.**

7. Apply a 20 milliampere dc current input signal to the converter.

8. Check for leaks using a soap solution. Check any components which were disassembled or disconnected.

## Parts Ordering

A serial number is assigned to each valve positioner or valve stem position transmitter and is stamped on the nameplate. Always refer to this number when corresponding with your Fisher representative regarding spare parts or technical information. When ordering parts, also give the eleven-digit part number shown in the following parts list.

## Parts Kits

Key	Description	Part Number
	Repair kit for positioner/transmitter (not for 3582NS) Kit contains keys 11, 16, 17, 33B, 34C, 73, and 104. This kit also contains keys 18C, 18E, and 18F for 3580 and 3581 Series positioners	
	For standard temperature applications	R3580X00022
	For high temperature applications	R3580X00032
	Repair kit w/nozzle and flapper for Type 3582 Positioner Kit contains keys 11, 16, 17, 18, 19B, 19E, 33B, 34C, 73, and 104.	
	For standard temperature applications, not for 3582NS	R3582X00012
	For high temperature applications, not for 3582NS	R3582X00022
	For Type 3582NS, contains EPDM parts	R3582X00032
	Repair kit for Type 582i electro-pneumatic converter Kit contains keys 3, 5, 6, 8, 20, and 23	R582X000012
	Replacement kit for Type 83L Relay Kit contains relay, gaskets and mounting screws (key 32 in figure 21, keys 10, 13, and 15 in figure 23)	
	For 3582 Series except 3582NS, std. const.	R3580XRS012
	For 3582 Series except 3582NS, hi-temp. const.	R3580XRH012
	For 3582NS	R3580XNS012
	For 3583 Series, std. const.	R3580XRS022
	For 3583 Series, hi-temp. const.	32B0255X0E2

## Parts List

### Note

Parts in the following list are common to both the 3582 Series valve positioners and the 3583 Series position transmitters, unless identified by specific type or series number.

## Diagnostic Connections (figure 9)

FlowScanner™ valve diagnostics system hook-up.

Includes connector body and body protector. If ordered for units with gauges, a stem is also included. Also, part number provides correct quantities of each item.

Key	Description	Part Number
	For 3582 Series pneumatic valve positioners	
	For units w/gauges	
	SST fittings	12B8045 X012
	brass fittings	12B8045 X022
	For units w/o gauges	
	SST fittings	12B8045 X032
	brass fittings	12B8045 X042
	For 3582i electro-pneumatic valve positioners	
	For units w/gauges	
	SST fittings	12B8046 X012
	brass fittings	12B8046 X022
	For units w/o gauges	
	SST fittings	12B8046 X032
	brass fittings	12B8046 X042

## Positioner/Transmitter Common Parts (figure 21)

Key	Description	Part Number
1	Case Assembly All except Type 3582NS, Aluminum and PEEK Type 3582NS, SST/Bronze	19B3103 X012 13B8769 X022
2*	Shaft Assembly, SST/steel For all except 3582NS and high vibration For travel up to 54 mm (2-1/8 inch) For travel up to 102 mm (4-inch) For 3582NS and high vibration For travel up to 54 mm (2-1/8 inch) For travel up to 102 mm (4-inch)	15A9609 X012 15A9609 X022 15A9609 X062 15A9609 X072
3	Nozzle Adaptor, SST	12A2613 X012
4	Cam, SST Cam A (For all types except 3582NS) Cam B (For all except Types 3582NS, 3583, 3583C) Cam C (For all except Types 3582NS, 3583, 3583C)	45A9614 X012 45A9615 X012 45A9616 X012
4	Cam (for Type 3582NS and high vibration) Cam A (for all types) Cam B (For all except Types 3583, 3583C) Cam C (For all except Types 3583, 3583C)	12B3642 X012 12B3643 X012 12B3644 X012
6	Cam Bolt, 416 SST	12A2616 X012
7*	Bellows Assembly Standard brass For sour gas	13B8783 X012 13B8783 X022
8	Range Spring, pl steel (also see table 5) 0.2 to 1.0 bar (3 to 15 psi) 0.4 to 2.0 bar (6 to 30 psi)	1V6217 27012 1V6219 27012
9	Spring Seat, aluminum	12A7355 X012
10	Machine Screw, pl steel	T13305 T0012

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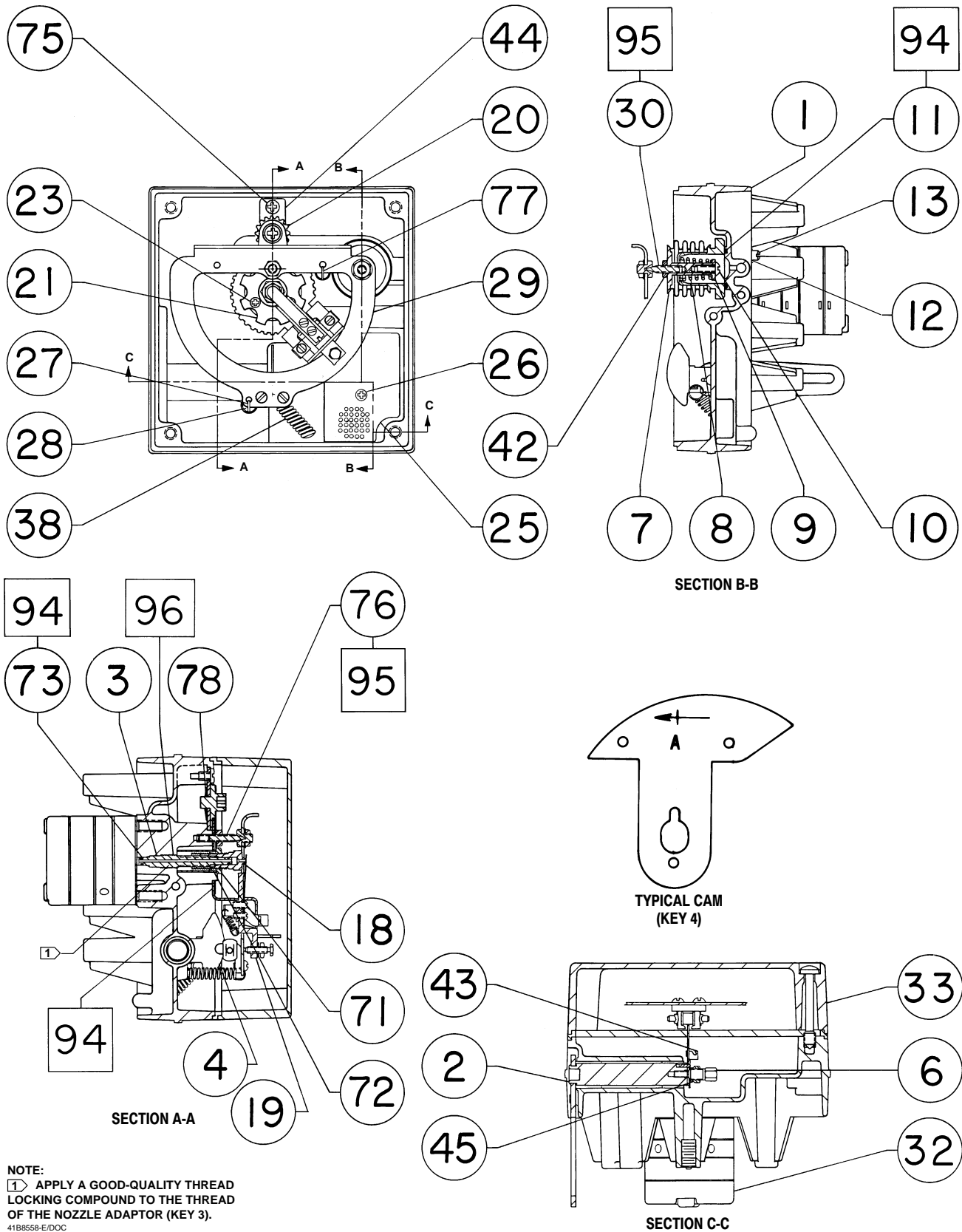
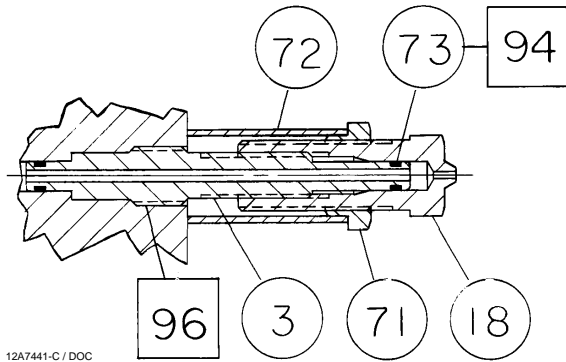
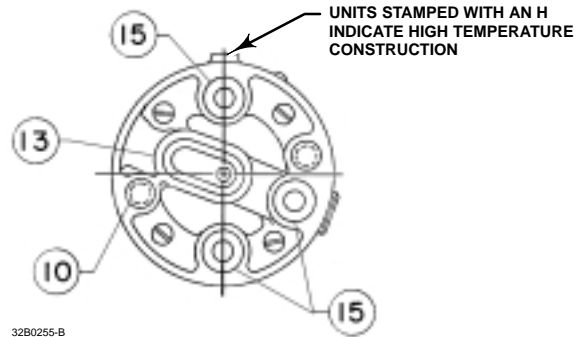


Figure 21. 3582 and 3583 Series Positioners and Transmitters Assembly Drawing



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Figure 22. Nozzle Sub-Assembly



32B0255-B

Figure 23. Type 83L Relay

Key	Description	Part Number
11*	O-Ring Std. const., Nitrile All except Type 3582NS Hi-temp. const., Fluoroelastomer Types 3582A, 3582C & 3583C Type 3582NS, EPDM Duro 80A	1F4636 06992 1N5714 06382 17B4784 X012
12	Lockwasher, pl steel (2 req'd)	1H3223 28982
13	Machine Screw, pl steel (2 req'd)	12B6351 X012
18	Nozzle, SST 3582 Series 3583 Series	12A9840 X012 12A9841 X012
19	Flapper Sub-Assembly All except Type 3582NS Type 3582NS	13A1451 X012 13A1451 X022

**Note**

Parts 19A through 19L are shown in figure 24.

19A	Adjustment Arm, pl steel	2V6066 25182
19B	Flapper, SST	13A1314 X012
19C	Machine Screw, pl steel (2 req'd)	14A7797 X012
19D	Flapper Arm, aluminum	23A1318 X012
19E	Machine Screw, pl steel (2 req'd)	13B8786 X012
19F	Flapper Spring, SST	13A1316 X012
19G	Zero Adjustment Screw, All except Type 3582NS, nylon Type 3582NS, 316 SST	13B8777 X012 17B4786 X012
19H	Hex Nut, pl steel	1A3303 28982
19J	Lockwasher, pl steel	1H2671 28982
19K	Arm Support, SST	13A1315 X012
19L	Pivot Pin, 440C SST	13A1317 X012
20	Setting Adjustment Gear, All except Type 3582NS, nylon Type 3582NS, 316 SST	2U9052 06162 27B4787 X012
21	Flapper Assembly Retainer, SST	2U9053 36012
23	Self Tapping Screw, pl steel (2 req'd)	13B8764 X012
25	Nameplate, aluminum	13B8758 X0A2
26	Self Tapping Screw, steel (2 req'd)	13B8764 X012
27	Extension Spring, SST	14A8214 X022
28	Machine Screw, pl steel (3 req'd)	13B8765 X012
29	Beam Sub-Assembly For all except 3582NS and high vibration For 3582NS and high vibration	19B3119 X012 22B3645 X012
30	Bellows Pivot Pin, SST	12A7357 X012
32	Type 83L Relay See "Parts Kits," Replacement Kit for Type 83L Relay	

Key	Description	Part Number
33	Cover Assembly Plastic For all types except 3582NS Aluminum For all types except 3583, 3583C For 3583 and 3583C	22B4905 X012 1U9065 000A2 1U9065 X00A2

**Note**

**Bypass block assembly (key 34) and parts are listed later in this parts list. Non-bypass block assembly (also key 34) and parts are listed following the bypass block assembly and parts.**  
Parts 35, 36 and 37 are shown in figures 25 and 26.

35	Pipe Plug, pl steel Req'd when gauges or test connections are not used: 3 req'd for 3582 Series, Plated carbon steel 316 SST	1D8293 28982 1D8293 X0012
36*	Output Gauge, Dual Scale Types 3582, 3582G, 3583 0-30 psig/0-2 kg/cm <sup>2</sup> 0-60 psig/0-4 kg/cm <sup>2</sup>	11B4040 X042 11B4040 X052
36*	Output Gauge, Triple Scale Types 3582, 3582G, 3583 0-30 psig/0-0.2 MPa/0-2 bar 0-60 psig/0-0.4 MPa/0-4 bar	11B4040 X012 11B4040 X022
37*	Supply Gauge, Dual Scale Types 3582, 3582G, 3583 0-30 psig/0-2 kg/cm <sup>2</sup> 0-60 psig/0-4 kg/cm <sup>2</sup>	11B4040 X042 11B4040 X052
37*	Supply Gauge, Triple Scale Types 3582, 3582G, 3583 0-30 psig/0-0.2 MPa/0-2 bar 0-60 psig/0-0.4 MPa/0-4 bar	11B4040 X012 11B4040 X022
38	Extension Spring, SST	12A2937 X022
39	Shipping Stop (not shown)	1V4517 06992
42	Hex Nut, pl steel (2 req'd)	1A5735 28982
43	Spring Retainer Bracket, SST	25A9611 X012
44	Gear Mounting Plate, aluminum	12A2611 X012
45	Locking Nut, aluminum	12A2618 X012

Key	Description	Part Number
	<b>Note</b>	
	<b>Parts 46 and 47 are shown in figures 25 and 26.</b>	
46*	Instrument Gauge, Dual Scale 0–30 psig/0–2 kg/cm <sup>2</sup> (3–15 psig/0.2–1.0 kg/cm <sup>2</sup> ranges)	11B4040 X042
	0–60 psig/0–4 kg/cm <sup>2</sup> (6–30 psig/0.4–2.0 kg/cm <sup>2</sup> ranges)	11B4040 X052
46*	Instrument Gauge, Triple Scale 0–30 psig/0–0.2 MPa/0–2 bar (3–15 psig/20–100 kPa/0.2–1 bar ranges)	11B4040 X012
	0–60 psig/0–0.4 MPa/0–4 bar (6–30 psig/40–200 kPa/0.4–2 bar ranges)	11B4040 X022
47	Test Connection	
	Types 3582C, 3582D (3 req'd)	
	Type 3583C (2 req'd)	1N9088 99012
	Type 3582NS (3 req'd)	17B4809 X012
71	Locking Nut, aluminum	12A2615 X012
72	Locking Sleeve, aluminum	12A2619 X012
73*	O-Ring (2 req'd)	
	Std. const., Nitrile	
	All except Type 3582NS	10A0871 X012
	Hi-temp. const., Fluoroelastomer	
	Types 3582A, 3582C & 3583C	14A0592 X012
	Type 3582NS, EPDM	17B4783 X012
75	Machine Screw, pl steel	13B8763 X012
76	Beam Pivot Pin, SST	12A7358 X012
77	Extension Spring, SST	14A8215 X022
78	Speed Nut, SST	12A0801 X012
93	Anti-seize Compound, Zink Plate No. 770 (not furnished with positioner)	
94	Lubricant, Dow Corning 111 (not furnished with positioner)	
95	Lubricant, All except Type 3582NS Lubriplate MAG-1 (not furnished with positioner)	
	Type 3582NS, Molykote No. 33 (not furnished with positioner)	
96	Adhesive, Loctite No. 680 (not furnished with positioner)	

**Note**

**Parts 104 and 105 shown in figures 25 and 26.**

103*	O-Ring, nitrile, (not shown) used with integrally mounted Type 67CFR filter regulator	1E5914 06992
104*	Case Gasket, Std. const.	1U9078 04132
	Hi-temp. const.	1U9078 X0012
	Type 3582NS, EPDM	17B4782 X012
105	Machine Screw, SST (2 req'd)	12B0909 X012
108	Shipping tag (not shown)	1N5864 06992

### For Units With Bypass (figure 25)

**Note**

**Bypass block assembly (key 34) and parts are listed below. Non-bypass block assembly (also key 34) and parts are listed following the bypass block assembly and parts.**

34	Block Assembly	
	Types 3582, 3582D	21B8557 X012
	Type 3582NS	21B8557 X032

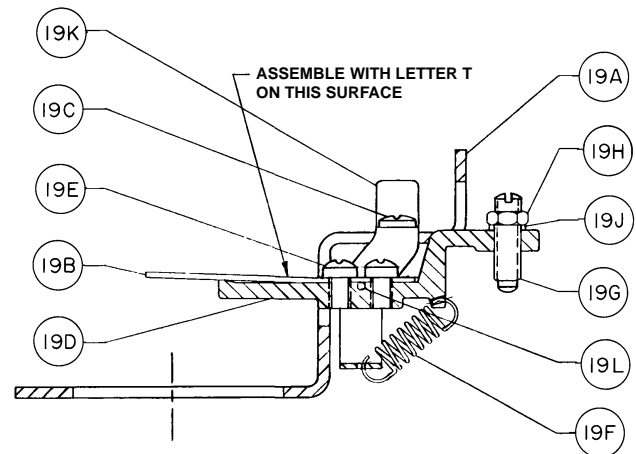


Figure 24. Flapper Sub-Assembly (Key 19)

Key	Description	Part Number
34A	Bypass Block, aluminum	41B5987 X012
34B	Groove-Pin, pl steel (not shown) (4 req'd)	1L9428 28992
34C*	Bypass Gasket	
	Types 3582, 3582D, neoprene	1V6062 04132
	Type 3582NS, EPDM	17B4780 X012
34D	Bypass Handle, aluminum	2V6071 08012
34E	Spring, pl steel	1V6063 X0022
34F	Washer, polyethylene	1V6061 06992
34G	Screw, pl steel	1V6058 24642
34K	Spring Seat, SST	1V6060 35032
34L	Spring Retainer, pl steel	1V6059 25072

### For Units Without Bypass (figure 26)

34	Non-Bypass Block Assembly	
	Std. const.	
	Types 3582A, 3582C, 3582G	21B8555 X012
	Types 3583, 3582C	21B8554 X012
	Hi-temp. const.	
	Types 3582A, 3582C	21B8555 X022
	Type 3583C	21B8554 X022
	Type 3582NS	21B8555 X052
34A	Bypass Block, aluminum	41B5987 X012
34C*	Gasket	
	Std. const., neoprene	1V6062 04132
	Hi-temp. const.	1V6062 X0012
	Type 3582NS, EPDM	17B4780 X012
34D	Manifold	
	3582 Series, std. and hi-temp. const.	1V9429 08012
	3583 Series, std. and hi-temp. const.	10A0746 X012
34G	Cap Screw, pl steel	1J5241 28982
106	Pipe Plug, pl steel	
	For Types 3583 & 3583C (2 req'd)	1A7675 24662

### Type 582i (figure 27)

—*	I/P Module	33B7073 X012
1	Housing	
	1/2-inch NPT conduit connection	22B0901 X012
2	Cap, aluminum	37B7575 X012
—	Screw, (not shown)	
	Used to lock cap	11B8574 X012

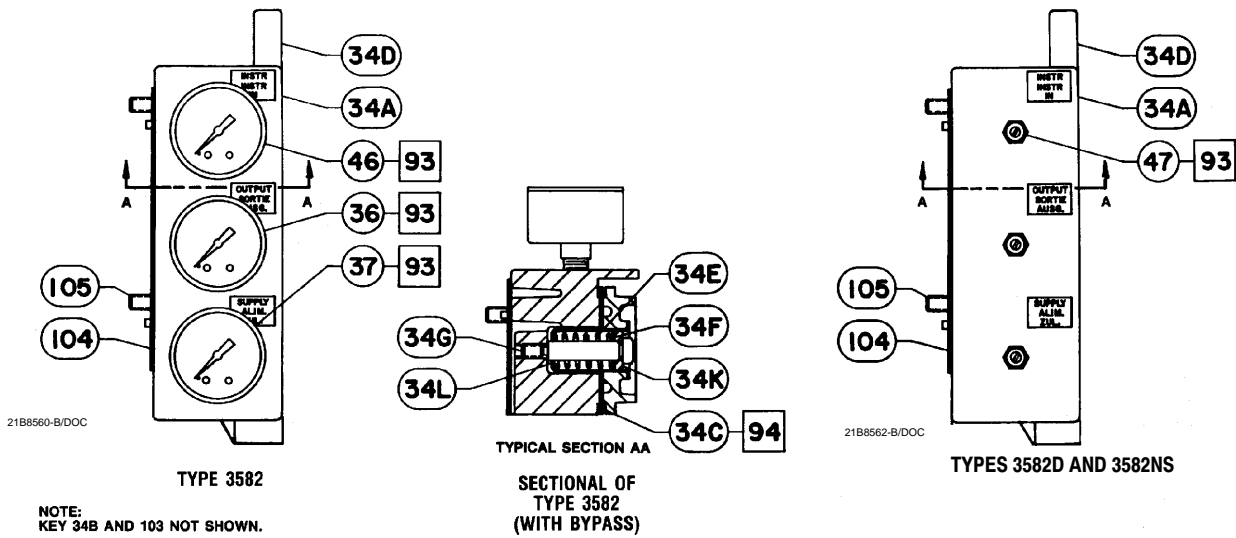


Figure 25. 3582 Series Block Assembly with Bypass

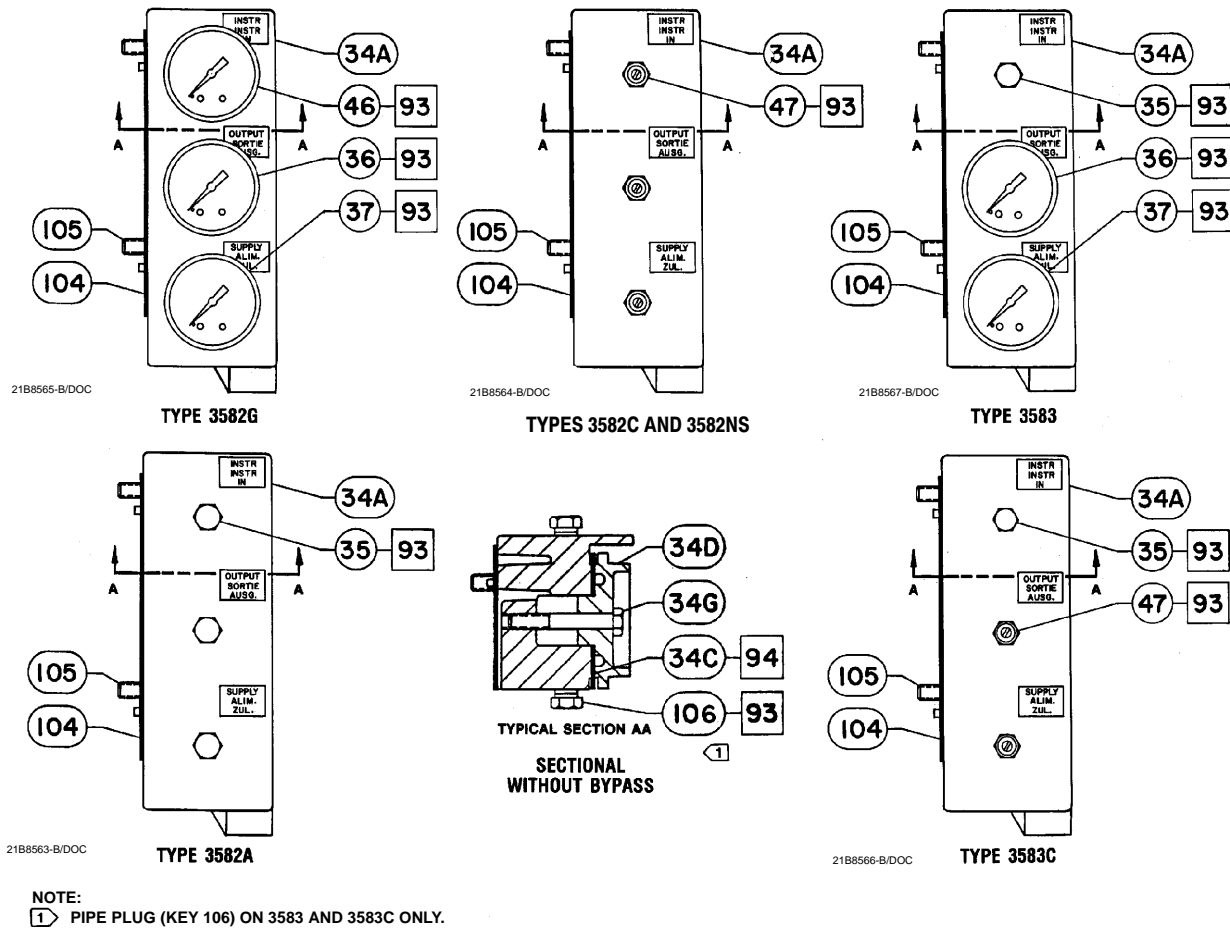
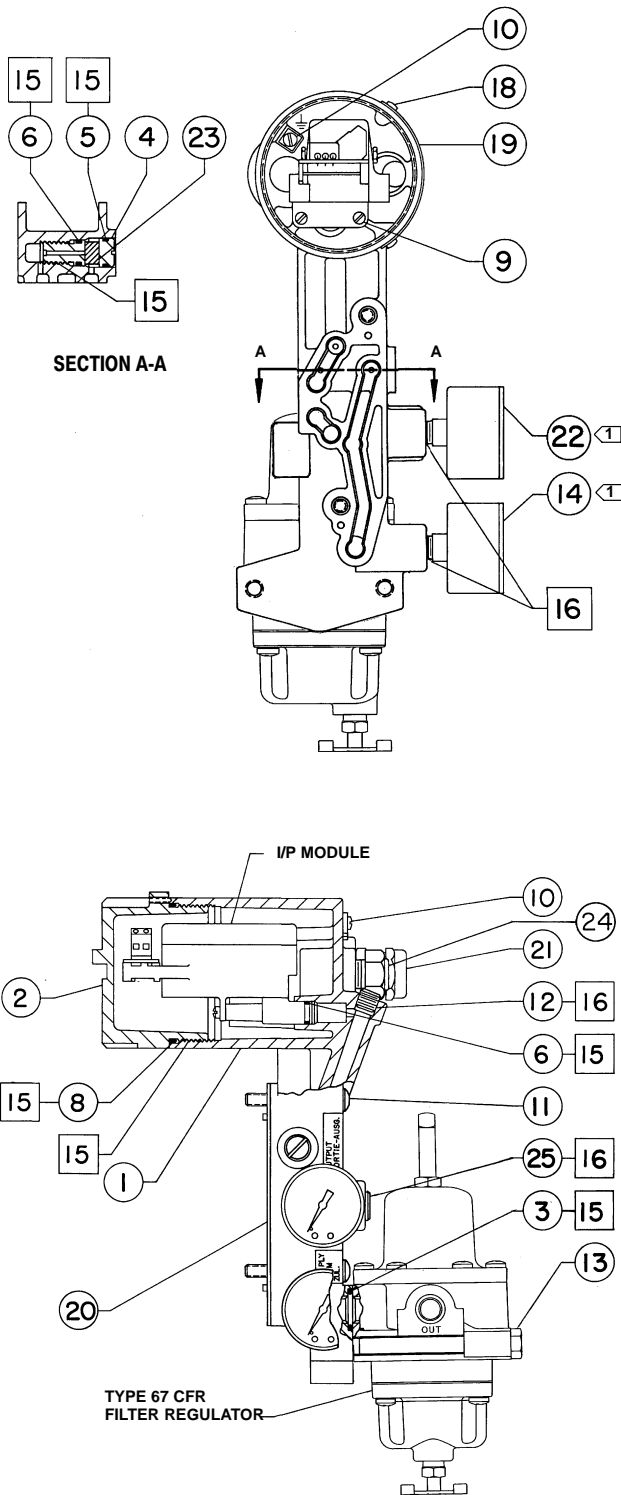


Figure 26. 3582 and 3583 Series Block Assemblies without Bypass



□ APPLY LUB/SEALANT

**NOTE:**

① GAUGES MAY BE REPLACED BY PIPE PLUGS (KEY 12) OR TIRE VALVES (KEY 7).

31B5995-G/DOC

Figure 27. Type 582i Converter

Key	Description	Part Number
3*	O-Ring, nitrile, used with integrally-mounted Type 67CFR filter regulator	1E5914 06992
4	Nozzle Restriction Assembly, Aluminum/Brass/SST	13B7116 X022
5*	O-Ring, Nitrile	1P4207 06992
6*	O-Ring, Nitrile (2 req'd)	1C8538 X0022
7	Tire Valve (not shown) (2 req'd w/tire valve option)	1N9088 99012
8*	O-Ring, Nitrile	1H8762 X0012
9	Machine Screw, 304 SST (2 req'd)	1A9021 X0012
10	Wire Retaining Screw (2 req'd)	16A2821 X012
11	Machine Screw, SST (2 req'd)	12B0909 X012
12	Pipe Plug, steel (2 req'd w/pipe plug option)	1E8231 28982
13	Screw, pl steel, used with integrally-mounted Type 67CFR filter/regulator (2 req'd)	T14109 T0012
14*	Supply Gauge, Dual Scale 0-30 psig/0-2 kg/cm <sup>2</sup> 0-60 psig/0-4 kg/cm <sup>2</sup>	11B4040 X042 11B4040 X052
14*	Supply Gauge, Triple Scale 0-30 psig/0-0.2 MPa/0-2 bar 0-60 psig/0-0.4 MPa/0-4 bar	11B4040 X012 11B4040 X022
15	Lubricant, Lubriplate MAG-1 (not furnished with positioner)	
16	Anti-seize compound, Zink Plate No. 770 (not furnished with positioner)	
18	Self-Tapping Screw, SST (2 req'd)	1P4269 28982
19	Nameplate, SST, without 3rd party approvals	11B5625 X0A2
20*	Case Gasket, cork	1U9078 04132
21	Cable Gland, plastic, for use with M20 housing	12B0908 F022
22*	Output Gauge, Dual Scale 0-30 psig/0-2 kg/cm <sup>2</sup> 0-60 psig/0-4 kg/cm <sup>2</sup>	11B4040 X042 11B4040 X052
22*	Output Gauge, Triple Scale 0-30 psig/0-0.2 MPa/0-2 bar 0-60 psig/0-0.4 MPa/0-4 bar	11B4040 X012 11B4040 X022
23*	Filter	11B5996 X012
24	Vent Assembly	11B8279 X012
25	Pipe Plug (required when a Type 582i is used without an integrally-mounted Type 67CFR filter/regulator)	Steel 1C3335 28992 SST 1C3335 X0012

### Mounting Parts

#### For Mounting 3582, 3582i, or 3583 Only (figure 3)

**Note**

Part 48 also shown in figure 28.

48	Connector Arm, pl steel <b>Type 478</b> (Type 3583 only) Size 40 Sizes 46 & 60 <b>Type 513</b> Size 20 Size 32	30A4897 X012 3V4796 25212 2V6722 25212 2U9099 25212
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\*Recommended spare parts



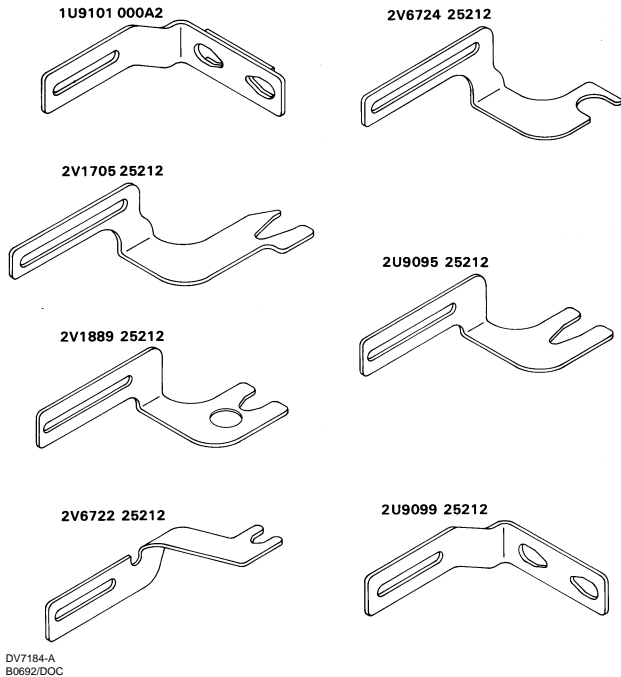


Figure 28. Connector Arm (Key 48)

Key	Description	Part Number
49	Washer, pl steel (cont'd)	
	<b>Type 513</b>	
	Size 20	---
	6.4 mm (1/4 inch) stem (none req'd)	---
	7.9 mm (5/16 inch) stem (1 req'd)	1B8659 28982
	9.5 mm (3/8 inch) stem (1 req'd)	1E7941 28992
	Size 32 (2 req'd)	1D7162 28982
	<b>Type 650</b> (2 req'd)	
	Size 30	1B8659 28982
	Size 40	1K8995 25072
	Size 60	1P5057 25072
	<b>Type 656</b>	
	Sizes 30, 40, & 60	
	12.7 mm (1/2 inch) stem (1 req'd)	1K8995 25072
	19.1 mm (3/4 inch) stem (none req'd)	---
	<b>Type 657</b>	
	W/o side-mtd. h'wheel	
	Sizes 30, 34, & 40 (2 req'd)	1D7162 28982
	Size 45 thru 70, & 100 (2 req'd)	1H7231 25072
	Sizes 80 & 87 (2 req'd)	1K8995 25072
	W/side-mtd. h'wheel	
	Size 34 thru 60 (none req'd)	---
	Size 70 (2 req'd)	
	up to 76 mm (3-inch) travel	1K8995 25072
	78 to 102 mm (3-1/16 to 4-inch) travel	1H7231 25072
	Sizes 80 & 87 (2 req'd)	1K8995 25072
	Size 100 (2 req'd)	1H7231 25072
	<b>Type 657-4</b> (2 req'd)	
	W/o side-mtd. h'wheel	
	Size 70	1H7231 25072
	W/side-mtd. h'wheel	
	Size 70	1H7231 25072
	Size 87	1K8995 25072
	<b>Type 657-8</b>	
	Sizes 30 & 34 (2 req'd)	1K8995 25072
	Sizes 40 thru 70 (none req'd)	---
	<b>Type 667</b>	
	W/o side-mtd. h'wheel	
	Sizes 30, 34, & 40 (2 req'd)	1D7162 28982
	Size 45 thru 70, & 100 (2 req'd)	1H7231 25072
	Size 80 (2 req'd)	1K8995 25072
	Size 87	
	up to 51 mm (2-inch) travel	1K8995 25072
	52 to 76 mm (2-1/16 to 3-inch) travel	1H7231 25072
	78 to 102 mm (3-1/16 to 4-inch) travel	1K8995 25072
	W/side-mtd. h'wheel	
	Size 34 thru 60 (none req'd)	---
	Size 70 (2 req'd)	
	up to 76 mm (3 inch) travel	1K8995 25072
	78 to 102 mm (3-1/16 to 4-inch) travel	1H7231 25072
	Size 80 & 87 (2 req'd)	1K8995 25072
	Size 100 (2 req'd)	1H7231 25072
	<b>Type 657NS or 667NS</b>	
	Size 40 (2 req'd)	1B8659 28982
	Size 45 (2 req'd)	1H7231 25072
	Size 70 (none req'd)	---
	Size 80 (none req'd)	---
	<b>Type 667-4</b> (2 req'd)	
	W/ or w/o side-mtd h'wheel	
	Size 70	1H7231 25072
	Size 87	1K8995 25072
	<b>Type 1250 or 1250R</b> (1 req'd)	10B6609 X012
48	Connector Arm, pl steel (cont'd)	
	<b>Type 650</b>	
	Size 30	20A5177 X012
	Size 40	10A4870 X012
	Size 60	10A4871 X012
	<b>Type 656</b>	
	Sizes 30, 40, & 60	2V1705 25212
	<b>Types 657 or 667</b>	
	W/o side-mtd. h'wheel	
	Sizes 30 & 34	1U9101 000A2
	Sizes 40 thru 100	2U9099 25212
	W/side-mtd. h'wheel	
	Size 34	2V1889 25212
	Sizes 40, 50, & 60	2U9095 25212
	Size 45 & 46	2V1705 25212
	Sizes 70 thru 100	2U9099 25212
	<b>Type 657NS or 667NS</b>	
	Size 40	25A8816 X012
	Size 45	26A9366 X012
	Size 70	25A8824 X012
	Size 80	25A8822 X012
	<b>Type 657-4, 667-4</b>	2U9099 25212
	<b>Type 657-8</b>	
	Sizes 30 & 34	2V1889 25212
	Sizes 40 thru 70	2V6724 25212
	<b>Type 1250 or 1250R</b>	
	Sizes 225 & 450	39A7853 X012
	Size 675	30B7285 X012
	For Competitor's Actuators	
	3/8 to 3/4 stem	2U9095 25212

Key	Description	Part Number	Key	Description	Part Number
50	Spacer, steel		50	Spacer, steel (cont'd)	
	<b>Type 478</b> (none req'd)	---		Size 100 (2 req'd)	
	<b>Type 513</b>			up to 64 mm (2-1/2 inch) travel	1J8307 24092
	Size 20 (none req'd)	---		65 to 102 mm (2-9/16 to 4-inch) travel	1C5590 24092
	Size 32 (2 req'd)	1J8307 24092		W/side-mtd. h'wheel	
	<b>Type 650</b> (2 req'd)			Size 34 (2 req'd)	1J8307 24092
	Sizes 30 & 60	1J8307 24092		Sizes 40, 50, & 60 (none req'd)	---
	Size 40	1C5590 24092		Size 45 & 46 (2 req'd)	1V1026 24092
	<b>Type 656</b> (2 req'd)			Sizes 70 & 87	1R8019 24092
	Sizes 30, 40, & 60	1L2006 24092		Size 80	
	<b>Type 657</b>			up to 51 mm (2-inch) travel (none req'd)	---
	W/o side-mtd. h'wheel			over 51 mm (2-inch) travel (2 req'd)	1J8307 24092
	Size 30 thru 60 (none req'd)	---		Size 100	
	Size 70			up to 64 mm (2-1/2 inch) travel	1J8307 24092
	up to 51 mm (2-inch) travel (2 req'd)	1J8307 24092		65 to 102 mm (2-9/16 to 4-inch) travel	1C5590 24092
	52 to 76 mm (2-1/16 to 3-inch) travel			<b>Type 657NS or 667NS</b>	
	(none req'd)	---		All except size 80 (3 req'd)	1N8229 24092
	78 to 102 mm (3-1/16 to 4-inch) travel			Size 80 (none req'd)	---
	(2 req'd)	1C5590 24092		<b>Type 667-4</b>	
	Size 80			W/ or w/o side-mtd h'wheel	
	up to 51 mm (2-inch) travel (none req'd)	---		Sizes 70 & 87	1R8019 24092
	over 51 mm (2-inch) travel (2 req'd)	1J8307 24092		<b>Type 1250 or 1250R</b> (none req'd)	---
	Size 87 (2 req'd)		52	Pipe Plug, 316 SST	1A6495 38992
	up to 76 mm (3-inch) travel	1J8307 24092	54	Elbow, 3/8 inch, brass (specify quantity)	15A6002 X162
	78 to 102 mm (3-1/16 to 4-inch) travel	1C5590 24092	55	Connector, 3/8 inch brass (not shown)	
	Size 100 (2 req'd)			(specify quantity)	15A6002 X202
	up to 64 mm (2-1/2 inch) travel	1J8307 24092	56	Cap Screw, pl steel (2 req'd)	
	65 to 102 mm (2-9/16 to 4-inch) travel	1C5590 24092		<b>Type 657NS or 667NS</b>	
	W/side-mtd. h'wheel			Sizes 40, 45, & 70	1C1970 24052
	Sizes 34, 50, & 60 (2 req'd)	1J8307 24092		All other types	T14109 T0012
	Size 40 (none req'd)	---	57	Hex Nut	
	Size 45 & 46 (2 req'd)	1V1026 24092		<b>Type 657NS or 667NS</b>	
	Sizes 70 & 87 (2 req'd)	1R8019 24092		Size 80 (none req'd)	---
	Size 80			All other types and sizes (2 req'd)	1A3527 24122
	up to 51 mm (2-inch) travel (none req'd)	---	58	Lockwasher	
	over 51 mm (2-inch) travel (2 req'd)	1J8307 24092		<b>Type 657NS or 667NS</b>	
	Size 100 (2 req'd)			Size 80 (none req'd)	---
	up to 64 mm (2-1/2 inch) travel	1J8307 24092		All other types and sizes (2 req'd)	1C2257 28982
	65 to 102 mm (2-9/16 to 4-inch) travel	1C5590 24092	59	Pin Lock, SST	
	<b>Type 657-4</b> (2 req'd)			<b>Type 650</b> , Sizes 30, 40, & 60 (none req'd)	---
	W/o side-mtd. h'wheel			All other types	1U9098 35032
	Size 70	1C5590 24092	60	Travel Pin, SST	
	W/side-mtd. h'wheel			<b>Type 650</b> , Sizes 30, 40, & 60 (none req'd)	---
	Size 70 & 87	1R8019 24092		<b>Type 657-8</b>	
	<b>Type 657-8</b> (2 req'd)			Size 30 & 34	1U9096 46332
	Sizes 30, 34, 47, & 70	1C5590 24092		Sizes 40 thru 70	10A2167 X012
	Size 40	1N9524 24092		<b>Type 657NS or 667NS</b>	
	Sizes 46 & 60	1R8019 24092		Size 80	15A8823 X012
	<b>Type 667</b>			All other types	1U9096 46332
	W/o side-mtd. h'wheel		61	Pin Holder, SST	
	Sizes 30 thru 60 (none req'd)	---		<b>Type 650</b> , Sizes 30, 40, & 60 (none req'd)	---
	Size 70			All other types	1U9097 35032
	up to 51 mm (2-inch) travel (none req'd)	---	62	Cap Nut, SST	
	52 to 76 mm (2-1/16 to 3-inch) travel			<b>Type 650</b> , Sizes 30, 40, & 60 (none req'd)	---
	(2 req'd)	1J8307 24092		All other types	1U9102 35032
	78 to 102 mm (3-1/16 to 4-inch) travel		63	Mounting Plate, steel	
	(2 req'd)	1R8019 24092		<b>Type 650</b> , Sizes 30, 40, & 60	31B8553 X012
	Size 80		63	Mounting Plate, steel (cont'd)	
	up to 51 mm (2-inch) travel (none req'd)	---		<b>Type 1250 &amp; 1250R</b>	39A7852 X012
	over 51 mm (2-inch) travel (2 req'd)	1J8307 24092		All other types	
	Size 87 (2 req'd)			For integrally mounted Type 67CFR	31B5993 X012
	up to 76 mm (3-inch) travel	1J8307 24092		For separately mounted Type 67CFR	37B1933 X012
	78 to 102 mm (3-1/16 to 4-inch) travel	1R8019 24092			

# Instruction Manual

Form 5054  
June 2002

# 3582 and 3583 Series

Key	Description	Part Number	Key	Description	Part Number
64	Cap Screw, pl steel <b>Types 1250 and 1250R</b> (3 req'd) All other types (5 req'd)	1A3816 24052 1A3816 24052	65	Cap Screw, pl steel (cont'd) Size 70 up to 76 mm (3-inch) travel (none req'd) 78 to 102 mm (3-1/6 to 4-inch) travel (2 req'd)	--- 1B3664 24052
65	Cap Screw, pl steel <b>Type 478</b> (none req'd) <b>Type 513</b> Size 20 (none req'd) Size 32 (2 req'd) <b>Type 650</b> , Sizes 30, 40, & 60 (none req'd) <b>Type 656</b> (none req'd) <b>Type 657</b> W/o side-mtd. h'wheel Sizes 30, 34, & 40 (2 req'd) Sizes 45 thru 60 (none req'd) Size 70 (2 req'd) up to 51 mm (2-inch) travel 52 to 102 mm (2-1/16 to 4-inch) travel Size 80 up to 51 mm (2-inch) travel (none req'd) over 51 mm (2-inch) travel (2 req'd) Size 87 up to 51 mm (2-inch) travel (2 req'd) 52 to 102 mm (2-1/16 to 4-inch) travel (none req'd) Size 100 (2 req'd) up to 64 mm (2-1/2 inch) travel 65 to 102 mm (2-9/16 to 4-inch) travel W/side-mtd. h'wheel Sizes 34 thru 60 (none required) Size 70 up to 76 mm (3-inch) travel (none req'd) 78 to 102 mm (3-1/16 to 4-inch) travel (2 req'd) Size 80 up to 51 mm (2-inch) travel (none req'd) over 51 mm (2-inch) travel (2 req'd) Size 87 up to 76 mm (3-inch) travel (none req'd) 78 to 102 mm (3-1/16 to 4-inch) travel (2 req'd) Size 100 (2 req'd) up to 64 mm (2-1/2 inch) travel 65 to 102 mm (2-9/16 to 4-inch) travel <b>Type 657-4</b> (2 req'd) W/o side-mtd. h'wheel Size 70 W/ side-mtd. h'wheel Size 70 Size 87 <b>Type 657-8</b> (none req'd) <b>Type 667</b> W/o side-mtd. h'wheel Sizes 30, 34, & 40 (2 req'd) Sizes 45 thru 70, & 87 (none req'd) Size 80 up to 51 mm (2-inch) travel (none req'd) over 51 mm (2-inch) travel (2 req'd) Size 100 (2 req'd) Up to 64 mm (2-1/2 inch) travel 65 to 102 mm (2-9/16 to 4-inch) travel W/side-mtd. h'wheel Sizes 34 thru 60 (none required)	--- --- 1B7624 24052 --- --- 1A3525 24052 --- 1A3751 24052 1A9145 24052 --- --- 1U6256 31192 1A9503 24052 1C3979 24052 1A6430 24052 --- --- 1B3664 24052 --- 1U6256 31192 --- 1A9503 24052 1C3979 24052 1A6430 24052 1A9145 24052 1B3664 24052 1A9503 24052 --- 1A3525 24052 --- --- 1C3979 24052 1A6430 24052 ---	65	Size 80 up to 51 mm (2-inch) travel (none req'd) over 51 mm (2-inch) travel (2 req'd) Size 87 up to 76 mm (3-inch) travel (none req'd) 78 to 102 mm (3-1/6 to 4-inch) travel (2 req'd) Size 100 (2 req'd) up to 64 mm (2-1/2 inch) travel 65 to 102 mm (2-9/16 to 4-inch) travel <b>Type 657NS or 667NS</b> Size 40 (2 req'd) Size 45, 70, & 80 (none req'd) <b>Type 667-4</b> W/o side-mtd. h'wheel Size 70 & 87 (none req'd) W/ side-mtd. h'wheel Size 70 (2 req'd) Size 87 (2 req'd) <b>Type 1250 or 1250R</b> (2 req'd) 66 Actuator Rod, pl steel (not shown) <b>Type 650</b> Size 30 Size 40 Size 60 All other types (none req'd) 67 Hex Nut, pl steel (not shown) <b>Type 650</b> Size 30 (2 req'd) Size 40 & 60 (none req'd) All other types (none req'd) 68 Anti-Torque Rod, steel (not shown) <b>Type 478</b> (Type 3583 only) Sizes 40, 46, & 60 All other types (none req'd) 69 Damper Control Swivel (not shown) <b>Type 650</b> Size 30, 40, & 60 (2 req'd) All other types (none req'd) 70 Cap Screw, pl steel (2 req'd) <b>Type 478</b> (Type 3583 only) Sizes 40, 46, & 60 (2 req'd) <b>Type 513</b> Sizes 20 & 32 (2 req'd) <b>Type 650</b> Sizes 30, 40, & 60 (2 req'd) <b>Type 656</b> Sizes 30, 40, & 60 (2 req'd) <b>Type 657</b> W/o side-mtd. h'wheel Sizes 30 thru 60 Size 70 Up to 51 mm (2-inch) travel 52 to 76 mm (2-1/16 to 3-inch) travel 78 to 102 mm (3-1/16 to 4-inch) travel Size 80 up to 51 mm (2-inch) travel over 51 mm (2-inch) travel	--- --- 1U6256 31192 1A9503 24052 1C3979 24052 1A6430 24052 1U7648 35532 --- --- 1B3664 24052 1A9503 24052 10B6605 X012 10A5176 X012 10A4872 X012 10A4873 X012 --- 1A9463 24122 --- --- 1V4738 24092 --- 10A4874 X012 --- 1A3816 24052 1A3816 24052 1A3525 24052 1P7937 X0012 1A3816 24052 1A3525 24052 1A3816 24052 1A5534 24052 1A3816 24052 1A3525 24052

# 3582 and 3583 Series

Key	Description	Part Number	Key	Description	Part Number
70	Cap Screw, pl steel (2 req'd) (cont'd)		86	Mounting Bracket (657NS and 667NS only)	
	Size 87			<b>Type 657NS</b>	
	up to 76 mm (3-inch) travel	1A3525 24052		Size 45	45A8814 X012
	78 to 102 mm (3-1/16 to 4-inch) travel	1A5534 24052		<b>Type 667NS</b>	
	Size 100			Size 45	45A8815 X012
	up to 64 mm (2-1/2 inch) travel	1A3525 24052		<b>Type 657NS or 667NS</b>	
	65 to 102 mm (2-9/16 to 4-inch) travel	1B7624 24052		Size 40	45A8814 X012
	W/side-mtd. h'wheel			Size 70	45A8817 X012
	Sizes 34, 50, & 60	1A3525 24052		Size 80	35A8821 X012
	Size 40	1A3816 24052	97	Spacer, steel	
	Size 45 & 46	1C8702 24052		<b>Type 657 or 667</b>	
	Sizes 70 & 87	1B9896 24052		W/ side-mtd. h'wheel	
	Size 80			Sizes 70 & 87	
	up to 51 mm (2-inch) travel	1A3816 24052		up to 51 mm (2-inch) travel (2 req'd)	1R4093 24092
	over 51 mm (2-inch) travel	1A3525 24052		52 to 76 mm (2-1/16 to 3-inch) travel	
	Size 100			(2 req'd)	1R4095 24092
	up to 64 mm (2-1/2 inch) travel	1A3525 24052		78 to 102 mm (3-1/16 to 4-inch) travel	
	65 to 102 mm (2-9/16 to 4-inch) travel	1B7624 24052		(none req'd)	---
	<b>Type 657-4</b>			W/ or W/o side-mtd. h'wheel	
	W/o side-mtd. h'wheel			Size 80	
	Size 70	1A5534 24052		up to 51mm (2-inch) travel (2 req'd)	1R4096 24092
	W/side-mtd. h'wheel			over 51 mm (2-inch) travel (none req'd)	---
	Sizes 70 & 87	1B9896 24052		All other types and sizes (none req'd)	---
	<b>Type 657-8</b>		98	Stud, continuous thread, steel (2 req'd)	
	Sizes 30, 34, 47, & 70	1A5534 24052		<b>Type 657 or 667</b>	
	Size 40	1C1970 24052		W/ side-mtd. h'wheel	
	Sizes 46 & 60	1B9896 24052		Sizes 70 & 87	
	<b>Type 667</b>			up to 76 mm (3-inch) travel (2 req'd)	1R1661 31012
	W/o side-mtd. h'wheel			78 to 102 mm (3-1/16 to 4-inch) travel	
	Sizes 30 thru 60	1A3816 24052		(none req'd)	---
	Size 70			W/ or W/o side-mtd. h'wheel	
	Up to 51 mm (2-inch) travel	1A3816 24052		Size 80	
	52 to 76 mm (2-1/16 to 3-inch) travel	1A3525 24052		up to 51 mm (2-inch) travel	1R1661 31012
	78 to 102 mm (3-1/16 to 4-inch) travel	1B9896 24052		over 51 mm (2-inch) travel (none req'd)	---
	Size 80			All other types and sizes (none req'd)	---
	up to 51 mm (2-inch) travel	1A3816 24052			
	over 51 mm (2-inch) travel	1A3525 24052	99	Hex Nut, pl steel	
	Size 87			<b>Type 657 or 667</b>	
	Up to 76 mm (3-inch) travel	1A3525 24052		W/ side-mtd. h'wheel	
	78 to 102 mm (3-1/16 to 4-inch) travel	1B9896 24052		Sizes 70 & 87	
	Size 100			up to 76 mm (3-inch) travel (2 req'd)	1A3412 24112
	up to 64 mm (2-1/2 inch) travel	1A3525 24052		78 to 102 mm (3-1/16 to 4-inch) travel	
	65 to 102 mm (2-9/16 to 4-inch) travel	1B7624 24052		(none req'd)	---
	W/side-mtd. h'wheel			W/ or W/o side-mtd. h'wheel	
	Size 34	1A3525 24052		Size 80	
	Sizes 40, 50, 60	1A3816 24052		up to 51 mm (2-inch) travel (2 req'd)	1A3412 24112
	Size 45 & 46	1C8702 24052		over 51 mm (2-inch) travel (none req'd)	---
	Size 70 & 87	1B9896 24052		All other types and sizes (none req'd)	---
	Size 80		102	Spacer, steel	
	up to 51 mm (2-inch) travel	1A3816 24052		<b>Type 657</b>	
	over 51 mm (2-inch) travel	1A3525 24052		W/o side-mtd h'wheel	
	Size 100			Size 34 to 60 (none req'd)	---
	up to 64 mm (2-1/2 inch) travel	1A3525 24052		Size 70	
	65 to 102 mm (2-9/16 to 4-inch) travel	1B7624 24052		up to 51 mm (2-inch) travel (2 req'd)	1U8307 24092
	<b>Type 657NS or 667NS</b>			52 to 102 mm (2-1/16 to 4-inch) travel	
	Sizes 40, 45, & 70 (3 req'd)	1A3525 24052		(none req'd)	---
	Size 80 (3 req'd)	1A3816 24052		Size 87	
	<b>Type 667-4</b>			up to 51 mm (2-inch) travel (2 req'd)	1R762324092
	Sizes 70 & 87	1B9896 24052		52 to 102 mm (2-1/16 to 4-inch) travel	
	For Competitor's Actuators			(none req'd)	---
	3/8 to 3/4-inch stem	1A3816 24052		<b>Type 667</b>	
	<b>Type 1250 or 1250R</b> (none req'd)	---		W/o side-mtd h'wheel	
				Size 34 thru 70 & 87 (none req'd)	---

# Instruction Manual

Form 5054  
June 2002

# 3582 and 3583 Series

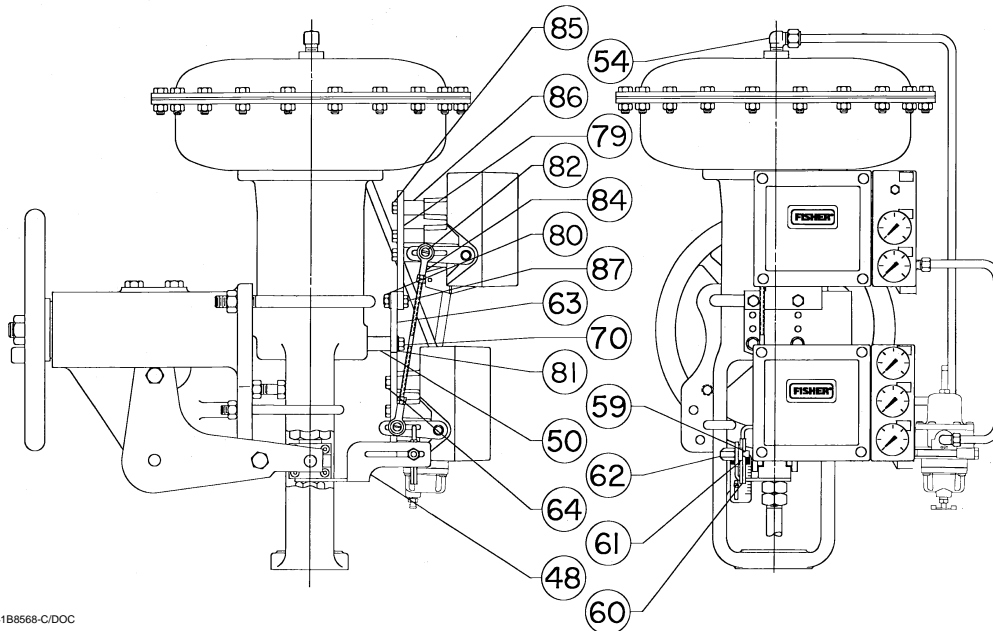
Key	Description	Part Number	Key	Description	Part Number
102	Spacer, steel (cont'd)		50	Spacer, steel	
	<b>Type 657 or 667</b>			<b>Type 657</b>	
	W/ side-mtd. h'wheel			Size 70 & 87	
	Size 34 thru 60 (none req'd)	---		up to 76 mm (3-inch) travel (none req'd)	---
	Size 70 & 87			77 to 102 mm (3-1/16 to 4-inch) travel	
	up to 76 mm (3-inch) travel (2 req'd)	1V6833 24092		(4 req'd)	1C5590 24092
	Size 70			<b>Type 667</b>	
	78 to 102 mm (3-1/16 to 4-inch) travel			Size 70 & 87	
	(4 req'd)	1R7370 24092		up to 51 mm (2-inch) travel (none req'd)	---
	Size 87			52 to 76 mm (2-1/16 to 3-inch) travel	
	78 to 102 mm (3-1/16 to 4-inch) travel,			(4 req'd)	1J8307 24092
	(2 req'd)	1R4096 24092		77 to 102 mm (3-1/16 to 4-inch) travel	
	W/ or W/o side-mtd. h'wheel			(4 req'd)	1V1026 24092
	Size 80 (2 req'd)	1V6833 24092		<b>Type 657 or 667</b>	
	Size 100			Sizes 30 thru 60, & 80 (none req'd)	---
	up to 64 mm (2-1/2 inch) travel (4 req'd)	10A2567 X012		Size 100 (4 req'd)	
	65 mm to 102 mm (2-9/16 to 4-inch) travel			up to 64 mm (2-1/2 inch) travel	1J8307 24092
	(2 req'd)	10A5252 X012		65 to 102 mm (2-9/16 to 4-inch) travel	1C5590 24092
	<b>Types 657-4 or 667-4</b>		59	Pin Lock, SST, all sizes (2 req'd)	1U9098 35032
	W/o side-mtd h'wheel		60	Travel Pin, SST, all sizes (2 req'd)	1U9096 46332
	Size 70 (none req'd)	---	61	Pin Holder, SST, all sizes (2 req'd)	1U9097 35032
	W/ side-mtd. h'wheel		62	Cap Nut, SST, all sizes (2 req'd)	1U9102 35032
	Size 70 (4 req'd)	1R7370 24092	63	Mounting Plate, steel, all sizes (2 req'd)	
	Size 87 (2 req'd)	1R4096 24092		For integrally mounted Type 67CFR	31B5993 X012
	All other types (none req'd)	---		For separately mounted Type 67CFR	37B1933 X012
			64	Cap Screw, pl steel, all sizes (8 req'd)	1A3816 24052
			65	Cap Screw, pl steel	
				Size 30 thru 87 (none req'd)	---
				Size 100 (4 req'd)	
				up to 64 mm (2-1/2 inch) travel	1C3979 24052
				65 to 102 mm (2-9/16 to 4-inch) travel	1A6430 24052
			70	Cap Screw, pl steel (4 req'd)	
				<b>Type 657</b>	
				Size 70 & 87	
				Up to 76 mm (3-inch) travel	1A3816 24052
				78 to 102 mm (3-1/16 to 4-inch) travel	1A5534 24052
				<b>Type 667</b>	
				Size 70 & 87	
				Up to 51 mm (2-inch) travel	1A3816 24052
				52 to 76 mm (2-1/16 to 3-inch) travel	1A3525 24052
				77 to 102 mm (3-1/16 to 4-inch) travel	1D7704 24052
				<b>Type 657 or 667</b>	
				Sizes 30 thru 60, & 80	1A3816 24052
				Size 100	
				up to 64 mm (2-1/2 inch) travel	1A3525 24052
				65 to 102 mm (2-9/16 to 4-inch) travel	1B7624 24052
			71	Stud, continuous thread, steel (not shown) (2 req'd)	
				<b>Type 657</b>	
				Size 70	12A1492 X012
				Size 87	
				Up to 51 mm (2-inch) travel	1R1661 31012
				52 to 102 mm (2-1/16 to 4-inch) travel	1A5190 X0012
				<b>Type 667</b>	
				Size 70	
				Up to 76 mm (3-inch) travel	1V6023 X0012
				77 to 102 mm (3-1/16 to 4-inch) travel	12A1492 X012
				Size 87	
				Up to 76 mm (3-inch) travel	1A5190 X0012
				77 to 102 mm (3-1/16 to 4-inch) travel	1R1661 31012
				<b>Type 657 or 667</b>	
				Sizes 30, 34, & 40	12A1491 X012
				Sizes 45 thru 60	12A1493 X012
				Size 80	1U4216 31012
				Size 100 (none req'd)	---

## For Mounting 3582, 3582i, and 3583 on Type 657 or 667 Actuator without Side-Mounted Handwheel

### Note

The following parts (key numbers 48 through 102) are used when mounting both a 3582 Series positioner and a 3583 Series transmitter on a Type 657 or 667 actuator without a side-mounted handwheel.

48	Connector Arm, pl steel (2 req'd)	
	Sizes 30 & 34	1U9101 000A2
	Sizes 40 thru 100	2U9099 25212
49	Washer, pl steel (4 req'd)	
	<b>Type 657</b>	
	Size 70	
	up to 51 mm (2-inch) travel	1D7162 28982
	52 mm to 76 mm (2-1/16 to 3-inch) travel	1H7231 25072
	77 to 102 mm (3-1/16 to 4-inch) travel	1D7162 28982
	Size 87	1K8995 25072
	<b>Type 667</b>	
	Size 70, all travels	1D7162 28982
	Size 87	
	up to 76 mm (3-inch) travel	1K8995 25072
	77 to 102 mm (3-1/16 to 4-inch) travel	1D7162 28982
	<b>Type 657 or 667</b>	
	Sizes 30 thru 40	1D7162 28982
	Sizes 45 thru 60	1H7231 25072
	Size 80	1K8995 25072
	Size 100	
	up to 64 mm (2-1/2 inch) travel	1H7231 25072
	65 to 102 mm (2-9/16 to 4-inch) travel	1D7162 28982



41B8568-C/DOC

Figure 29. Typical Application of Transmitter and Positioner

Key	Description	Part Number	Key	Description	Part Number
72	Hex Nut, pl steel (not shown) (4 req'd) <b>Type 657 or 667</b> Sizes 30, 34, & 40 Sizes 45 thru 60 Size 70 Size 80 & 87 Size 100 (none req'd)	1E9440 24112 1A3753 24122 1A3753 24122 1A3412 24122 ---			
102	Spacer <b>Type 657</b> Size 70 Up to 51 mm (2-inch) travel (4 req'd) 52 to 102 mm (2-1/16 to 4-inch) travel (none req'd) Size 87 Up to 51 mm (2-inch) travel 52 to 102 mm (2-1/16 to 4-inch) travel (none req'd) <b>Type 667</b> Size 70 Up to 76 mm (3-inch) travel (none req'd) 77 to 102 mm (3-1/16 to 4-inch) travel (4 req'd) Size 87 Up to 76 mm (3-inch) travel (none req'd) 77 to 102 mm (3-1/16 to 4-inch) travel (4 req'd) <b>Type 657 or 667</b> Sizes 30 thru 60 (none req'd) Size 80 (4 req'd) Size 100 up to 64 mm (2-1/2 inch) travel (8 req'd) 65 to 102 mm (2-9/16 to 4-inch) travel (4 req'd)	1U4371 24092 --- 1R7623 24092 --- 1U4371 24092 --- 1R7623 24092 --- 1V6833 24092 10A2567 X012 10A5252 X012			
			48	Connector Arm, pl steel	2V1705 25212
			50	Spacer, steel (2 req'd)	1V1026 24092
			54	Elbow, 3/8 inch, brass	15A6002 X162
			55	Connector, 3/8 inch brass (not shown)	15A6002 X202
			59	Pin Lock, SST (2 req'd)	1U9098 35032
			60	Travel Pin, SST (2 req'd)	10A2167 X012
			61	Pin Holder, SST (2 req'd)	1U9097 35032
			62	Cap Nut, SST (2 req'd)	1U9102 35032
			63	Mounting Plate, steel (2 req'd) For integrally mounted Type 67CFR For separately mounted Type 67CFR	31B5993 X012 37B1933 X012
			64	Cap Screw, pl steel (8 req'd)	1A3816 24052
			70	Cap Screw, pl steel (2 req'd)	1C8702 24052
			79	Mounting Plate, steel	22A6848 X012
			80	Hex Nut, pl steel, for <b>Type 667</b> only (2 req'd)	1A3527 24122
			81	Lockwasher, pl steel <b>Type 657</b> (2 req'd) <b>Type 667</b> (4 req'd)	1C2257 28982 1C2257 28982
			82	Machine Screw, pl steel (2 req'd)	1V4058 28982
			83	Elastic Stop Nut, pl steel (not shown) (2 req'd)	1J7192 28982
			84	Connecting Linkage, pl steel	1R6839 99012
			85	Cap Screw, pl steel, for <b>Type 667</b> only (5 req'd)	1A5534 24052
			86	Spacer, pl steel for <b>Type 667</b> only (5 req'd)	1C5590 24092
			87	Cap Screw, pl steel for <b>Type 667</b> only (2 req'd)	1A3526 24052

### For Mounting 3582, 3582i, and 3583 on Type 657 or 667 Actuator with Side-Mounted Handwheel

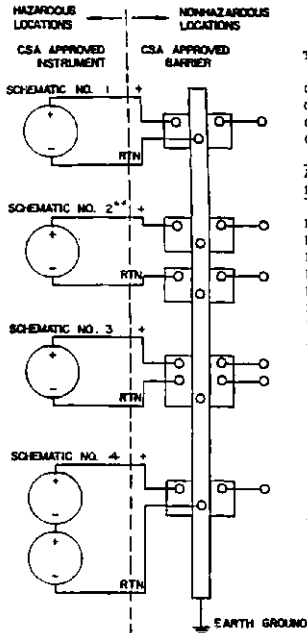
#### Note

The following parts (key numbers 48 through 87) are used when mounting both a 3582 Series positioner and a 3583 Series transmitter on a Type 657 or 667 Size 45 actuator with side-mounted handwheel.

## Loop Schematics

This section includes loop schematics required for wiring of intrinsically safe installations. If you have any questions, contact your Fisher Controls sales representative or sales office.

### CSA Loop Schematic



TYPE 3622, 582I, 3661 AND 646: CSA PARAMETRIC RATINGS\* (SCHEMATICS 1 AND 4)

CLASS I, GROUP A,B,C,D CSA RATING 30 V MAX, 330 OHM MIN, SINGLE INSTRUMENT  
 CLASS I, GROUP A,B,C,D CSA RATING 28 V MAX, 300 OHM MIN, SINGLE INSTRUMENT  
 CLASS I, GROUP A,B,C,D CSA RATING 22 V MAX, 150 OHM MIN, SINGLE INSTRUMENT  
 CLASS I, GROUP C,D CSA RATING 30 V MAX, 150 OHM MIN, SINGLE INSTRUMENT OR SPLIT RANGE

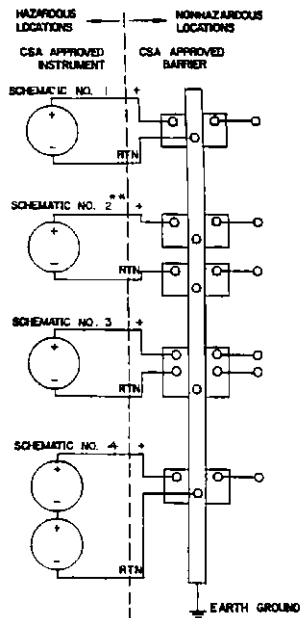
APPROVED BARRIER	BARRIER TYPE	MFG. INST. MANUAL	SCHEM NO.	APPLICABLE HAZARDOUS LOCATIONS	CSA BARRIER RATING
FOXBORO	2A0-V21-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-V31-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-V51-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2A0-V41-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	3A2-D21-CS-E/CGB-A	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	3A2-D31-CS-E/CGB-A	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
FOXBORO	2AS-131-CGB	MI 200-255	3	CL I, DIV 1, GP A,B,C,D	
STAHL	8903/31-200/050/7	89 036 01 31 0	2	CL I, DIV 1, GP A,B,C,D	20.41V, 300 OHM
STAHL	8901/33-293/000/7	89 016 03 31 0	2	CL I, DIV 1, GP C,D	28.1V, 470 OHM
STAHL	8901/31-280/165/8	89 016 03 31 0	2	CL I, DIV 1, GP C,D	27.3V, 179 OHM
STAHL	8901/33-293/000/7	89 016 03 31 0	2	CL I, DIV 1, GP C,D	28.1V, 470 OHM
STAHL	8901/31-199/100/7	89 016 03 31 0	1,4	CL I, DIV 1, GP A,B,C,D	19V, 220 OHM
STAHL	8903/31-200/050/7	89 036 01 31 0	1,4	CL I, DIV 1, GP A,B,C,D	19.95V, 286.7 OHM
STAHL	8903/31-263/050/7	89 036 01 31 0	1	CL I, DIV 1, GP A,B,C,D	26.5V, 386 OHM
BAILEY	766610AAAV1	4576K16-034	3	CL I, DIV 1, GP C,D	27V, 345 OHM/10V, 40 OHM

\* ALSO APPLICABLE FOR CLASS II, GROUPS E,F,G WITH APPROPRIATE INSTRUMENT AND BARRIER APPROVAL

\*\* SCHEMATIC 2 REQUIRES THAT BARRIERS MUST BE USED IN PAIRS AS LISTED

LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURER'S INSTRUCTIONS  
 SEE ANSI/ISA RP12.6 FOR GUIDANCE ON INSTALLATION

21B5606-B Sheet 1 of 2 / DOC



APPROVED BARRIER	BARRIER TYPE	MFG. INST. MANUAL	SCHEM NO.	APPLICABLE HAZARDOUS LOCATIONS	CSA BARRIER RATING
TAYLOR	5850FL84100	IB-21E600	1	CL I, DIV 1, GP A,B,C,D	25.75V, 350 OHM
TAYLOR	5851FL84100	IB-21E600	1	CL I, DIV 1, GP A,B,C,D	25.75V, 350 OHM
TAYLOR	1130PG21000	IB-17E211	1	CL I, DIV 1, GP C,D	30V, 206 OHM
TAYLOR	1135FG21000	IB-17E212	1	CL I, DIV 1, GP C,D	30V, 266 OHM
TAYLOR	1150FE21010	IB-17E220	1	CL I, DIV 1, GP A,B,C,D	26V, 342 OHM
METL	128+	PS-300-13	1	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM
METL	122+	PS-300-13	1	CL I, DIV 1, GP A,B,C,D	22V, 150 OHM
METL	187+	PS-300-13	3	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM/30V (DIODE)
METL	787+	PS-700-2	3	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM/28V (DIODE)
METL	728+	PS-700-2	1	CL I, DIV 1, GP A,B,C,D	28V, 300 OHM
METL	722+	PS-700-2	1	CL I, DIV 1, GP A,B,C,D	22V, 150 OHM
HONEYWELL	38545-0000-0110-113-C5D5	S 385-22	1	CL I, DIV 1, GP A,B,C,D	20V, 150 OHM
HONEYWELL	38545-0000-0110-111-C5D5	S 385-22	1	CL I, DIV 1, GP C,D	28V, 200 OHM
HONEYWELL	38545-0000-0110-111-C5D5	S 385-22	2	CL I, DIV 1, GP C,D	28V, 200 OHM
HONEYWELL	38545-0000-0110-112-C5D5	S 385-22	2	CL I, DIV 1, GP C,D	28V, 200 OHM

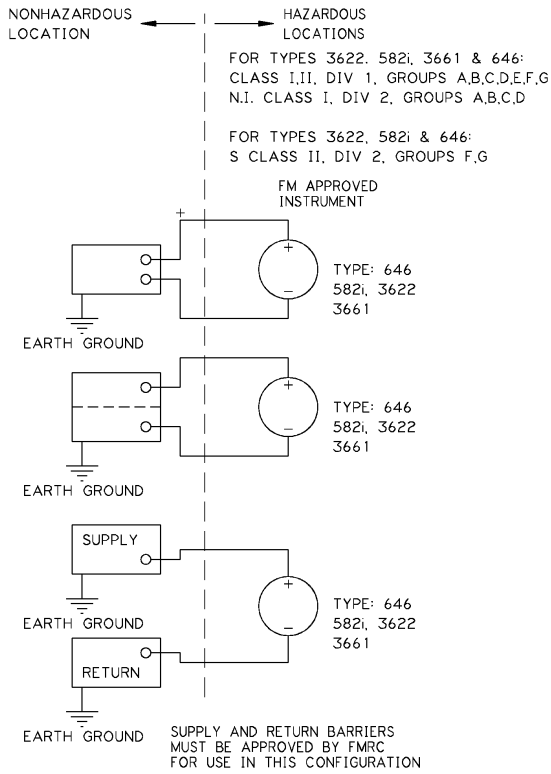
\* ALSO APPLICABLE FOR CLASS II, GROUPS E,F,G WITH APPROPRIATE INSTRUMENT AND BARRIER APPROVAL

\*\* SCHEMATIC 2 REQUIRES THAT BARRIERS MUST BE USED IN PAIRS AS LISTED

LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURER'S INSTRUCTIONS  
 SEE ANSI/ISA RP12.6 FOR GUIDANCE ON INSTALLATION

21B5606-B SHT 2 / DOC

### FM Loop Schematic



TYPE: 3622, 582i, 3661, 646 ENTITY PARAMETERS

$$V_{max} = 40V_{dc} \quad I_{max} = 200mA \quad C_i = 0 \quad L_i = 0$$

NOTES:

-LOOPS MUST BE CONNECTED ACCORDING TO THE BARRIER MANUFACTURERS INSTRUCTION

-SEE ANSI/ISA RP12.6 FOR GUIDANCE IN INSTALLATION

-BARRIER PARAMETERS MUST MEET THE FOLLOWING REQUIREMENTS:

$$V_{dc} \text{ OR } V_T \leq V_{max} \quad I_{sc} \text{ OR } I_T \leq I_{max} \quad C_o (\mu F) > 0.0 \quad L_o (mH) > 0.0$$

-THE  $C_o$  AND  $L_o$  PARAMETERS FOR THE BARRIER MUST BE GREATER THAN THE SUM OF THE CONNECTING CABLE PARAMETERS AND  $C_i$  AND  $L_i$  OF THE I.S. APPARATUS

-MAXIMUM SAFE AREA VOLTAGE SHOULD NOT EXCEED  $250 V_{rms}$

-RESISTANCE BETWEEN BARRIER GROUND AND EARTH GROUND MUST BE LESS THAN ONE OHM

-CL I, DIV 2 APPLICATIONS MUST BE INSTALLED AS SPECIFIED IN NEC SECTION 501-4 (b) WHEN BARRIERS ARE NOT USED

NORMAL OPERATING CONDITIONS 30 VDC, 20 mADC

21B5607-D / DOC



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PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 1		
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : SHUT DOWN VALVES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11	
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468	
								DATE	03/11/2005	
								REQ.		
				BY	CHK'D	APPR.				
G 1	TAG NO.	SDV-633		SDV-634		SDV-650		SDV-651		
E 2	SERVICE	DEETHANIZER REB BURNER		DEETHANIZER REB PILOT		GLYCOL REGEN BURNER		GLYCOL REGEN PILOT		
N 3	LINE NO. / VESSEL NO.	H-633		H-650		H-650		H-651		
E 4	LINE SIZE / SCHED. NO.	33MM SCH 80		21MM SCH 80		33MM SCH 80		21MM SCH 80		
5	TYPE OF BODY									
6	BODY SIZE	PORT SIZE	33 mm	mm	21 mm	mm	33 mm	mm	21 mm	mm
7	GUIDING	NO. OF PORTS	STD	ONE(1)	STD	ONE(1)	STD	ONE(1)	STD	ONE(1)
B 8	END CONN. & RATING	33 mm NPT		21 mm NPT		33 mm NPT		21 mm NPT		
O 9	BODY MATERIAL	A351-CF8M		A351-CF8M		WCB		WCB		
D 10	PACKING MATERIAL	STD		STD		STD		STD		
Y 11	LUBRICATOR	ISOLAT. VALVE								
12	BONNET TYPE	STD BONNET		STD BONNET		STD BONNET		STD BONNET		
13	TRIM FORM									
14	TRIM MATERIAL	SEAT / PLUG	SS/POLYCARBON SEATS		SS/POLYCARBON SEATS		SS/POLYCARBON SEATS		SS/POLYCARBON SEATS	
		SHAFT / MAT'L	SS		SS		SS		SS	
15	REQUIRED SEAT TIGHTNESS									
16	MAX. ALLOW SOUND LEV. dBA									
A 17	MODEL NO. & SIZE	VCI AP3-SR5		VCI AP2-SR5		VCI AP3-SR5		VCI AP2-SR5		
C 18	TYPE OF ACTUATOR	RACK & PINION		RACK & PINION		RACK & PINION		RACK & PINION		
T 19	CLOSE AT	OPEN AT	20 kPa	551 kPa	20 kPa	551 kPa	20 kPa	551 kPa	20 kPa	551 kPa
U 20	FLOW ACTION TO									
A 21	FAIL POSITION	CLOSE		CLOSE		CLOSE		CLOSE		
T 22	HANDWHEEL & LOCATION									
P 23	MFR. & MODEL NO.									
O 24	FILT REG   GAGES   BYPASS									
S 25	INPUT SIGNAL									
I 26	OUTPUT SIGNAL									
T 27	AIR SUPPLY PRESS	551 kPa		551 kPa		551 kPa		551 kPa		
T 28	MFR. & MODEL NO.									
R 29	INPUT SIGNAL									
N 30	OUTPUT SIGNAL									
O 31	LIMIT SWITCH	VR7C2YAA2NGA-LS		VR7C2YAA2NGA-LS		VR7C2YAA2NGA-LS		VR7C2YAA2NGA-LS		
P 32	SHUTDOWN SOLENOID	EF8320G714-24VDC-SOL		EF8320G714-24VDC-SOL		EF8320G714-24VDC-SOL		EF8320G714-24VDC-SOL		
T 33										
34	FLOW UNITS	STD M*3/D		STD M*3/D		STD M*3/D		STD M*3/D		
35	FLUID	NAT GAS		NAT GAS		NAT GAS		NAT GAS		
36	QUANT. MAX.	MAX. Cv								
S 37	QUANT. OPER.	OPER Cv	618		2.5		220		2.5	
E 38	VALVE Cv	VALVE FL								
R 39	NORM IN PRES	NORM DELTA P	82 kPa(g)	82 kPa	14 kPa(g)	14 kPa	82 kPa(g)	82 kPa	14 kPa(g)	14 kPa
V 40	MAX. INLET PRESS.	1034 kPa		1034 kPa		1034 kPa		1034 kPa		
I 41	MAX. SHUT OFF	MAX. DELTA P	1034 kPa(g)	1034 kPa	1034 kPa(g)	1034 kPa	1034 kPa(g)	1034 kPa	1034 kPa(g)	1034 kPa
C 42	TEMP. MAX.	OPER. TEMP	38 °C	24 °C	38 °C	24 °C	38 °C	24 °C	38 °C	24 °C
E 43	OPER. SP. GR.	MOL. WT.		19.5		19.5		19.5		19.5
44	OPER. VISC.	% FLASH								
45	% SUPERHEAT	% SOLIDS								
46	VAPOR PRESS	CRIT PRESS	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)
47	PREDICTED SOUND LEVEL dBA									
48	MANUFACTURER	FPS AUTOMATIC GAS VALVES		FPS AUTOMATIC GAS VALVES		FPS AUTOMATIC GAS VALVES		FPS AUTOMATIC GAS VALVES		
49	MODEL NO.	VCI CSA201F-66-PB-SE-V50		VCI CSA201F-66-PB-SE-V50		VCI CSA201F-46-PB-SE-V50		VCI CSA201F-46-PB-SE-V50		
50	P. O. NUMBER									

NOTES: Rated for -40°C      Rated for -40°C      Rated for -20°C      Rated for -20°C  
C/W Detrol speed control to ensure slow opening of valve

AREA. UNIT # :



BOILER CONTROL, COMBUSTION MANAGEMENT & HARDWARE FOR THE STEAM POWER INDUSTRY

SDV-633 / 634 / 650 / 651

VALVES

# Automatic Gas Valves

## CGA/CSA/ANSI Approved

By integrating the highest quality components, Fossil Power Systems Inc. (FPS) is able to offer a series of automated gas valves, that provide unparalleled design features for reliable operation and ease of maintenance, even in the most demanding gas applications.

Valve construction consists of the following components:

- Worcester Ball Valves
- Parker-Hannifin Solenoids
- Bettis/Worcester Actuators
- Honeywell Limit Switches
- FPS Stainless Steel Brackets and Couplers

### AVAILABLE MODELS

- Sizes 1/2" to 2" with threaded or socket-weld connections
- Sizes 3" to 6" have ANSI 16.5, 150# flange connections
- 120VAC or 24VDC
- NEMA 4x or NEMA 7, 9/Class I, Divisions 1 and 2, Groups A, B, C and D; Class II, Divisions 1 and 2, Groups E, F and G
- All available as either "Fail Closed" or "Fail Open" upon the loss of power or air supplies
- Carbon Steel or Stainless Steel bodies

## KEY FEATURES

### GENERAL

- Visible OPEN/CLOSED indication on limit switch bracket
- Direct linear connection of valve to limit switch for positive proof of closure and opening

### VALVE

- Three-piece valve body design allows the center section to swing out for easy replacement of the ball, seats and seals without disturbing any pipe thread connections.
- Ball valve seals in both directions ensuring successful pre-start-up leak test
- The ball valve and stem are held in place using Belleville washers and locknuts, which permits easy in-line adjustment without disassembly. This design provides automatic compensation for normal wear and for expansion and contraction from temperature fluctuations
- Stainless steel ball, stem and hardware

### ACTUATOR

- The pneumatic rack and pinion spring return actuator consists of:
- Precision anodized and fluoropolymer impregnated aluminum alloy body
- Die cast aluminum alloy end caps
- Die cast aluminum alloy pistons
- One piece aluminum alloy shaft and pinion
- Nitrile seals
- Nylatron piston bearings
- Carbon steel spring
- Stainless steel fasteners

### SOLENOID

- Anodized aluminum body is mounted directly on the actuator using the accepted NAMUR pattern of mounting and portholes



2 INCH THREADED GAS VALVE

### LIMIT SWITCH

- Rugged cast aluminum housing is weather-sealed, explosion proof and provides protection from the entry of water, dust and oil as defined by NEMA 1, 3, 3R, 4, 12 and 13. The switches are also protected from flammable hydrocarbon atmospheres, metal dust, coal dust and grain dust as defined by NEMA 7 Class 1 groups C&D and 9 Class 2 groups E, F & G
- Rotary type "dry contact" open and closed limit switches

Controlling  
the **power**  
of **steam**



# Automatic Gas Valves

CGA/CSA/ANSI Approved

## CERTIFICATIONS

- ANSI Z21.21-2000/CSA 6.5-2000 – Automatic Valves For Gas Appliances
- CGA 3.9-M94 – Automatic Safety Shut-off Gas Valves
- Commercial / Industrial (C/I)

## SPECIFICATIONS

### MAX. OPERATING PRESSURE

- 150 psig (1035 kPa)

### MAX. AMBIENT OPERATING TEMP.

- 50° C (122° F)

### MIN. AMBIENT OPERATING TEMP.

- -20° C (-4° F)

### MOUNTING

- Multi-position

## SPECIFICATIONS (con't)

### FLOW

- Bi-Directional

### SOLENOID SPECIFICATIONS

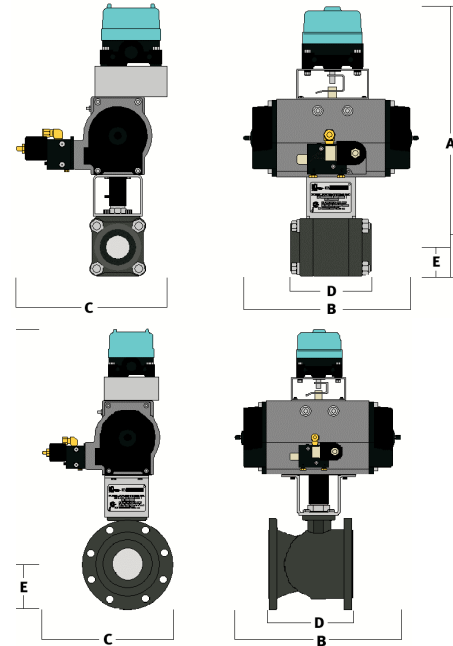
- 120 VAC/0.14 mA Steady State  
0.23 mA Inrush
- 24VDC/0.41 mA Steady State

### ACTUATOR/SOLENOID AIR SUPPLY

- Dry or Lubricated Non-Corrosive Gas
- Min 60 psig (415 kPa)
- Max 120 psig (830 kPa)

### LIMIT SWITCH SPECIFICATIONS

- 15 A-120, 250 or 480 VAC
- 1/8 HP-125 VAC, 1/4 HP – 250 VAC
- 1/2 A – 125 VDC, 1/4 A – 250 VDC



SIZE	CV	"A"	"B"	"C"	"D"	"E"	WEIGHT
1/2" NPT/ Socket Weld	8	13.25" 337mm	7.25" 184mm	8.00" 203mm	2.57" 65mm	0.65" 17mm	8.5 Lbs 3.9 Kg
3/4" NPT/ Socket Weld	12	13.75" 349mm	7.25" 184mm	8.00" 203mm	2.79" 71mm	0.80" 20mm	10.5 Lbs 4.8 Kg
1" NPT/ Socket Weld	32	14.20" 361mm	8.50" 216mm	9.25" 235mm	3.69" 93mm	0.90" 23mm	13.8 Lbs 6.3 Kg
1-1/4" NPT/ Socket Weld	57	14.50" 368mm	8.50" 216mm	9.25" 235mm	4.19" 106mm	1.25" 32mm	18.5 Lbs 6.9 Kg
1-1/2" NPT/ Socket Weld	82	16.00" 406mm	8.50" 216mm	9.25" 235mm	4.53" 115mm	1.56" 40mm	21.5 Lbs 9.8 Kg
2" NPT/ Socket Weld	120	17.0" 432mm	10.75" 273mm	9.75" 248mm	4.94" 125mm	1.88" 48mm	30.35 Lbs 11.33 Kg
3" FLANGED	350	22.00" 559mm	14.55" 370mm	13.5" 343mm	8.00" 203mm	3.88" 99mm	60 Lbs 27.3 Kg
4" FLANGED	720	23.47" 596mm	14.55" 370mm	13.5" 343mm	9.00" 229mm	4.48" 114mm	95 Lbs 43.2 Kg
6" FLANGED	1020	31.00" 787mm	14.55" 370mm	13.5" 343mm	10.5" 267mm	6.19" 157mm	185 Lbs 84.1 Kg

DISTRIBUTED BY:



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MAY/03 9640-1002

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : TEMPERATURE CONTROL VALVES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
				BY	CHK'D	APPR.			
G 1	TAG NO.	TCV-630		TCV-650		TCV-633			
E 2	SERVICE	DEETHANIZER REBOILER		GLYCOL REGEN RBLR		DEETHANIZER REBOILER			
N 3	LINE NO. / VESSEL NO.	H-633		H-650		H-633			
E 4	LINE SIZE / SCHED. NO.	60MM SCH 40		33MM SCH.80		33mm SCH.80			
5	TYPE OF BODY	GLOBE							
6	BODY SIZE	PORT SIZE	48 mm	47.6 mm	33 mm	mm	33 mm	mm	
7	GUIDING	NO. OF PORTS	STD	ONE(1)	STD	ONE(1)	STD	ONE(1)	
B 8	END CONN. & RATING	48MM NPT		33mm NPT		33mm NPT			
O 9	BODY MATERIAL	CS		CI		CI			
D 10	PACKING MATERIAL	STD		STD		STD			
Y 11	LUBRICATOR	ISOLAT. VALVE							
12	BONNET TYPE	STD BONNET		STD BONNET		STD BONNET			
13	TRIM FORM	EQUAL PERCENTAGE							
14	TRIM MATERIAL SEAT / PLUG	STD		STD		STD			
		SHAFT / MAT'L	STD	STD	STD	STD	STD	STD	
15	REQUIRED SEAT TIGHTNESS								
16	MAX. ALLOW SOUND LEV. dBA								
A 17	MODEL NO. & SIZE	667-34							
C 18	TYPE OF ACTUATOR	DIAPHRAGM		DIAPHRAGM		DIAPHRAGM			
T 19	CLOSE AT	OPEN AT	20 kPa	100 kPa	20 kPa	100 kPa	20 kPa	100 kPa	
U 20	FLOW ACTION TO	OPEN		OPEN		OPEN			
A 21	FAIL POSITION	CLOSED		CLOSED		CLOSED			
T 22	HANDWHEEL & LOCATION	---		---		---			
P 23	MFR. & MODEL NO.	---							
O 24	FILT REG   GAGES   BYPASS								
S 25	INPUT SIGNAL								
I 26	OUTPUT SIGNAL								
T 27	AIR SUPPLY PRESS	kPa		kPa		kPa			
T 28	MFR. & MODEL NO.								
R 29	INPUT SIGNAL								
N 30	OUTPUT SIGNAL								
O 31									
P 32									
T 33									
34	FLOW UNITS	L/MIN		STD M <sup>3</sup> /D		STD M <sup>3</sup> /D			
35	FLUID	H.C.LIQUIDS		NATURAL GAS		NATURAL GAS			
36	QUANT. MAX.	MAX. Cv							
S 37	QUANT. OPER.	OPER Cv	58.4	15.1	220		618		
E 38	VALVE Cv	VALVE FL	35.8						
R 39	NORM IN PRES	NORM DELTA P	1970 kPa(g)	3.5 kPa	82 kPa(g)	82 kPa	82 kPa(g)	82 kPa	
V 40	MAX. INLET PRESS.		3792 kPa		861 kPa		861 kPa		
I 41	MAX.SHUT OFF	MAX.DELTA P	3792 kPa(g)	3792 kPa	861 kPa(g)	861 kPa	861 kPa(g)	861 kPa	
C 42	TEMP. MAX.	OPER. TEMP	204 ° C	83.6 ° C	38 ° C	24 ° C	38 ° C	24 ° C	
E 43	OPER. SP. GR.	MOL. WT.	0.485			19.5		19.5	
44	OPER. VISC.	% FLASH					---	---	
45	% SUPERHEAT	% SOLIDS							
46	VAPOR PRESS	CRIT PRESS	kPa(g)	kPa(g)	kPa(g)	kPa(g)	---	kPa(g)	
47	PREDICTED SOUND LEVEL dBA								
48	MANUFACTURER	FISHER		KIMRAY		KIMRAY			
49	MODEL NO.	667-ED-34		130-SMT-DAB		130-SMT-DAB			
50	P. O. NUMBER								

NOTES:

AREA. UNIT # :

## Type 667 Diaphragm Actuator Sizes 30-76 and 87

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Figure 1. Type 667 or 667-4 Actuator Mounted  
on *easy-e*<sup>®</sup> Valve

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# Type 667 Size 30-76 & 87

Table 1. Specifications

SPECIFICATION <sup>(1)</sup>		ACTUATOR SIZE										
		30	34	40	45	46	50	60	70 <sup>(1)</sup>	76	87 <sup>(1)</sup>	
Nominal Effective Area	Sq Inch	46	69	69	105	156	105	156	220	156	220	
	Sq cm	297	445	445	667	1006	677	1006	1419	1006	1419	
Yoke Boss Diameter	Inch	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	3-9/16	5	
	mm	54	54	71	71	71	90	90	90	90	125	
Acceptable Valve Stem Diameter	Inch	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	3/4	1	
	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	19.1	25.4	
Maximum Allowable Output Thrust <sup>(4)</sup>	LB	2300	2300	2700	5650	7550	5650	6800	8800	6800	8800	
	N	10,230	10,230	12,010	25,131	33,582	25,131	30,246	39,142	30,246	39,142	
Maximum Travel <sup>(2)</sup>	Standard	Inch	3/4	1-1/8	1-1/2	2	2	2	2	3 <sup>(3)</sup>	2	3 <sup>(3)</sup>
	Standard	mm	19	29	38	51	51	51	51	76 <sup>(3)</sup>	51	76 <sup>(3)</sup>
	Top-Loaded	Inch	---	3/4	---	3/4	---	---	1-1/8	---	1-1/8	3
	Top-Loaded	mm	---	19	---	19	---	---	29	---	29	76
Maximum Casing Pressure for Actuator Sizing <sup>(4,6)</sup>	Psig	55	70	70	65	55	65	55	50	50	50	
	Bar	3.8	4.8	4.8	4.5	3.5	4.5	3.5	3.4	3.4	3.4	
Maximum Excess Diaphragm Pressure <sup>(4,5)</sup>	Psig	55	20	20	10	10	10	10	10	10	10	
	Bar	3.9	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Maximum Diaphragm Casing Pressure <sup>(4,6,7)</sup>	Psig	110	90	90	75	65	75	65	60	60	60	
	Bar	7.6	6.2	6.2	5.2	4.5	5.2	4.5	4.1	4.1	4.1	
Approximate Weight	Pounds	34	48	50	90	121	94	122	254	190	260	
	Kg	15	22	23	41	55	43	55	115	86	118	
Material	Nitrile Elastomers	-40 to 180°F (-40 to 82°C)										
Temperature	Silicone Elastomers	-65 to 300°F (-54 to 149°C)										
Capabilities	Fluoroelastomers	0 to 300°F (-18 to 149°C)										

1. These values also apply to the Type 667-4 actuator construction.  
2. Actuator travel may be less than the value listed after connected to the valve.  
3. Maximum actuator travel for Type 667-4 is 4 inches (102 mm).  
4. See also the Specification portion of the introduction section.  
5. Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result. See the Maximum Pressure Limitation section.  
6. Maximum diaphragm casing pressure must not be exceeded and must not produce a force on the actuator stem greater than the maximum allowable actuator output thrust or the maximum allowable stem load. See the Maximum Pressure Limitation section.  
7. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

## Introduction

### Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Type 667 actuator in sizes 30 through 76 and size 87. The Type 667-4 actuator in sizes 70 and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Only personnel qualified through training or experience should install, operate, and maintain a Type 667 actuator (see figure 1). If you have any questions about these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

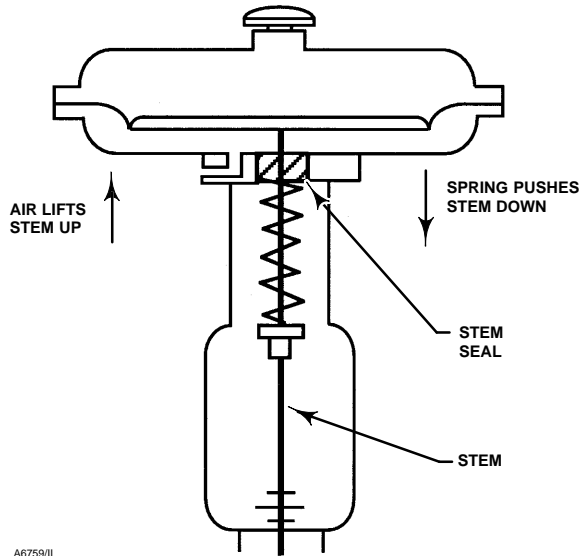
### Description

The Type 667 actuator (figure 1) and the Type 667-4 actuator are reverse-acting, spring-opposed dia-

phragm actuators. They provide automatic operation of control valves. The Type 667 actuator provides 3 inches (76 mm) maximum actuator travel. The Type 667-4 actuator provides 4 inches (102 mm) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the diaphragm. Figure 2 shows the operation of these actuators.

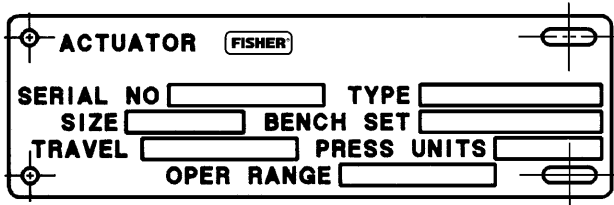
A Type 667 or 667-4 actuator can be furnished with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is usually used as an adjustable down travel stop. (A down travel stop limits actuator travel in the down direction. "Down" means that the stem is traveling out of the actuator. "Up" means that the stem is traveling into the actuator.) A side-mounted handwheel assembly is usually used as an auxiliary manual actuator. The side-mounted handwheel can also be used as an adjustable up or down travel stop. Casing-Mounted adjustable up or down travel stops are also available on this actuator.

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Figure 2. Schematic of Type 667 and 667-4 Actuators



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Figure 3. Type 667 and 667-4 Actuator Nameplate

## Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

## Specifications

Refer to table 1 for Specifications of the Type 667 and 667-4 actuators. See the actuator nameplate (figure 3) for specific information for your actuator.

control valve, or loss of control of the process caused by excessive pressure, do not exceed the Maximum Pressures listed in table 1. Refer to the Maximum Pressure Limitations section below.

## Maximum Pressure Limitations

The casing and diaphragm of Type 667 actuators are pressure operated. This air pressure provides energy to compress the spring, to stroke the actuator, and to seat the valve. The following explanations describe the maximum pressure limits for an actuator. Refer to the nameplate or table 1 for maximum values for your actuator.

- Maximum Casing Pressure for Actuator Sizing:** This is the maximum pressure that can be applied at less than full travel of the actuator. If this stroking pressure is exceeded before the upper diaphragm plate contacts the travel stop, damage to the stem or other parts might result.

- Maximum Excess Diaphragm Pressure:** Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result.

Because the actuator has traveled its specified travel, and the diaphragm head is physically stopped from movement, the energy from any additional air pressure is transmitted to the diaphragm and diaphragm casings. The amount of air pressure that can be added once the actuator has traveled to the stops is limited by the resultant adverse effects that may occur. Exceeding this limiting factor could result in leakage or casing fatigue due to the deformation of the upper diaphragm casing.

- Maximum Diaphragm Casing Pressure:** If the Maximum Diaphragm Casing Pressure is exceeded, damage to the diaphragm, diaphragm casing, or actuator might result.

## Installation

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted. Also, refer to figure 4 for location of parts.

### WARNING

To avoid personal injury and property damage caused by bursting of parts and to avoid parts damage, malfunction of

### WARNING

To avoid personal injury or parts damage, do not exceed any of the maximum Diaphragm Pressures listed in table 1.

# Type 667 Size 30-76 & 87

- **Valve/Actuator Assembly:** If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the loading connection procedures.

- **Actuator Mounting:** If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the following actuator mounting procedures before placing the valve in service. It is recommended that you perform the bench set spring adjustment procedures in this section to confirm that the actuator is adjusted correctly for the valve travel.

- **Positioner:** If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.

- **Handwheel Cap:** If the handwheel cap (key 247, figures 10, 11, or 16) is not in place, install the cap by pushing it on by hand until it snaps into place.

## Mounting the Actuator on the Valve



- The Type 667 actuator spring load pushes the stem down out of the actuator yoke (see figure 2), and it can come in contact with the valve stem during actuator mounting.

- If the valve stem is allowed to remain in the up position (towards the actuator) during actuator mounting, it can interfere with the actuator stem during mounting. It is possible to damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

It may be necessary to apply a temporary loading pressure to the actuator to move the actuator stem away from the valve during installation.

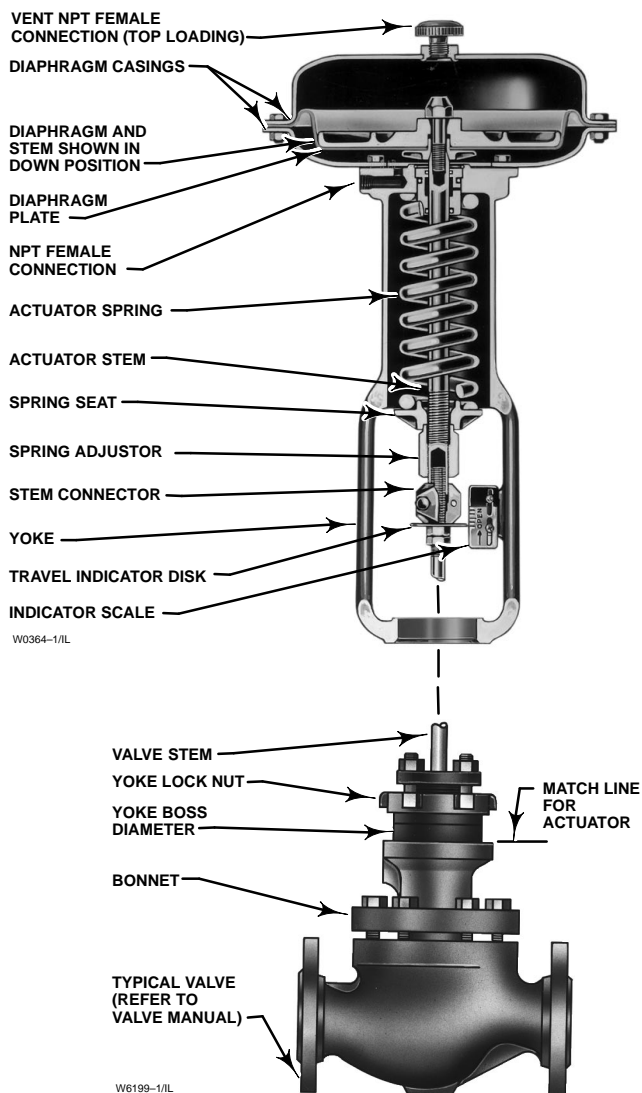


Figure 4. Actuator-Mounting Components for Size 30 through 70 Actuators

If it is not possible to provide a temporary loading pressure, be very careful when lowering the actuator over the valve stem to prevent damage to valve stem and threads.



When moving the actuator stem with loading pressure applied, exercise caution to keep hands and tools out of the actuator stem travel path. If the loading pressure is accidentally disconnected, personal injury and property damage is



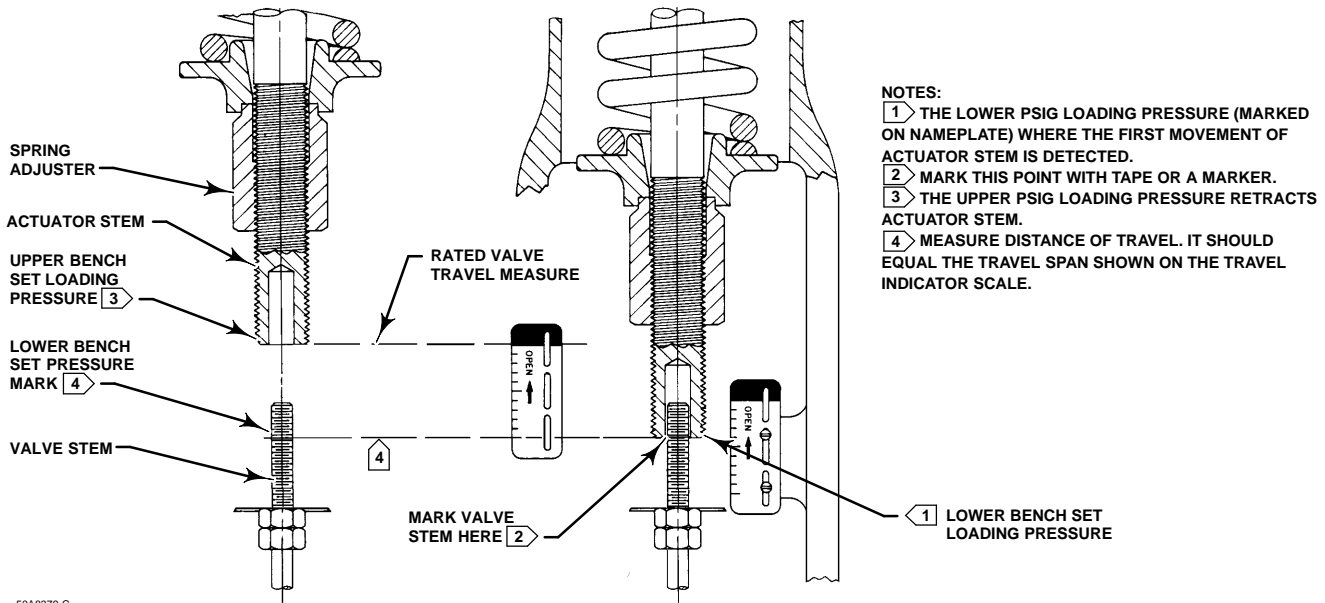


Figure 5. Bench Set Adjustment

possible if something is caught between the actuator stem and other control valve parts.

1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.

2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 34) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)

3. Lift or hoist the actuator onto the valve bonnet:

a. **For size 87 actuators:** Slowly lower the actuator down onto the valve while guiding the valve stem into the opening in the end of the the actuator stem (see figure 5). Once the actuator is in place, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.

b. **For all other size actuators:**

- Slowly lower the actuator down onto the valve. As the yoke passes over the end of the valve stem, place the yoke locknut over the valve stem. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator onto the valve because the disk will not go through the actuator yoke opening).

- Continue to lower the actuator while guiding the valve stem into the opening in the end of the actuator stem until the actuator is in place (see figure 5).

- Screw the yoke locknut onto the valve bonnet and tighten the locknut.

4. Do not connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended that you perform the *Bench Set Spring Adjustment* procedures below, to verify that the actuator is still adjusted correctly.

## Discussion of Bench Set

The bench set pressure range is used to adjust the initial compression of the actuator spring with the valve-actuator assembly “on the bench.” The correct initial compression ensures that the valve-actuator assembly will function properly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set range is established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by “loose” packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the *Bench Set Spring Adjustment Procedure*).

If you are attempting to adjust the bench set range after the actuator is connected to the valve and the

# Type 667 Size 30-76 & 87

packing tightened, you must take friction into account. Make the spring adjustment such that full actuator travel occurs at the bench set range (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

For an assembled valve-actuator assembly, the valve friction may be determined by following the procedure described below:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

## Note

**Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.**

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than its mid-travel position.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches its mid-travel position.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

5. Calculate the actual friction force:

$$\text{Friction Force, pounds} = 1/2 \left( \begin{array}{c} \text{Difference} \\ \text{in pressure} \\ \text{readings, psig} \end{array} \right) \times \left( \begin{array}{c} \text{Effective} \\ \text{diaphragm area,} \\ \text{inches}^2 \end{array} \right)$$

Refer to table 1 for the effective diaphragm area.

When determining valve friction, you can make diaphragm pressure readings at a travel position other than mid-travel if you desire. If you take readings at zero or at the full travel position, take extra care to ensure that the readings are taken when the travel just begins or just stops at the position selected.

It is difficult to rotate the spring adjustor (key 74, figure 7, 8, and 9) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

## Bench Set Spring Adjustment

The term “bench set” means that the actuator is **not** connected to the valve, or any other loads. Ensure that the actuator diaphragm is at the bottom of its travel as shown in figure 5. (Note: Some spring compression is required to move the diaphragm to the **bottom** of its travel.)

Also, provide a certified pressure gauge that will accurately read the diaphragm pressure from 0 through the upper bench set pressure marked on the nameplate. Apply loading pressure to the diaphragm.

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly. It is important to be sure that the actuator assembly is **not** binding or producing any friction on the actuator stem movement.

Key numbers are shown in figures 7, 8, and 9.

## For Direct-Acting Valves (PDTTC)

1. If not already accomplished, push the valve stem down away from the actuator to the closed position.
2. Set the diaphragm loading pressure to 5 psig (0.3 bar) over the upper bench set pressure. The upper travel stop should be contacting the diaphragm casing.
3. Slowly decrease the pressure towards the upper bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the upper pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the upper bench set pressure. (Note: You may need to lower the loading pressure to reduce spring compression, allowing the spring adjuster to turn.)
5. Be sure the spring adjuster is adjusted to meet the requirements of step 4 above.
6. Apply the lower bench set loading pressure to the diaphragm. This will extend the actuator stem toward the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
7. Slowly increase the diaphragm pressure until the upper bench set loading pressure is applied. Again, the travel stop should be against the diaphragm casing.
8. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
9. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
10. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that

may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## For Reverse-Acting Valves (PDTO)

1. If not already accomplished, push the valve stem down away from the actuator to the open position. Later, when installing the connector, pull up the valve stem to the closed position.
2. Set the diaphragm loading pressure to a value less than the lower bench set pressure (near zero). The down travel stop should be contacting the yoke.
3. Slowly increase the pressure towards the lower bench set pressure while checking for the **first** movement of the actuator stem.
4. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 5). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the lower bench set pressure.
5. Apply the upper bench set loading pressure to the diaphragm. This will retract the actuator stem away from the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
6. Slowly decrease the diaphragm pressure until the lower bench set loading pressure is applied. Again, the down-stops should be against the yoke.
7. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the travel span shown on the travel indicator scale (key 32).
8. If the span of travel is correct, bench set is complete. Proceed to the *Installing the Stem Connector Assembly* subsection.
9. If the travel span is not exact, remember there are free-length and load rate tolerances for the spring that may produce a slightly different span than specified. Or, contact your Fisher Controls sales office or sales representative for assistance.

## Installing the Stem Connector Assembly

When installing the stem connector assembly (key 31), the actuator and valve stem threads should engage the threads of the stem connector by a distance equal to the diameter of the stem.

### Note

**Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard it, if present, before clamping the actuator and valve stems together.**

1. If necessary, push the valve stem down so that the valve plug is touching the seat ring on direct-acting valves. For reverse-acting valves, pull the stem up to the closed position. Always start with the valve plug on the seat.
2. If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 34) is on top of the locknuts.
3. Apply the diaphragm pressure to the lower bench set pressure. (Or, the upper bench set pressure for reverse-acting valves.) This should be the same pressure used in the bench set steps, and it is marked on the nameplate.
4. Place the stem connector half with the threaded holes, approximately half way between the actuator and valve stems. Refer to figures 7, 8, and 9 to help locate the connector position.

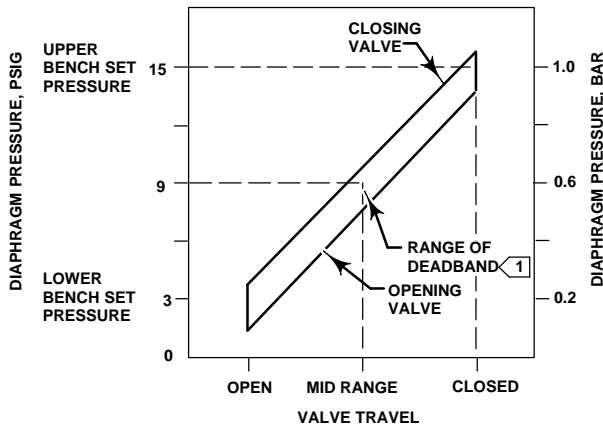
Be sure that the actuator and valve stem threads are engaging the threads of the stem connector by a distance equal to one diameter of the stem.

### CAUTION

**Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely.**

5. Install the other half of the stem connector and insert the cap screws and tighten them. If installing a positioner, also attach the feedback bracket at the same time.
6. Screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector, or for size 87 actuators, tighten the locknuts against the stem connector. Do not overtighten the locknuts.
7. Slowly increase and then decrease pressure several times, stroking the valve from the lower bench set pressure to the upper pressure.

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NOTE:  
 1 DEADBAND IS CAUSED BY FRICTION.  
 A6588 / IL

Figure 6. Typical Direct Acting Valve Response to Deadband

Be sure that the valve is in the closed position (up or down, depending on valve action). Loosen the screws on the travel scale, and align it with the travel indicator disk. Stroke the valve full travel to ensure that the travel matches the valve travel on the travel indicator plate. If valve travel is not correct, repeat the stem connector procedure.

## Note

**For push-down-to-close valves, the valve plug seat is the limit for downward travel and the actuator up-stop is the limit for upward (away from the valve) movement. For push-down-to-open valves, the actuator down-stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement. For Type 667 actuators, a down-stop (key 77, figure 7) is installed to limit actuator diaphragm downward movement when the actuator provides the limit.**

## Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 6). Each actuator spring has a fixed spring rate (force). You have verified that the right spring was installed in the actuator by completing the bench set spring adjustment steps.

Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

Deadband, psi

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn \%}$$

## Loading Connection

Key number locations are shown in figures 7, 8, and 9, unless otherwise noted.

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary. For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT female connection in the side of the yoke (key 73).
2. For size 70 and 87 actuators, if necessary, remove the 1/4-inch NPT bushing if a 1/2-inch NPT female connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.
4. If valve stem travel appears to be incorrect, refer to the bench set spring adjustment procedures at the beginning of this section. Do not place the valve in service if it is not reacting correctly to diaphragm loading pressure changes.

## Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions. Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher Controls.

### WARNING

**Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring pre-compression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

The maintenance instructions are divided into several sections: Actuator, Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop), Side-Mounted Handwheel Assembly (Manual Actuator) for Size 34 through 60 Actuators, Side-Mounted Handwheel Assembly (Manual Actuator) for Size 70, 76 and 87 Actuators, and Casing-Mounted Travel Stops.

## Actuator Maintenance

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key are shown in figures 7, 8, or 9, unless otherwise noted. Figure 7 shows the size 30 through 60 actua-

tors, figure 8 shows the size 70 actuator, and figure 9 shows the size 87 actuator.

## Actuator Disassembly

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

1. Remove the tubing or piping from the connection in the top of the yoke (key 73). For a top-loaded construction, also remove the piping or tubing from the connection in the upper diaphragm casing (key 1).
2. Turn the spring adjuster (key 74) counterclockwise (**toward the valve body**) until all spring compression is relieved.

### WARNING

**To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector cap screws when the stem connector has spring force applied to it.**

3. If necessary, remove the actuator from the valve body by separating the stem connector (key 31). Loosen the stem locknuts for the size 87 actuator, and removing the stem connector nuts. For all other sizes, separate the stem connector by loosening the stem locknuts (keys 69 and 75) and unscrewing the two stem connector cap screws.
4. Unscrew the spring adjuster (key 74) from the actuator stem (key 144). Also lift the spring seat and spring (Key 19 and 18) out of the yoke.
5. Remove the diaphragm casing cap screws and nuts (keys 13 and 14), and lift off the upper diaphragm casing (key 1).
6. Remove the following connected parts: the diaphragm (key 3), upper diaphragm plate (key 4), spacer (key 2), cap screw (key 12), lower diaphragm plate (key 71), and actuator stem (key 144). Be careful when pulling the threads of the actuator stem through the seal bushing (key 7) to avoid damaging the O-rings (key 8).
7. Remove the cap screw (key 12) to separate the parts of this assembly.
8. To remove the seal bushing, remove the snap ring (key 72), and lift out the bushing. Inspect, and if necessary, replace O-rings (8 and 9).
9. Remove cap screws (key 30), and take off the lower diaphragm casing (key 64) and the gasket (key 70),

# Type 667 Size 30-76 & 87

size 30 through 60 and 76) or O-ring (key 70, size 70 or 87). If necessary, the down travel stops (key 77) can be removed.

## Actuator Assembly

1. Coat the O-rings (key 70, sizes 70 and 87) with lubricant (key 237 or equivalent). Or, coat the gasket with sealant (key 238 or equivalent). Place a new gasket or O-ring (key 70) on the yoke (key 73). Position the lower diaphragm casing (key 64) on the yoke, align the holes, and insert and tighten the cap screws (key 30). If down travel stops (key 77) were removed, insert and tighten them.
2. Coat the O-rings (keys 8 and 9) with lubricant (key 237 or equivalent) and place the O-rings in the seal bushing (key 7).
3. Fill the seal bushing with lubricant (key 237 or equivalent), slide the bushing into the yoke (key 73), and install the snap ring (key 72).
4. Assemble the actuator stem (key 144), lower diaphragm plate (key 71), diaphragm (key 3), upper diaphragm plate (key 4), and the travel stop cap screw and spacer (keys 12 and 2). Coat the cap screw threads with Lubriplate Mag-1 or equivalent (key 237). Tighten the cap screw (key 12) to 30 lbf•ft (41 N•m) torque for size 30 actuators, 70 lbf•ft (95 N•m) torque for size 34 and 40 actuators, or 190 lbf•ft (258 N•m) torque for size 45 to 70 and 87 actuators. Place this assembly in the actuator. Take care when pushing the actuator stem through the seal bushing so that the threads do not damage the O-rings.



## CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Install the upper diaphragm casing (key 1), and install the cap screws and nuts (keys 13 and 14). Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Install the actuator spring (key 18) and spring seat (key 19). Apply lubricant (key 239 or equivalent) to the threads of the actuator stem and to the surface of the spring adjuster (key 74) that contacts the spring seat. Thread the spring adjuster onto the actuator stem.
7. Mount the actuator onto the valve in accordance with the procedures in the Installation section.

## Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop)

Actuator key numbers are shown in figures 7, 8, and 9. And, top-mounted handwheels are shown in figures 10, 11, and 12.

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.**

A top-mounted handwheel assembly (figures 10, 11, and 12) is usually used as an adjustable down travel stop to limit full extension of the actuator stem. Turning the handwheel counterclockwise pulls the extension rod (key 150, figures 10, 11, and 12) up, retracting the actuator stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

## Disassembly for Top-Mounted Handwheel

1. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
2. Turn the handwheel (key 58) clockwise so that the handwheel assembly is not causing any spring compression.
3. Turn the actuator spring adjuster (key 74) to relieve all the compression from the spring (key 18).
4. If servicing just the thrust bearing, races, and handwheel screw (keys 180, 181, and 160) only, use the following steps:
  - Remove the cap and drive out the groove pin. Remove the castle nut, bearing retainer, thrust bearing, and races (keys 247, 167, 166, 180, and 181).
  - Use the handwheel to remove the handwheel screw (key 160) from the handwheel body (key 148).
  - It necessary, remove the extension rod (key 150) at this time. Most maintenance procedures do not require the rod to be removed.
  - Clean and inspect all parts or replace parts as necessary. Upon re-assembly, lubricate handwheel threads, bearings, and races with Never-Seez Nickel Special (key 239) or equivalent.

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- Lubricate and re-install the handwheel screw into handwheel body (key 148). Lubricate and replace the races, bearing, and retainer (keys 181, 180, and 182). Replace the castle nut (key 166), tighten it, and insert the groove pin (key 167). Replace the handwheel cap (key 247).

## 5. For size 30 through 60 and 76 actuator handwheels (figures 10 and 11):

- Remove the cap screws (key 161). Make sure that the guide plate can turn between the handwheel body and the mounting plate (keys 157, 148 and 158).

- Remove the cap (key 247) and drive out the groove pin (key 167). Remove the castle nut (key 166) and, if necessary, unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1) and the mounting plate (key 158).

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## 6. For size 70 and 87 actuator handwheels (figure 12):

- Remove the cap (key 247). Drive out the groove pin (key 167) and remove the castle nut, the bearing retainer, and thrust bearing (keys 166, 182, 181, and 180). It is not necessary to remove the extension rod (key 150) at this time.

- Remove the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1), handwheel body (key 148) and attached parts.

- If travel stops (key 152) are used, note and record their position relative to the cap screws (key 154) for use in assembly. Remove the travel stops and cap screws, and remove either the mounting plate (key 158, figure 12) or the handwheel body (key 148, figure 12) and attached parts.

- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.

- If necessary, perform other actuator maintenance before returning to the following assembly steps.

## Assembly for Top-Mounted Handwheel

### For size 30 through 60 and 76 actuator handwheels:

Refer to figures 10 and 11 for top-mounted handwheel assemblies.

1. If it was removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place. Also, install the guide post (key 150) if it was removed.

2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).

3. Install the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9) with the cap screws (key 154). Finger tighten the screws.

4. If travel stops were used, install the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

6. If necessary, screw the extension rod (key 150) into the connector (key 27). Slide the guide plate (key 157) onto the extension rod (key 150). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). If necessary, replace the extension rod (key 150). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

7. Lubricate and install the thrust bearings (keys 181 and 180), install the bearing retainer (key 182), install the castle nut (key 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

8. Refer to the Assembly portion of the Actuator maintenance section.

# Type 667 Size 30-76 & 87

## For size 70 and 87 actuators handwheels (figure 12):

Refer to figure 12 for top-mounted handwheel assemblies.

1. If removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place.
2. Generously coat the threads of the handwheel screw (key 160) with lubricant (key 239 or equivalent). Turn the screw into the handwheel body (key 148).
3. If necessary, install the extension rod (key 150) into the connector (key 27) and tighten it. Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**

5. Slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.
6. Lubricate and install the thrust bearings (keys 180 and 181), install the bearing retainer (key 182), install the castle nut (keys 166) on the extension rod. Do not overtighten the castle nut on the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).
7. Refer to the Assembly portion of the Actuator maintenance section.

## Side-Mounted Handwheel Assembly for Size 34 through 60 Actuators

A side-mounted handwheel assembly (figures 13 and 14) is usually used as a manual actuator. This design is frequently used to drive the valve open or closed under loading conditions. Turning the handwheel clockwise past the neutral position always closes a push-down-to-close valve. A pair of levers (key 146, figure 13) on a handwheel assembly close the valve by moving the valve stem.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

## Disassembly for Side-Mounted Handwheel (34-60)

1. If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the nuts (keys 147 and 170) from the U-bolts (keys 166 and 143) that hold the assembly to the yoke.
2. Remove retaining ring (key 154), and drive out the lever pivot pin (key 153).
3. There are two screws (key 156) that hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove screw (key 161) and pointer mounting bolt (key 159, not shown) located behind pointer (key 160).
5. Remove nut (key 54), lockwasher (key 150), and washer (key 149), and take off the handwheel (key 51). Be careful not to lose the small ball (key 55) and spring (key 56).
6. Unscrew the bearing retainer (key 136) after loosening the locking set screw (key 168, not shown).
7. Pull the screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also, remove the bushing (key 151) on sizes 34 and 40.
8. If required, remove the bearings (key 152), one from the bearing retainer and the other from the handwheel body.
9. **Size 34, 40, 45 and 76 actuator handwheels (figures 10 and 11)**, fasten the mounting plate (key 158) to the diaphragm casing (key 1, figures 7, 8, and 9):
  - If travel stops were used, install the travel stops to their original positions as recorded in preceding disassembly steps.
  - Install the cap screws (key 154). Tighten the screws and travel stops.
10. If travel stops were used, return the travel stops to their original positions as recorded in preceding Disassembly steps. Tighten the screws and travel stops.

### CAUTION

**Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.**



11. **Size 60 and 76 actuator handwheels**, position the diaphragm casing (key 1, figures 7, 8, and 9), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

- Slide the guide plate (key 157) onto the extension rod (key 150), and screw the extension rod into the connector (key 27). For size 45 through 76, place the spacer (key 253) on top of the guide plate (key 157). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the guide plate (key 157) or spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).

12. **Size 70 or 87 actuator handwheel**, slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 7, 8, and 9) with the attached parts on the diaphragm. Insert and tighten the cap screws and hex nuts (keys 13 and 14, figures 7, 8, and 9).

13. **Size 34 through 60, and 76 actuator handwheels**, re-lubricate the thrust bearings (key 180), install the washer and castle nut (keys 162 and 166) on the extension rod. Do not overtighten the bearing. Drive in the groove pin (key 167). Replace the cap (key 247).

- **Size 70 and 87 actuators handwheels**, screw the extension rod (key 150) into the connector (key 27). Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 7, 8, and 9), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.

14. **Size 70 or 87 actuator handwheels**, re-lubricate the thrust bearing (key 180), install the thrust bearing and bearing retainer (keys 180 and 181) on the extension rod (key 150), and screw on the castle nut (key 166). Do not overtighten the bearing. Drive in the groove pin (key 167), and replace the cap (key 247).

15. Refer to the Assembly portion of the Actuator maintenance section.

## ***Assembly for Side-Mounted Handwheel (Sizes 34-60)***

1. Pack the bearings (key 152) with lubricant (key 239 or equivalent). Insert one bearing and the bushing (key 151) in the handwheel body (key 142) as shown in figure 13 or 14. The bushing is not used in a handwheel assembly for size 45 through 60 actuators.

2. Coat the screw threads with lubricant (key 239) or equivalent, and thread the operating nut onto the screw. Slide the second bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151) as shown in figure 13 or 14 or into the bearing.

3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, not shown) to hold the bearing retainer in place.

4. Coat the groove in the handwheel body (key 142) with lubricant (key 237 or equivalent). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51). Holding the ball and spring in the handwheel, put the handwheel (key 51), the washer (key 149), the lock-washer (key 150), and the hex nut (key 54) on the end of the screw (key 145). Tighten the hex nut.

5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160) as shown in figure 13 or 14. Insert and tighten the screw (key 161).

6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for size 45, 50, and 60 actuators or with the machine bolts (key 156) for handwheel assemblies on size 34 and 40 actuators.

7. If the handwheel assembly was removed from the yoke, remount the handjack assembly to the yoke using the dowel pins for alignment. Position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten nuts (key 144). Finish tightening the U-bolt nuts to 120 lbf•ft [163 N•m] (key 170) and 30 lbf•ft [41 N•m] (key 147). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

8. Position the levers (key 146) as shown in figure 13 or 14. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

## **Side-Mounted Handwheel Assembly (Sizes 70, 76, and 87)**

A side-mounted handwheel assembly (figure 15) is usually used as a manual actuator. Turning the handwheel clockwise past the neutral position always closes the valve body. A sleeve (key 123, figure 15) on a handwheel assembly for a size 70, 76 or 87 actuator opens the valve body by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

# Type 667 Size 30-76 & 87

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## **Disassembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

Bypass the control valve. Reduce the loading pressure to atmospheric. Disconnect the loading pressure tubing or piping at the yoke.

Remove cover band (key 87), and relieve spring compression by turning the spring adjuster (key 74) counterclockwise.

Remove the cap screws and nuts (keys 13 and 14) and lift off the upper diaphragm casing (key 1).

Remove the travel stop screw (key 12) and spacer (key 2), and take off the diaphragm plate (key 4), the diaphragm (key 3), and the lower diaphragm plate (key 71).

Unscrew the cap screws (key 90) and remove the following connected parts: the lower diaphragm casing (key 64), the O-ring (key 70), spring case adaptor (key 89), the seal bushing, O-rings, and snap ring (keys 7, 8, 9, and 72).

Remove the snap ring (key 72), and slide the seal bushing and O-rings (keys 7, 8, and 9) out of the spring case adaptor (key 89).

Take out the actuator spring (key 18).

Remove the stem connector (key 31) and stem connector cap screws.

Pull the actuator stem (key 144) up and out of the yoke. The spring seat (key 19), spring adjuster (key 74), thrust bearing (key 128), and the pinned adjusting screw (key 131) will come out with the actuator stem.

Turn the handwheel so that the lower sleeve (key 123) extends out of the bottom of the yoke. DO NOT move the neutral indicator scale (key 125).

Loosen two set screws (key 121), and unscrew the bearing retainer flange (key 45). Take out the worm gear and two thrust bearings (key 132), one on each side of the gear.

The worm shaft (key 51) and associated parts can be disassembled, if desired, by first removing handwheel nut (key 127) and the handwheel (key 58). Do not lose the small ball (key 141) and spring (key 142).

Loosen the set screw (key 52) for each worm shaft retainer (keys 48 and 49). Unscrew the two worm retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers.

## **Assembly for Side-Mounted Handwheel (Sizes 70, 76, & 87)**

1. The front and back worm retainers (keys 48 and 49) each have a slot in their threads for a set screws (key 52). Pack the ball bearings (key 50) with lubricant (key 239) or equivalent, and insert one ball bearing in the back worm retainer (key 49) as shown in figure 15.

2. Thread the back bearing retainer and ball bearing (keys 49 and 50) into the yoke. Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 52), and tighten it.

3. Coat the worm shaft (key 51) threads with lubricant (key 239 or equivalent), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back bearing retainer.

4. Insert the bearing in the front bearing retainer (key 49), and thread the retainer and ball bearing into the yoke. Align the slot in the retainer with the hole in the yoke, insert the set screw (key 52), and tighten it.

5. Put the spring and ball (keys 141 and 142) in the handwheel (key 58). Slide the handwheel onto the worm shaft (key 51). Thread the hex nut (key 127) onto the worm shaft.

6. Pack the two needle bearings (key 132) and coat the worm gear (key 44) threads with lubricant (key 239) or equivalent. Insert the key (key 122), the bearings, and the worm gear in the yoke (key 73) as shown in figure 15.

7. Slots are cut in the threads of the bearing retainer flange (key 45). Thread the flange into the yoke so that the slots and the holes for the set screws (key 121) align. Insert the screws, and tighten them.

8. The lower sleeve (key 123) has a milled groove in one end. Coat the sleeve threads with lubricant (key 239 or equivalent), slide the end of the lower sleeve with the groove into the bearing retainer flange, turn the handwheel, and feed the sleeve through the worm gear so that the slot in the lower sleeve engages the key (key 122) in the yoke. Continue turning the handwheel until the lower sleeve protrudes 3.19 inches (81 mm) below the surface of the yoke. The bottom of the lower sleeve should be even with the bottom of the extension on the neutral indicator.

9. Pack the thrust bearing (key 128) with lubricant (key 239) or equivalent. Slide the actuator stem (key 144) and the attached adjusting screw (key 131), pin (key 130), thrust bearing (key 128), spring seat (key 19), and spring adjuster (key 74) into the yoke. The lower end of the stem slides through the lower sleeve (key 123) and the lower sleeve slides into the adjusting screw (key 131), as shown in figure 15.

10. Position the actuator stem (key 144) against the valve stem. Clamp both stems between the two halves of the stem connector (key 31), and be sure the threads are engaged properly on both stems. The stem connector should not be closer than 0.125 inches (3.2 mm) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 0.125 inches (3.2 mm) of free travel of the lower sleeve in either direction for manual operation. Fasten the halves together with the cap screws.

11. Put the actuator spring (key 18) in the yoke on the spring seat (key 19).

12. Coat the O-rings (keys 8 and 9) with lubricant (key 237) or equivalent, and insert them in the seal bushing (key 7). Slide the seal bushing and O-rings into the spring case adaptor (key 89).
13. Install the snap ring (key 72).
14. Slide the seal bushing and O-rings (keys 7, 8, and 9) over the actuator stem (key 144), and position the spring case adaptor (key 89), lower diaphragm casing (key 64), and O-ring (key 70) on the yoke.
15. Insert and tighten the cap screws (key 90).
16. Slide the lower diaphragm plate (key 71), the diaphragm (key 3) with the patterned side up, the diaphragm plate (key 4), the spacer (key 2), and the cap screw (key 12) on the actuator stem (key 144). Tighten the cap screw.
17. Put the diaphragm casing (key 1) on the diaphragm. Align the holes in the diaphragm (key 3) and the diaphragm casings (keys 1 and 64).



## CAUTION

**Over-tightening the cap screws and hex nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) of torque.**

18. Install the cap screws and hex nuts (keys 13 and 14) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a criss-cross pattern.
19. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

## Casing-Mounted Travel Stops

### Note

**If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as manual operator.**

Casing-mounted adjustable travel stops (shown in figures 16 through 20) are available to limit travel in the down direction (extending the actuator stem) or in the up direction (retracting the actuator stem). The travel stop in figure 16 is a down travel stop, the travel stop in figure 17 is an up and down travel stop, and the travel stops in figures 18, 19, and 20 are up travel stops.

Use the locknuts (key 151, figures 16 and 17), stem (key 150, figure 18), handwheel (key 58, figure 19) or cap screw (key 177, figure 20) to set the point at which the travel stop limits travel. Be sure to tighten the locknuts and replace the cap (key 149, figures 16 and 18; key 247, figure 17) after setting the travel stop.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 16 through 20.

1. Remove the cap (key 149 or 247) if the travel stop uses one. For down travel stops, loosen the locknuts (key 151, figures 16 and 17) so that the stop is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection in top of the yoke (key 73, figures 7, 8, and 9).
3. For down travel stops, turn the spring adjuster (key 74, figures 7, 8, and 9) out of the yoke toward the stem connector (key 31) to relieve all the compression in the spring (key 18).
4. **For style 11 travel stops (figure 17)**, unscrew the cap screws (key 161), and make sure that the guide plate (key 157) can turn between the handwheel body (key 148) and the mounting plate (key 158).
5. Use a wrench on the nuts (key 151) to unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
6. Unscrew the hex nuts and cap screws (keys 14 and 13, figures 7, 8, and 9) from the diaphragm casings. Lift off the upper diaphragm casing (key 1, figures 7, 8, and 9) and, for the style 11 travel stop, the mounting plate (key 158). For styles 10, 12 and 13, the travel stop assembly will be removed with the casing.
7. Note and record the position of travel stops (key 152) relative to the cap screws (key 154) for use in assembly. Unscrew the travel stops and cap screws, and remove either the mounting plate (key 158) or the handwheel body (key 148) and attached parts.
8. Separate the stem (key 150) and screw (key 160, figure 17) from the handwheel body.
9. Before reassembling, lubricate parts indicated by key 239 in figures 16 through 20. Use lubricant (key 239 or equivalent).
10. Reassemble parts in the reverse order of removal.
11. When replacing the cap screws (key 154) and, if used, the travel stops (key 152), be sure to return them to their original position as recorded in step 6.

# Type 667 Size 30-76 & 87



## CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14), figures 7, 8, and 9 can damage the diaphragm. Do not exceed 20 lbf•ft (27 N•m) torque.

12. Install the cap screws and nuts (keys 13 and 14, figures 7, 8, and 9) and finger tighten. Tighten the diaphragm cap screws and nuts to 20 lbf•ft (27 N•m) torque in a crisscross pattern.

13. Return the spring adjuster (key 74, figure 7, 8, and 9) to its original position. Re-adjust the travel stop.

## Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Fisher Controls sales office or sales representative regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts Kits and Parts List sections.

## Parts Kits

### Side-Mounted Handwheels Retrofit Kits

Key	Description	Part Number
	RETROFIT KIT INCLUDES PARTS TO ADD A SIDE-MOUNTED HANDWHEEL.	
	SIZE 34 PUSH-DOWN-TO-CLOSE	30A8778X0E2
	SIZE 34 PUSH-DOWN-TO-OPEN	30A8778X0F2
	SIZE 40 PUSH-DOWN-TO-CLOSE	30A8778X0G2
	SIZE 40 PUSH-DOWN-TO-OPEN	30A8778X0H2
	SIZE 45 & 46 PUSH-DOWN-TO-CLOSE	40A8779X0A2
	SIZE 45 & 46 PUSH-DOWN-TO-OPEN	40A8779X0B2
	SIZE 50 & 60 PUSH-DOWN-TO-CLOSE	40A8779X0C2
	SIZE 50 & 60 PUSH-DOWN-TO-OPEN	40A8779X0D2

### Top-Mounted Handwheels Retrofit Kits

RETROFIT KIT INCLUDES PARTS TO ADD A TOP-MOUNTED HANDWHEEL. KIT NUMBER 1 INCLUDES THE HANDWHEEL ASSEMBLY ONLY. KIT NUMBER 2 INCLUDES KIT NUMBER 1 AND A NEW DIAPHRAGM CASE THAT IS REQUIRED TO MOUNT THE HANDWHEEL ASSEMBLY.

Key	Description	Part Number
	KIT 1	
	SIZE 30	30B3940X102
	SIZES 34	39B3940X022
	SIZES 40	39B3940X042
	SIZES 45 & 50	33B9224X012
	SIZES 46, 60, AND 76	33B9224X012
	SIZES 70 & 87	CV8060X0012

Key	Description	Part Number
	KIT 2	
	SIZE 30	30B3940X052
	SIZES 34	30B3940X062
	SIZES 40	30B3940X092
	SIZES 45 & 50	33B9224X022
	SIZES 46, 60 AND 76	33B9224X032
	SIZES 70 & 87	CV8060X0022

## Actuator Repair Kits

PARTS KIT INCLUDES KEYS 8, 9, AND 70. O-RING MATERIAL IS NITRILE, AND GASKET MATERIAL IS COMPOSITION.

Key	Description	Part Number
	SIZE 30	R667X000302
	SIZE 34 & 40	R667X000402
	SIZE 45 THROUGH 60	R667X000502
	SIZE 70 & 87	R667X000702
	SIZE 76	R667X000762

## Parts List

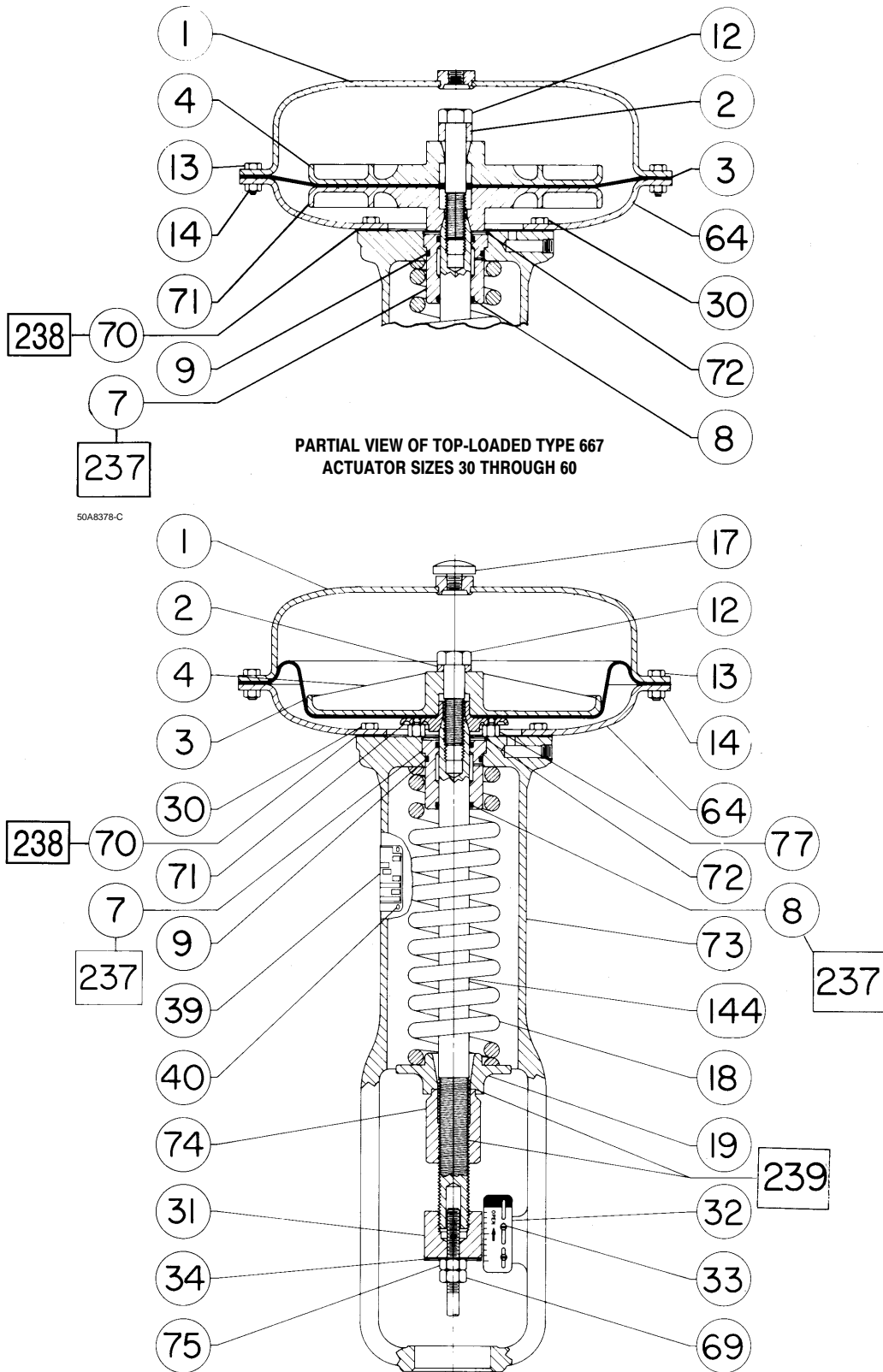
### Actuator Assembly

Key	Description	Part Number	Qty
1	UPPER DIAPHRAGM CASING [STEEL, ZINC PLATED (ZN PL)]		
	SIZE 30	2E800728992	1
	SIZE 34 & 40	2E681428992	1
	SIZE 45 & 50	3E844628992	1
	SIZE 46, 60 & 76	3E846728992	1
	SIZE 70 & 87	2N127828992	1
	W/TOP-MOUNTED HANDWHEEL		
	SIZE 30	2E792225062	1
	W/TOP-MTD HANDWHEEL OR STYLE 11 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	SIZE 46, 60 & 76	2E847425062	1
	SIZE 70 & 87	2N127125062	1
	W/STYLE 10 OR 13 TRAVEL STOP		
	SIZE 30	2E792225062	1
	W/STYLE 10 OR 12 TRAVEL STOP		
	SIZE 34 & 40	2E806325062	1
	SIZE 45 & 50	3E831625062	1
	W/STYLE 10, 12, OR 13 STOP		
	SIZE 46, 60 & 76	2E847425062	1
	W/STYLE 12 STOP OR REVERSE VALVE		
	SIZE 70 & 87	2N127125062	1
	W/STYLE 14 TRAVEL STOP		
	SIZE 30	2F486225062	1
	SIZE 34 & 40	2F753428992	1
	SIZE 45 & 50	3F860628992	1
	SIZE 46, 60 & 76	1K131025062	1
2	TRAVEL STOP SPACER	SEE FOLLOWING TABLE	
3*	DIAPHRAGM		
	MOLDED NITRILE/NYLON		
	SIZE 30	2E800002202	1
	SIZE 34 & 40	2E669902202	1
	SIZE 45 & 50	2E859602202	1
	SIZE 46, 60 & 76	2E859802202	1
	SIZE 70 & 87	2N130902202	1
	FLUOROELASTOMER/NOMEX		
	SIZE 30	1K7982X00A2	1
	SIZE 34 & 40	1F3620X00A2	1
	SIZE 45 & 50	1J381902402	1
	SIZE 46, 60 & 76	1R7728X00A2	1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
3*	DIAPHRAGM (Cont'd)		12	SCREW, CAP, HEX HD	
	MOLDED SILICONE/POLYESTER			STANDARD HANDWHEEL, TRAVEL STOP STYLE 13, ADJ.	
	SIZE 30	2E8000X0022 1		UP STOP STYLE 14, FOR:	
	SIZE 34 & 40	2E6699X0042 1		SIZE 30	
	SIZE 45 & 50	2E8596X0012 1		1/4, 5/16, & 11/16-INCH (6, 8, & 17 mm)	
	SIZE 46, 60 & 76	2E8598X0012 1		TRAVEL	1A8678X0012 1
	SIZE 70 & 87	2N1309X0012 1		7/16, 5/8, & 3/4-INCH (11, 16, & 19 mm)	
4	UPPER DIAPHRAGM PLATE			TRAVEL	1B227523052 1
	ALUMINUM [200°F (93°C) MAXIMUM]			3/8, 7/16, 1/2, 9/16, & 5/8-INCH (10, 11, 13,14, & 16 mm)	
	SIZE 30	31B2028X012 1		TRAVEL	1A8678X0032 1
	SIZE 34 & 40	31B2029X012 1		11/16 & 3/4-INCH (17 & 19 mm)	
	SIZE 45 & 50	41B2030X012 1		TRAVEL	1B2275X0022 1
	SIZE 46, 60 & 76	41B2031X012 1	13	HEX HD CAP SCREW (STEEL, ZN PL)	
	CAST IRON			SIZE 30	1E760324052 12
	SIZE 30	2E880419042 1		SIZE 34 & 40	1E760324052 16
	SIZE 34 AND 40	3E880519042 1		SIZE 45 & 50	1A675124052 20
	SIZE 45 & 50	2E831519042 1		SIZE 46, 60 & 76	1A675124052 24
	SIZE 46, 60, & 76	2E847519042 1		SIZE 70 & 87	1A582824052 28
	SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	2N127019042 1			
	SIZE 70 & 87 4 IN. (102 mm) TRAVEL	10A2421X012 1	14	HEX NUT (STEEL, ZN PL)	
	SIZE 70 & 87 TYPE 667-4	10A2421X012 1		SIZE 30	1A346524122 12
	WCB STEEL			SIZE 34 & 40	1A346524122 16
	SIZE 30	2H510922012 1		SIZE 45 & 50	1A346524122 20
	SIZE 34 & 40	3H511122012 1		SIZE 46, 60 & 76	1A346524122 24
	SIZE 45 & 50	2H511322012 1		SIZE 70 & 87	1A346524122 28
	SIZE 46, 60, & 76	2H511522012 1	17	VENT ASSEMBLY	
	SIZE 70 & 87	2N757522012 1		ALL SIZES	17A5515X012 1
7*	BUSHING, SEAL		18	SPRING	SEE FOLLOWING TABLE
	BRASS		19	SEAT, LOWER SPRING	
	SIZE 30	1E791214012 1		G10300 (STEEL, ZN PL)	
	SIZE 34 & 40	1E682814012 1		SIZE 30	1U425623122 1
	SIZE 45 THROUGH 60	1E845714012 1		SIZE 34 & 40	1R179923122 1
	SIZE 70, 76 & 87	1N1316X0052 1		SIZE 45 THROUGH 60	1R180023122 1
	S41600 [416 STAINLESS STEEL (SST)]			CAST IRON	
	SIZE 30	1E7912X0012 1		STANDARD	
	SIZE 34 & 40	1E6828X0012 1		SIZE 70, 76 & 87	1N129619052 1
	SIZE 45 THROUGH 60	1E8457X0012 1		WCB STEEL	
	PTFE W/25% GLASS			STANDARD	
	SIZE 70, 76 & 87	1N1316X0042 1		SIZE 70 & 87	1N757722012 1
8*	O-RING			CAST IRON	
	NITRILE			W/HANDWHEEL	
	SIZE 30	1E591406992 2		SIZE 70, 76 & 87	1N887119042 1
	SIZE 34 & 40	1D237506992 2	27	EXTENSION ROD CONN (STEEL, ZN PL)	
	SIZE 45 THROUGH 60	1C562206992 2		W/TOP-MOUNTED HANDWHEEL	
	SIZE 70, 76 & 87	1E736906992 2		SIZE 30	1F118824092 1
	FLUOROELASTOMER			W/TOP-MTD HANDWHEEL OR STYLE 11	
	SIZE 30	1E5914X0062 2		SIZE 34 & 40	1F135924092 1
	SIZE 34 & 40	1D237506382 2			
	SIZE 45 THROUGH 60	1N285406382 2	27	EXTENSION ROD CONN (STEEL, ZN PL) (CONT.)	
9*	O-RING			SIZE 45 THROUGH 60 & 76	1F119424092 1
	NITRILE			STEEL, ZN PL	
	SIZE 30 THROUGH 40	1C415706992 1		W/TOP-MOUNTED HANDWHEEL	
	SIZE 45 THROUGH 87	1E845806992 1		SIZE 70 & 87 TO 3 IN. (76 mm) TRAVEL	1N838331012 1
	FLUOROELASTOMER			SIZE 70 & 87 W/4 IN. (102 mm) TRAVEL	11A8130X012 1
	SIZE 30 THROUGH 40	1C4157X0032 1	30	HEX HD CAP SCREW (STEEL, ZN PL)	
	SIZE 45 THROUGH 87	1E8458X0022 1		SIZE 30	1D529824052 6
12	SCREW, CAP, HEX HD	SEE FOLLOWING TABLE		SIZE 34 & 40	1A368424052 6
				SIZE 45 THROUGH 60 & 76	1A368424052 8
				SIZE 70 & 87	1N129328992 12

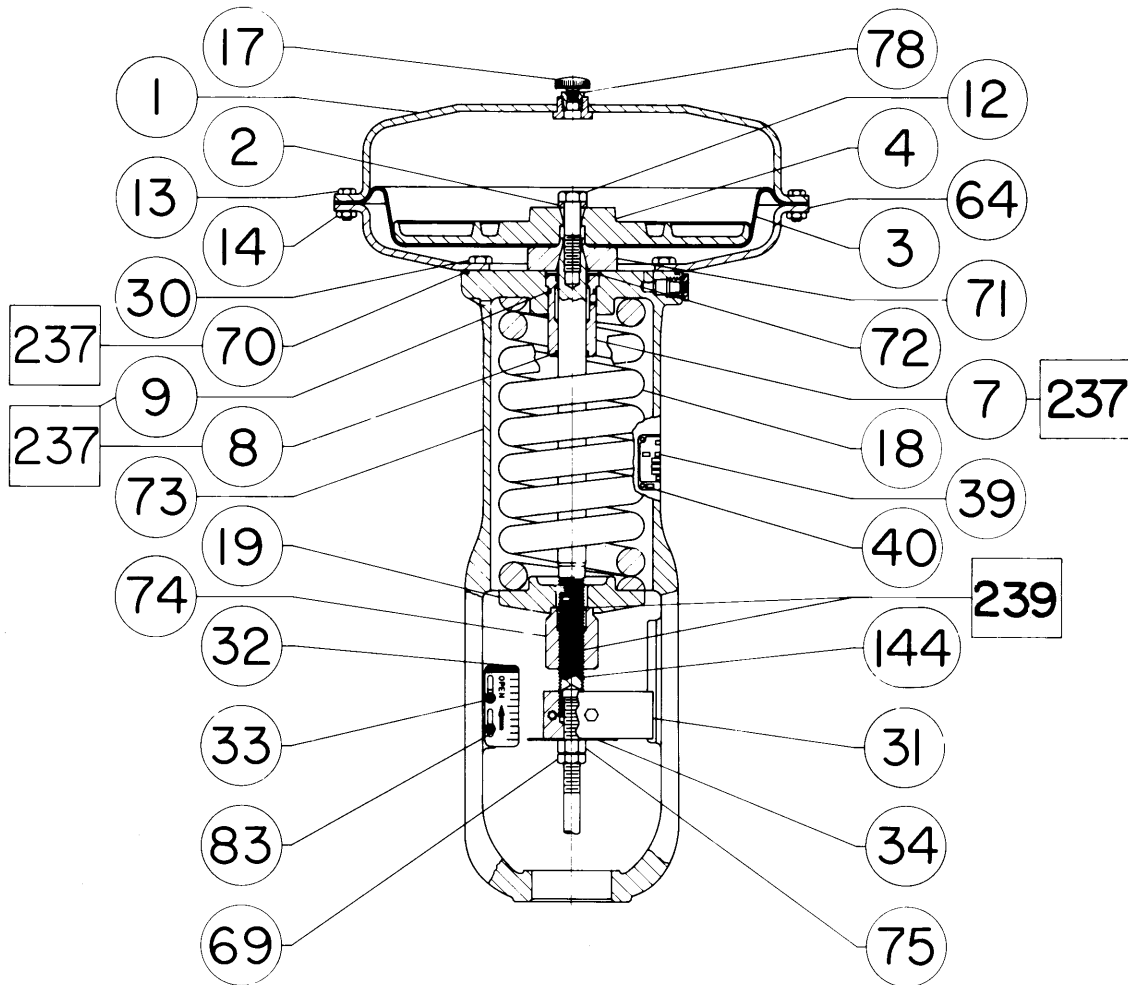
# Type 667 Size 30-76 & 87



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50A8379-C/IL

Figure 7. Type 667 Actuator Sizes 30 through 60

# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT  
50A8598-E / IL

Figure 8. Type 667 Size 70 Actuator

Key	Description	Part Number	Key	Description	Part Number
31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL)		31	STEM CONNECTOR ASSEMBLY (STEEL, ZN PL) (Con't.)	
	STANDARD			W/PMV POSITIONER	
	SIZE 30 & 34	18A1243X012 1		SIZE 70 3/4 TO 4 IN. (19 TO 102 mm)	
	SIZE 40	18A1668X012 1		TRAVEL	11B2000X012 1
	SIZE 45 & 46	18A1671X012 1			
	SIZE 50 & 60	18A1672X012 1	32	TRAVEL INDICATOR SCALE	SEE FOLLOWING TABLE
	SIZE 70 & 76	18A1675X012 1			
	SIZE 87	18A1825X012 1	33	SCREW, SELF TAPPING	
	W/SIDE-MOUNTED HANDWHEEL			STAINLESS STEEL	
	SIZE 34	1F659225142 1		STANDARD	
	SIZE 40	1F659125142 1		SIZE 30 THROUGH 46	1E793238992 2
	SIZE 45 & 46	2F1678000A2 1		SIZE 50 THROUGH 87	1E831338992 2
	SIZE 50 & 60	2F1672000A2 1			
	SIZE 70 3/4 THROUGH 3 IN. (19 TO 76 mm)		33	SCREW, MACH. FILL HD (STEEL, PLATED)	
	TRAVEL	18A1678X012 1		W/HANDWHEEL	
	SIZE 70 3/4 THROUGH 4 IN. (19 TO 102 mm)			SIZE 45 & 46	1B992528992 2
	TRAVEL	21A8254X012 1		SIZE 70, 76 & 87	1A340628982 2
	SIZE 76	18A1678X012 1			
	SIZE 87 1 IN. (25.4 mm) VALVE STEM	18A1825X012 1			
	SIZE 87 1-1/4 (31.8 mm) VALVE STEM	18A1833X012 1			

# Type 667 Size 30-76 & 87

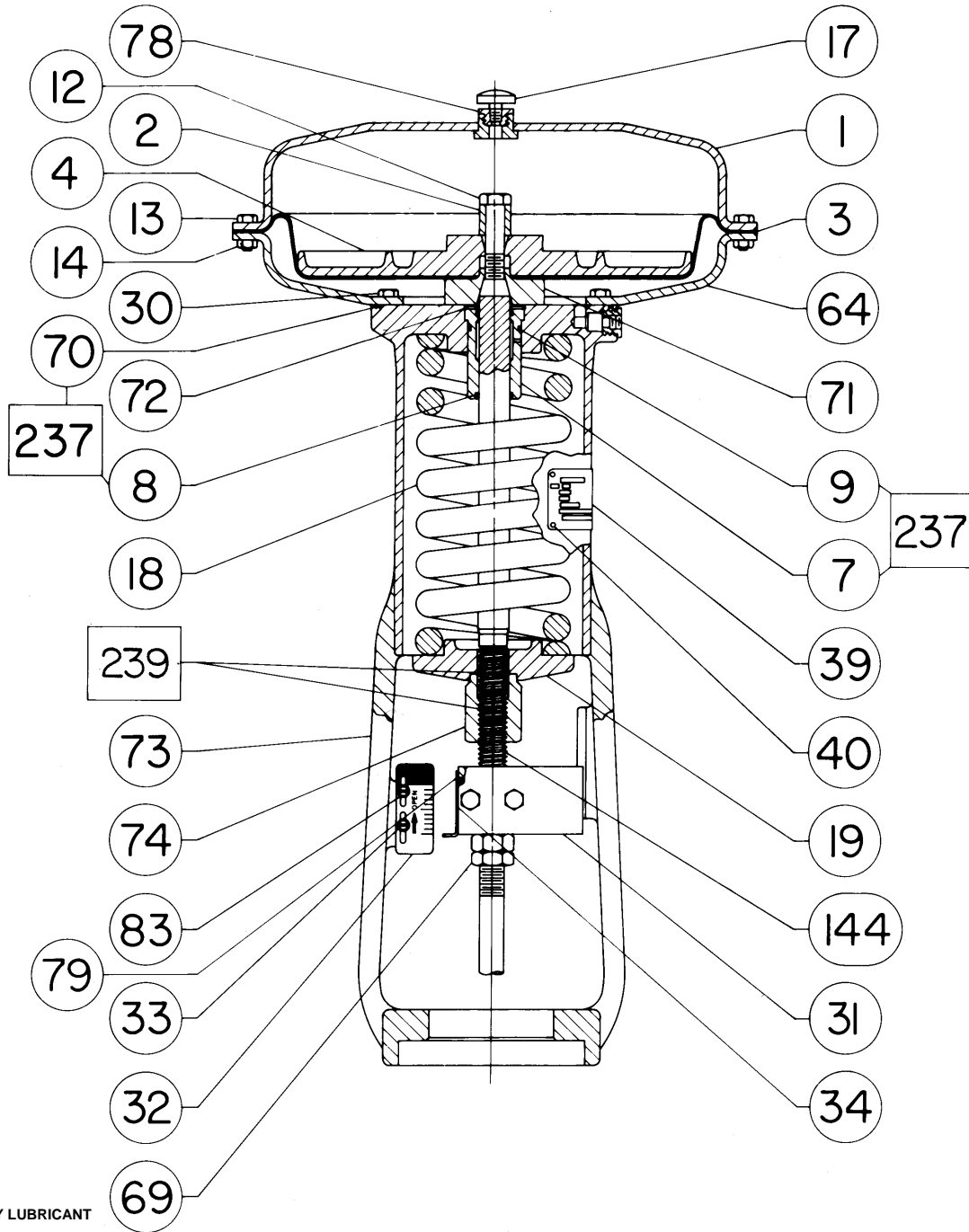


Figure 9. Type 667 Size 87 Actuator

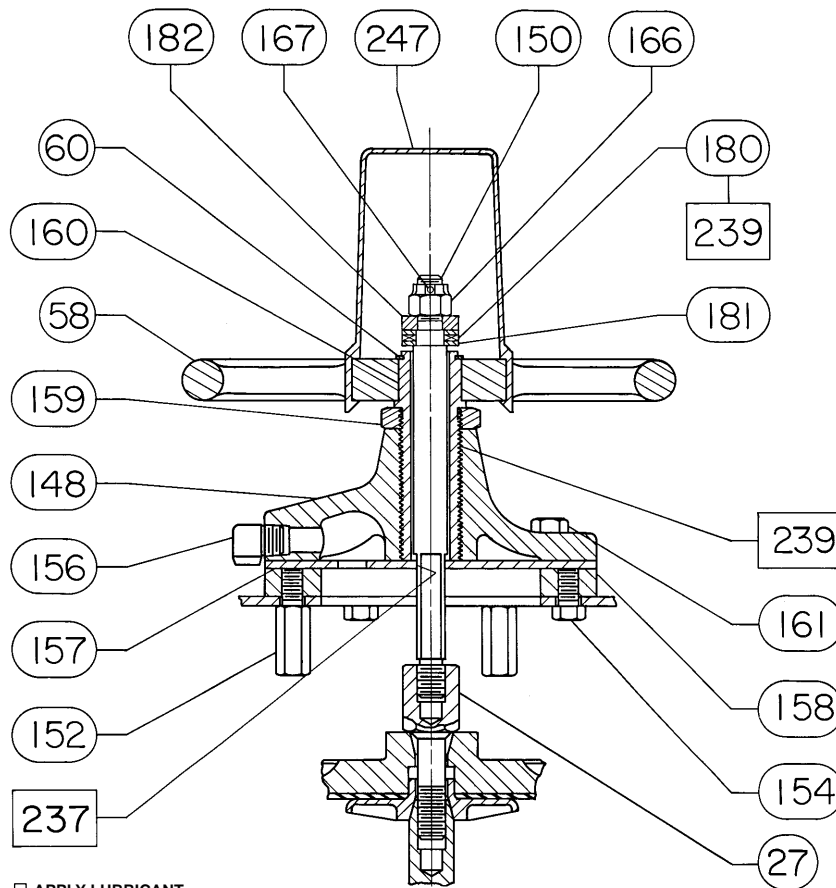
Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) STANDARD		34	DISC, TRAVEL INDICATOR (SST) (Cont'd) W/SIDE-MOUNTED HANDWHEEL	
	SIZE 30 & 34	1E793138992 1		SIZE 34	1E793138992 1
	SIZE 40 THROUGH 46	1E807538992 1		SIZE 40	1E807538992 1
	SIZE 50 & 60	1E832838992 1		SIZE 46	11B7008X012 1
	SIZE 70 & 76	1B971838992 1		SIZE 60 & 70	1E832838992 1
	SIZE 87	10A8487X012 1		SIZE 76	1B971838992 1



# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
34	DISC, TRAVEL INDICATOR (SST) (Cont'd)		73	YOKE	
	W/TYPE 304 SWITCH			CAST IRON	
	SIZE 30 & 34	10A0038X012	2	MOUNTING BOSS UNTAPPED	
	SIZE 40 THROUGH 46	1N253936012	2	SIZE 30	3E801419042
	SIZE 50 & 60	1N254036012	2	SIZE 34	3E884619042
39	NAMEPLATE			SIZE 40	3E820819042
	STAINLESS STEEL			SIZE 45 & 46	3E900819042
	ALL SIZES	12B6508X0A2	1	SIZE 50 & 60	3E845919042
40	SCREW, DRIVE			SIZE 70	3N130319042
	STAINLESS STEEL			SIZE 76	42B5909X012
	ALL SIZES	1A368228982	6	SIZE 87	3N664219042
64	LOWER DIAPHRAGM CASING (STEEL)			MOUNTING BOSS UNTAPPED W/HANDWHEEL	
	STANDARD			SIZE 70 & 76	4N890119042
	SIZE 30	2E801125062	1	SIZE 87 TO 3 IN. (76 mm) TRAVEL	4N886619042
	SIZE 34 & 40	2E682625062	1	MOUNTING BOSS TAPPED	
	SIZE 45 & 50	3E845325062	1	SIZE 30	3L921419042
	SIZE 46, 60 & 76	3E847725062	1	SIZE 34	3L9203X0012
	SIZE 70 & 87	2N131025062	1	SIZE 40	3L921619042
	W/ 1/2 NPT CONNECTION			SIZE 45 & 46	3L894219042
	SIZE 30	2H3822X00A2	1	SIZE 50 & 60	3L921919042
	SIZE 34 & 40	2K506725062	1	SIZE 70	3N130419042
	SIZE 45 & 50	2H3081X00A2	1	SIZE 76	42B6795X012
	SIZE 46 & 60	2F803325062	1	SIZE 70 TYPE 667-4	31A7392X012
69	NUT, HEX, JAM (STEEL ZN PL)			SIZE 87	3N664319042
	STANDARD			SIZE 87 TYPE 667-4	31A3813X012
	SIZE 45	1A353724122	2	MOUNTING BOSS TAPPED W/HANDWHEEL	
	SIZE 40 & 46	1A353724122	1	SIZE 70 & 76	4N890219042
	SIZE 50 THROUGH 70 & 76	1A351124122	1	SIZE 70 TYPE 667-4	4N890119042
	1 IN. (25.4 mm) VALVE STEM			SIZE 87	4N889019042
	SIZE 87	1C635224122	2	SIZE 87 TYPE 667-4	4N889019042
	1-1/4 (31.8 mm) VALVE STEM			WCB (STEEL)	
	SIZE 87	0W073524122	2	MOUNTING BOSS UNTAPPED	
70*	GASKET			SIZE 30	3K815622012
	COMPOSITION [UP TO 450°F (232°C)]			SIZE 34	3H787122012
	SIZE 30 THROUGH 40	1E801204022	1	SIZE 40	3H787322012
	SIZE 45 THROUGH 60 & 76	1E845404022	1	SIZE 45 & 46	3H787522012
				SIZE 50 & 60	3K830322012
				SIZE 70	3N130622012
				SIZE 87	3N758722012
70*	O-RING			MOUNTING BOSS TAPPED	
	NITRILE			SIZE 30	3L921522012
	SIZE 70 & 87	1D269106992	1	SIZE 34	3L9202X0012
				SIZE 40	3L921722012
				SIZE 45 & 46	3L921822012
71	LOWER DIAPHRAGM PLATE			SIZE 50 & 60	3L922022012
	ZINC			SIZE 70	3N130722012
	SIZE 30	1E791344022	1	SIZE 87	3N758822012
	SIZE 34 & 40	1E682744022	1		
	SIZE 45 THROUGH 60 & 76	1E845544022	1	74	SPRING ADJUSTER (STEEL, ZN PL)
	STEEL			SIZE 30	1E801724102
	SIZE 34 & 40	1F885824092	1	SIZE 34 & 40	1E821024102
	SIZE 45 THROUGH 60	1F890924092	1	SIZE 45 THROUGH 60	1E846224102
	STANDARD CONSTRUCTION			SIZE 70 & 87 W/HANDWHEEL	1N886924392
	SIZE 70 & 87 TO 3-IN. (76 mm) TRAVEL	1N131524092	1	SIZE 70 & 87 TYPE 667-4	11A3811X012
	STANDARD OR W/SIDE-MTD HANDWHEEL			SIZE 70 & 87 TYPE 667-4 W/HANDWHEEL	1N886924392
	SIZE 70 & 87 W/4-IN. (102 mm) TRAVEL	1V7826X0012	1	SIZE 76	
				MAX SPRING ADJUSTMENT (ADJ)	
72	RING, SNAP			2-INCH (51 mm)	1N131824102
	S30200 (302 SST)			2.5-INCH (64 mm)	1N909524502
	STANDARD			3.5-INCH (89 mm)	1U1079X00A2
	SIZE 30 THROUGH 40	1E801337022	1	MAX SPRING ADJ W/SIDE-MOUNTED HANDWHEEL	
	SIZE 45 THROUGH 87	1E845638992	1	2.25-INCH (57 mm)	1N886924392
				2.75-INCH (70 mm)	1V176624092

# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT

NOTE:

THE TOP MOUNTED HANDWHEEL IS NOT DESIGNED FOR USE UNDER HEAVY LOAD OR FREQUENT USE.

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Figure 10. Top-Mounted Handwheel Assembly for Size 30 through 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
75	NUT, HEX (STEEL, ZN PL) STANDARD SIZE 30 & 34	1P131224142 2	81	SCREW, MACH, RD HD (CARBON STEEL, PLATED) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1A331928982 2
	SIZE 40 & 46	1A413224122 1			
75	NUT, HEX (Cont.) SIZE 50 THROUGH 76	1A375424122 1	82	INDICATOR, TRAVEL, ADAPTOR (BRASS) W/SIDE-MOUNTED HANDWHEEL SIZE 45 & 46	1F548214012 2
76	NUT, SPEED, TWIN STAINLESS STEEL STANDARD SIZE 30 & 34	1E793938992 1	83	WASHER, PLAIN CARBON STEEL-PLATED SIZE 70, 76 & 87 W/HANDWHEEL	1E873028992 2
	SIZE 40 THROUGH 46	1E808438992 1		BRASS SIZE 70, 76 & 87 W/HANDWHEEL	1F565618992 2
	SIZE 50 THROUGH 87	1E833538992 1			
77	STOP, TRAVEL (STEEL, ZN PL) (USE FOR PUSH-DOWN-TO-OPEN) SIZE 30 THROUGH 40	1H493524092 2	89	SPRING CASE ADAPTOR (CAST IRON) STANDARD SIZE 70 & 87 TYPE 667-4	2N889419042 1
	SIZE 45 THROUGH 60	1H494324092 2		W/HANDWHEEL SIZE 70 & 87 TYPE 667-4	3R675819042 1
78	BUSHING, PIPE, HEX (STEEL, PLATED ) SIZE 70 & 87	1C379026232 1	90	SCREW, CAP (STEEL, ZN PL) SIZE 70 & 87 TYPE 667-4	1N872428992 12
79	SCREW, MACH, FLAT HD (STEEL PLATED) SIZE 87	1H736528982 2	102	PLUG, PIPE, HEX HD (STEEL) W/ 1/2 NPT CONNECTION SIZE 30 THROUGH 60	1A767524662 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
144	ACTUATOR STEM (CHROMIUM PLATED STEEL)			<b>Top-Mounted Handwheel (Figures 10, 11, And 12)</b>	
	STANDARD		58	HANDWHEEL (CAST IRON)	
	SIZE 30	2E8016X0022 1		SIZE 30	1F119119042 1
	SIZE 34	3E8847X0012 1		SIZE 34 & 40	1F115819042 1
	SIZE 40	2E8209X0042 1		SIZE 45 TO 60 & 76	1F119819042 1
	SIZE 45 & 46	2J3328X0042 1		SIZE 70 & 87	2N837919042 1
	SIZE 50 & 60	2E8461X0042 1		STEEL	
	SIZE 70 & 76	2N131724222 1		SIZE 34 & 40	1H551922012 1
	SIZE 87	2N664724222 1		SIZE 45 TO 60 & 76	1H552122012 1
	W/SIDE-MOUNTED HANDWHEEL			SIZE 70 & 87	23B9744X012 1
	SIZE 34	2E8209X0042 1	60	RETAINER RING (STEEL, ZN PL)	
	SIZE 40	2F3259X0012 1		SIZE 34 & 40	1A911628992 1
	SIZE 70 3-IN. (76 mm) TRAVEL	2N890624222 1		Size 45 To 60 & 76	
	SIZE 70 TO 4-IN. (102 mm) TRAVEL	21A9816X012 1		8-INCH (203 mm) HANDWHEEL	1F120028992 1
	SIZE 76	23B7066X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	SIZE 87 3-IN. (76 mm) TRAVEL	2N889624222 1		SIZE 70 & 87	
	SIZE 87 TO 4-IN. (102 mm) TRAVEL	22A1501X012 1		14-INCH (356 mm) HANDWHEEL	1N837328992 1
	TYPE 667-4 STANDARD		148	HANDWHEEL BODY	
	SIZE 70	21A3812X012 1		CAST IRON	
	SIZE 87	22A1963X012 1		SIZE 30 TO 40	27A9446X012 1
	TYPE 667-4 W/HANDWHEEL			SIZE 45 TO 60 & 76	27A9444X012 1
	SIZE 70	23A1793X012 1		SIZE 70 & 87	2N837719022 1
	SIZE 87	23A0125X012 1		STEEL	
	S31600 (316 SST)			SIZE 34 & 40	27A9636X012 1
	STANDARD			SIZE 45 TO 60 & 76	27A9445X012 1
	SIZE 30	1N429135162 1		SIZE 70 & 87	
	SIZE 34	1N429235162 1		EXTENSION ROD (416 SST)	
	SIZE 40	1N429335162 1		SIZE 30	29A9896X012 1
	SIZE 45	1N429535072 1		SIZE 34 & 40	29A9897X012 1
	SIZE 46 & 50	1N429435072 1		SIZE 45 TO 60 & 76	
	SIZE 60	1N429535072 1		UNDER 4000 LB (17,000 N·M)	23B9217X012 1
227	WASHER, PLAIN (STEEL, ZN PL)			4000 TO 6000 LB (17,000 TO 26,700 N·M)	23B9219X012 1
	W/TYPE 304 SWITCH			SIZE 45 TO 60 P-2	29A9900X012 1
	SIZE 40 THROUGH 46	1E658828982 2		SIZE 70 & 87	
	CARBON STEEL			3/4 IN. (19 mm) THROUGH	
	W/TOP-MOUNTED HANDWHEEL			3 IN. (76 mm) TRAVEL	24B0242X012 1
	SIZE 70 TO 3-IN. (76 mm) TRAVEL	1A521228992 1		4 IN. (102 mm) TRAVEL	24B0243X012 1
	W/TYPE 304 SWITCH		152	TRAVEL STOP (STEEL, ZN PL)	SEE FOLLOWING TABLE
	SIZE 60	1A375728992 2		154	CAP SCREW (PL STEEL)
	SIZE 70 & 76	1A375728992 1		SIZE 30 TO 40	1D529824052 3
228	STEM DISC SPACER [S41600 (416 SST)]			SIZE 45 TO 60 & 76	1A368424052 4
	W/TYPE 304 SWITCH			SIZE 70 & 87	1N129328992 9
	SIZE 70 TO 3-IN (76 mm) TRAVEL	1N952635132 1		156	VENT ASSEMBLY
	SIZE 76	1N952635132 1		SIZE 30 TO 60 & 76	27A5516X012 1
237	LUBRICANT, LUBRIPLATE MAG-1			SIZE 70 & 87	17A6572X022 1
	OR EQUIVALENT	---		157	GUIDE PLATE (STEEL)
	NOT FURNISHED WITH ACTUATOR	---		SIZE 30 TO 40	1F116428992 1
238	SEALANT, PERMATEx #2,			SIZE 45 TO 60 & 76	1F119528992 1
	FORM-A-GASKET			SIZE 70 & 87	1N837528982 1
	NOT FURNISHED WITH ACTUATOR	---		158	MOUNTING PLATE
239	LUBRICANT, ANTI-SIZE LUB-3			CAST IRON	
	NEVER-SEEZ OR EQUIVALENT			SIZE 30 TO 40	1F116519042 1
	NOT FURNISHED WITH ACTUATOR	---		SIZE 45 TO 60 & 76	1F119319042 1
254	WARNING NAMEPLATE	14B6769X0A2		STEEL, ZN PL	
				SIZE 34 & 40	1H552622012 1
				SIZE 45 TO 60 & 76	1H550922012 1

# Type 667 Size 30-76 & 87

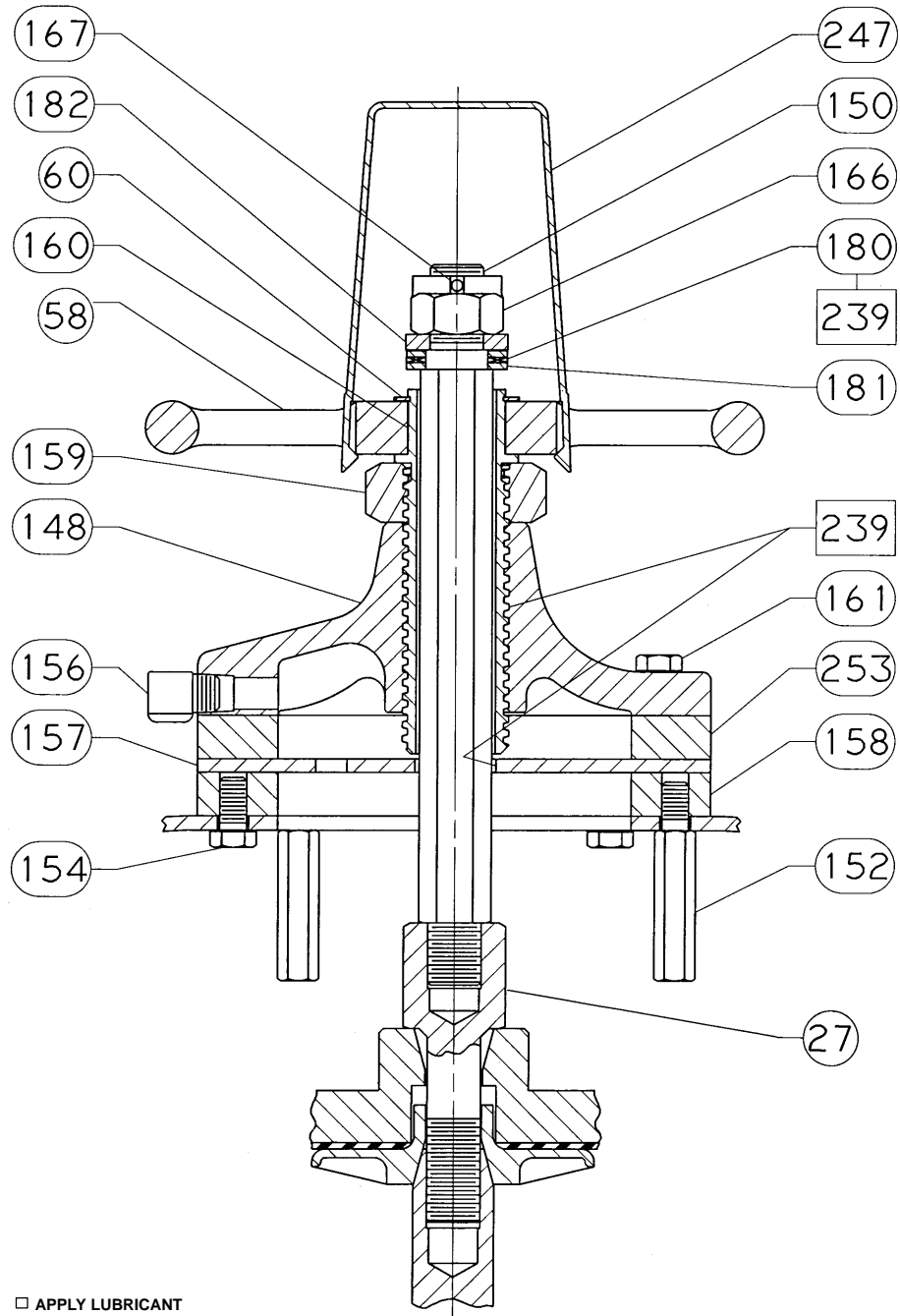


Figure 11. Top-Mounted Handwheel Assembly for Size 45-76 Actuators

# Type 667 Size 30-76 & 87

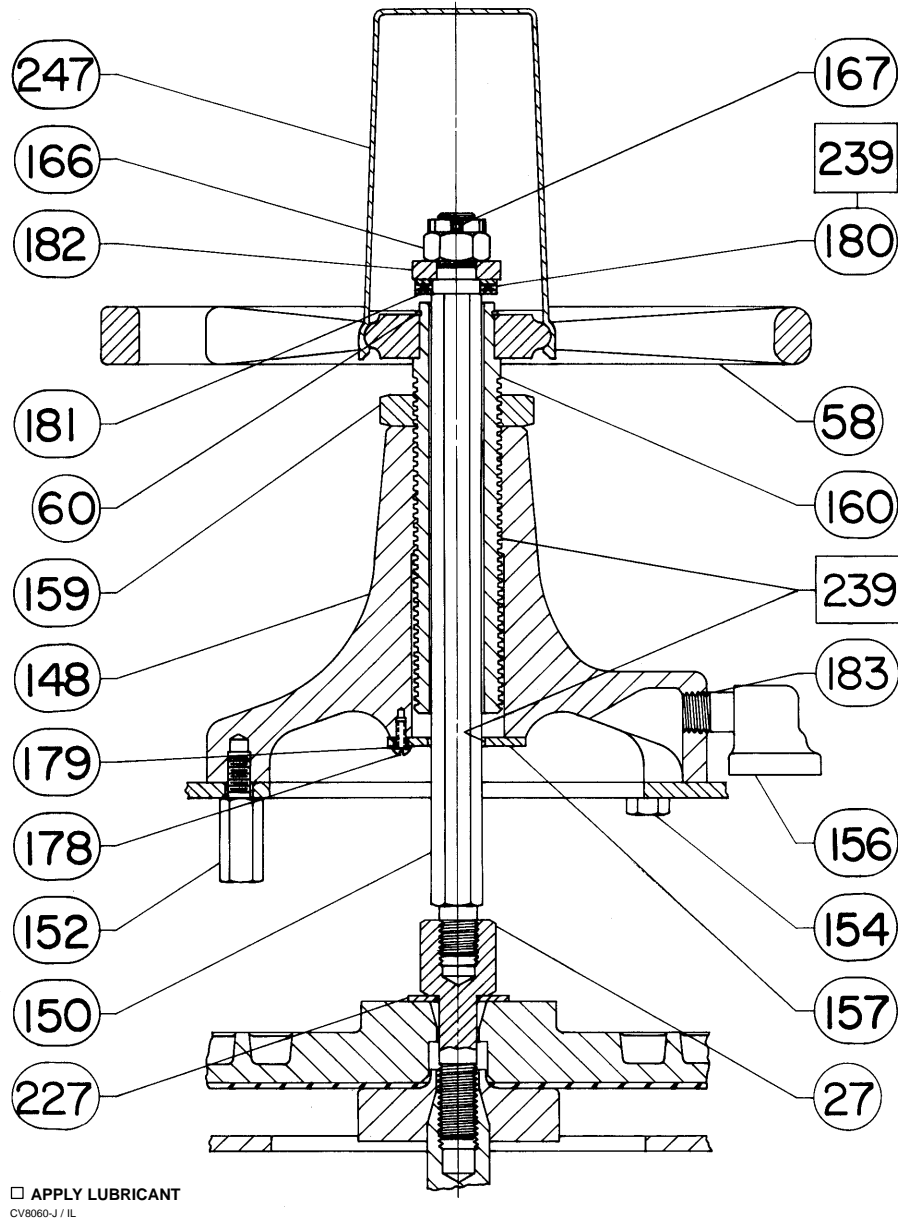


Figure 12. Top-Mounted Handwheel Assembly for Size 70 and 87 Actuators

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
159	LOCK NUT BRASS SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 STEEL, ZN PL SIZE 70 & 87	18A1271X012 1 18A2302X012 1 18A2302X012 1 1N837824102 1	247	HANDWHEEL CAP PLASTIC FOR CAST IRON HANDWHEEL SIZE 30 SIZE 34 TO 60 & 76 FOR STEEL HANDWHEEL SIZE 34 TO 60 & 76 FOR CAST IRON OR STEEL HANDWHEEL SIZE 70 & 87	27A8621X012 1 27A8622X012 1 28A1609X012 1 37A8623X012 1
160	HANDWHEEL SCREW (BRONZE) SIZE 30 SIZE 34 & 40 SIZE 45 TO 60 & 76 SIZE 45 TO 60 P-2 SIZE 70 & 87	27A9639X012 1 27A9640X012 1 27A9637X012 1 27A9638X012 1 1N837414042 1	253	SPACER, HANDJACK CAST IRON SIZE 45 TO 76 STEEL SIZE 45 TO 76	23B9218X012 1 23B9221X012 1
161	CAP SCREW (PL STEEL) CAST IRON HANDWHEEL BODY SIZE 30 TO 40 STEEL HANDWHEEL BODY SIZE 34 & 40 CAST IRON & STEEL HANDWHEEL BODIES SIZE 45 TO 60 & 76	1A344924052 6 1N568232982 6 1A341824052 8	<b>Side-Mounted Handwheel (30-60, Figures 13 and 14)</b>		
166	CASTLE NUT (PL STEEL) SIZE 30 TO 40 SIZE 45 TO 87	1K193424122 1 1F120224122 1	51	HANDWHEEL CAST IRON SIZE 34 & 40 SIZE 45 TO 60	2D358519052 1 2D405019042 1
167	COTTER PIN SST SIZE 30 TO 40 SIZE 45 TO 87	1C5959X0012 1 1J340238992 1	54	HEX JAM NUT PL STEEL SIZE 34 & 40 SIZE 45 TO 60	1A352424112 1 1A352424122 1
178	MACHINE SCREW (PL STEEL) SIZE 70 & 87	1B877428992 4	55	BALL STEEL	1A342732992 1
179	LOCKWASHER (PL STEEL) SIZE 70 & 87	1A329128982 4	56	SPRING BRONZE	0D005916012 1
180	THRUST BEARING (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5444X012 1 1N838099012 1 13B9737X012 1	132	OPERATING NUT (STEEL) LEFT-HAND (DIRECT-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60 RIGHT-HAND (REVERSE-ACTING VALVE) SIZE 34 & 40 SIZE 45 TO 60	1F659024092 1 2F548524092 1 1F658924092 1 2F548424092 1
181	THRUST RACE (STEEL) SIZE 30 TO 40 SIZE 45 TO 76 SIZE 70 AND 87	14A5446X012 2 1N838199012 2 13B9737X012 2	136	BEARING RETAINER STEEL SIZE 45 TO 60	1D385224092 1
182	BEARING RETAINER (STEEL, ZN PL) SIZE 30 TO 40 SIZE 45 THROUGH 60 & 76 SIZE 70 & 87	19A9895X012 1 19A9898X012 1 13B9741X012 1	142	HANDWHEEL BODY CAST IRON SIZE 34 & 40 SIZE 45 TO 60	3F6572000A2 1 3F1446000A2 1
183	PIPE NIPPLE (STEEL,GALV, ZN PL) SIZE 70 & 87	1K201526022 1	143	MOUNTING BOLTS STEEL SIZE 34 & 40 SIZE 45 & 46 SIZE 50 & 60	10A8522X012 2 18A9147X012 2 1F155624092 2
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	144	HEX NUT PL STEEL SIZE 34, 40, 50 & 60 SIZE 45 & 46	1A375324122 4 1A375324122 2
			145	HANDWHEEL SCREW BRONZE	

# Type 667 Size 30-76 & 87

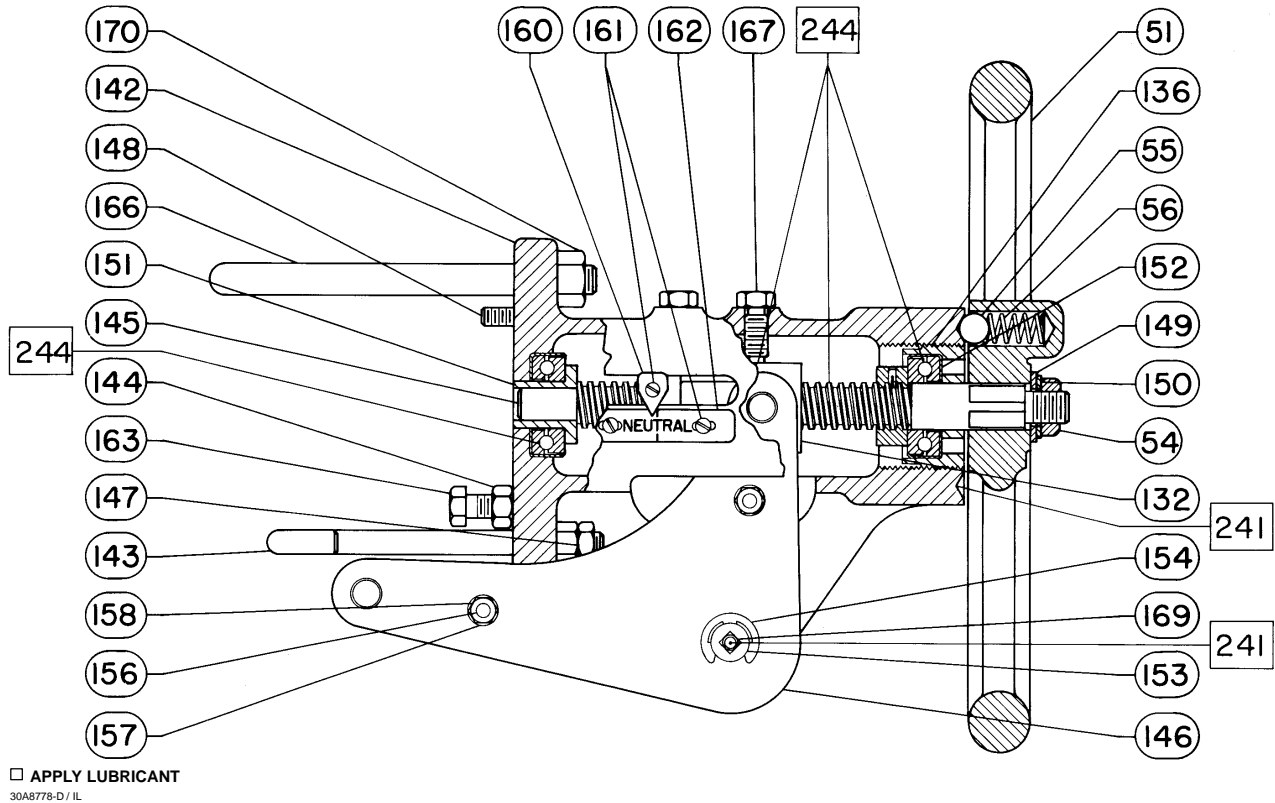
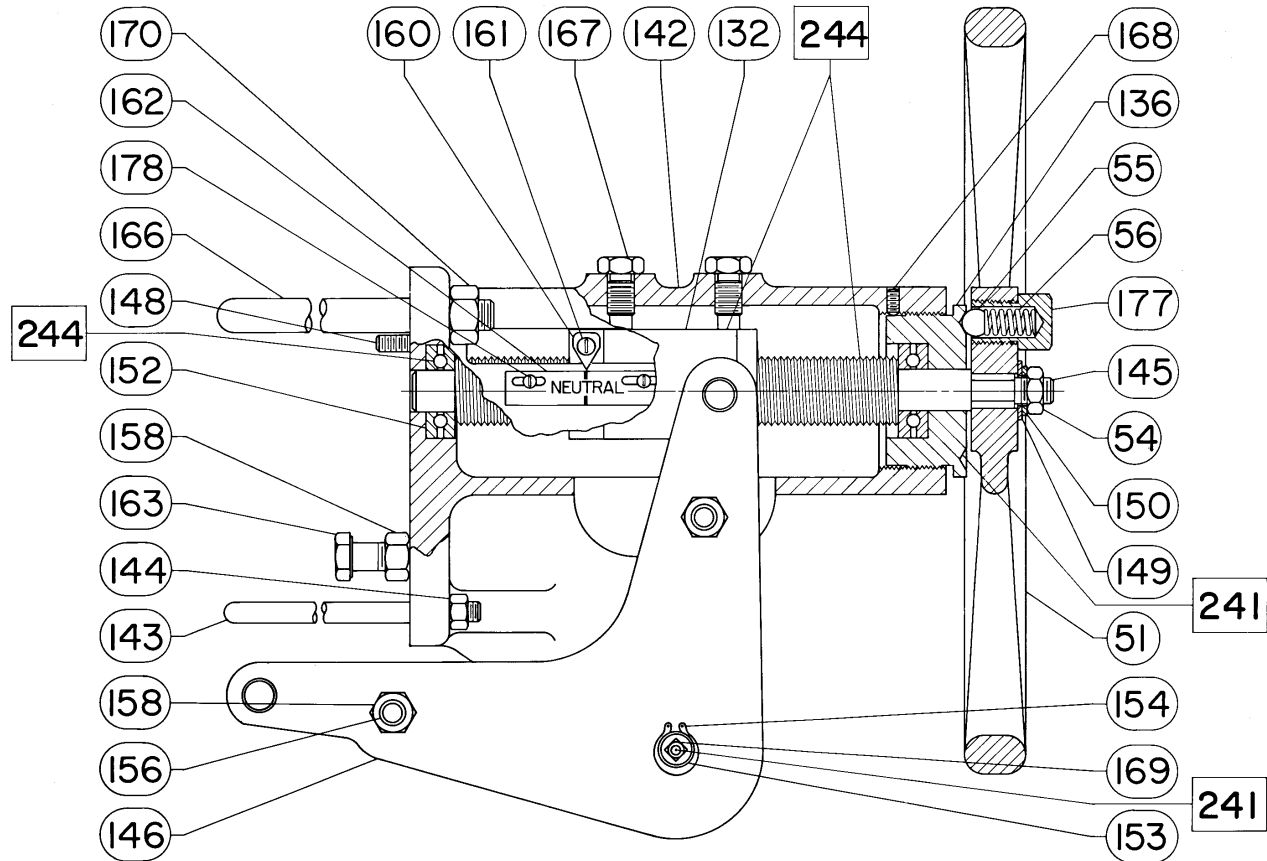


Figure 13. Side Mounted Handwheel Assembly for Size 34 and 40 Actuators

Key	Description	Part Number	Key	Description	Part Number
	LEFT-HAND (DIRECT-ACTING VALVE)		153	LEVER PIVOT PIN (416 SST)	
	SIZE 34 & 40	1F6584000A2 1		SIZE 34 & 40	1F658135232 1
	SIZE 45 TO 60	1F548614052 1		SIZE 45 TO 60	1F156235232 1
	RIGHT-HAND (REVERSE-ACTING VALVE)		154	RETAINING RING (PL STEEL)	
	SIZE 34 & 40	1F6583000A2 1		SIZE 34 & 40	1F599428982 2
	SIZE 45 TO 60	1F548714052 1		SIZE 45 TO 60	1A903028992 2
146	LEVER & PIN ASSEMBLY		155	SPACER (STEEL)	
	STEEL			SIZE 34 & 40	1F658224092 2
	RIGHT-HAND SIDE			SIZE 45 TO 60	1F162524092 2
	SIZE 34 & 40	1F6614000A2 1	156	SCREW (PL STEEL)	
	SIZE 45 TO 60	1F1541000A2 1		SIZE 34 & 40	1D980628982 2
	LEFT-HAND SIDE			SIZE 45 TO 60	1F157624052 2
	SIZE 34 & 40	1F6613000A2 1	157	LOCKWASHER (PL STEEL) SIZE 34 & 40	1C225628982 2
	SIZE 45 TO 60	1F1539000A2 1	158	HEX NUT (PL STEEL) SIZE 34 & 40	1A345724122 2
147	HEX JAM NUT (PL STEEL)			SIZE 45 TO 60	1A341224122 4
	SIZE 34 & 40	1A352224122 2	159	POINTER MOUNTING BOLT (416 SST)	
148	DOWEL PIN (STEEL, ZN PL)			SIZE 34 & 40	1F657835132 1
	SIZE 34 TO 60	1D419828992 2		SIZE 45 TO 60	1F156535132 1
149	WASHER (PL STEEL)	1A518925072 1	160	POINTER (302 SST)	1F157536012 1
150	LOCKWASHER (PL STEEL)	1A353828982 1	161	MACHINE SCREW (PL STEEL)	
151	BUSHING (PL STEEL)			SIZE 34 & 40	1A344524052 8
	SIZE 34 & 40	1F657924092 1		SIZE 45 TO 60	1E175828982 1
152	BALL BEARING (STEEL)	1D361399012 2			

# Type 667 Size 30-76 & 87



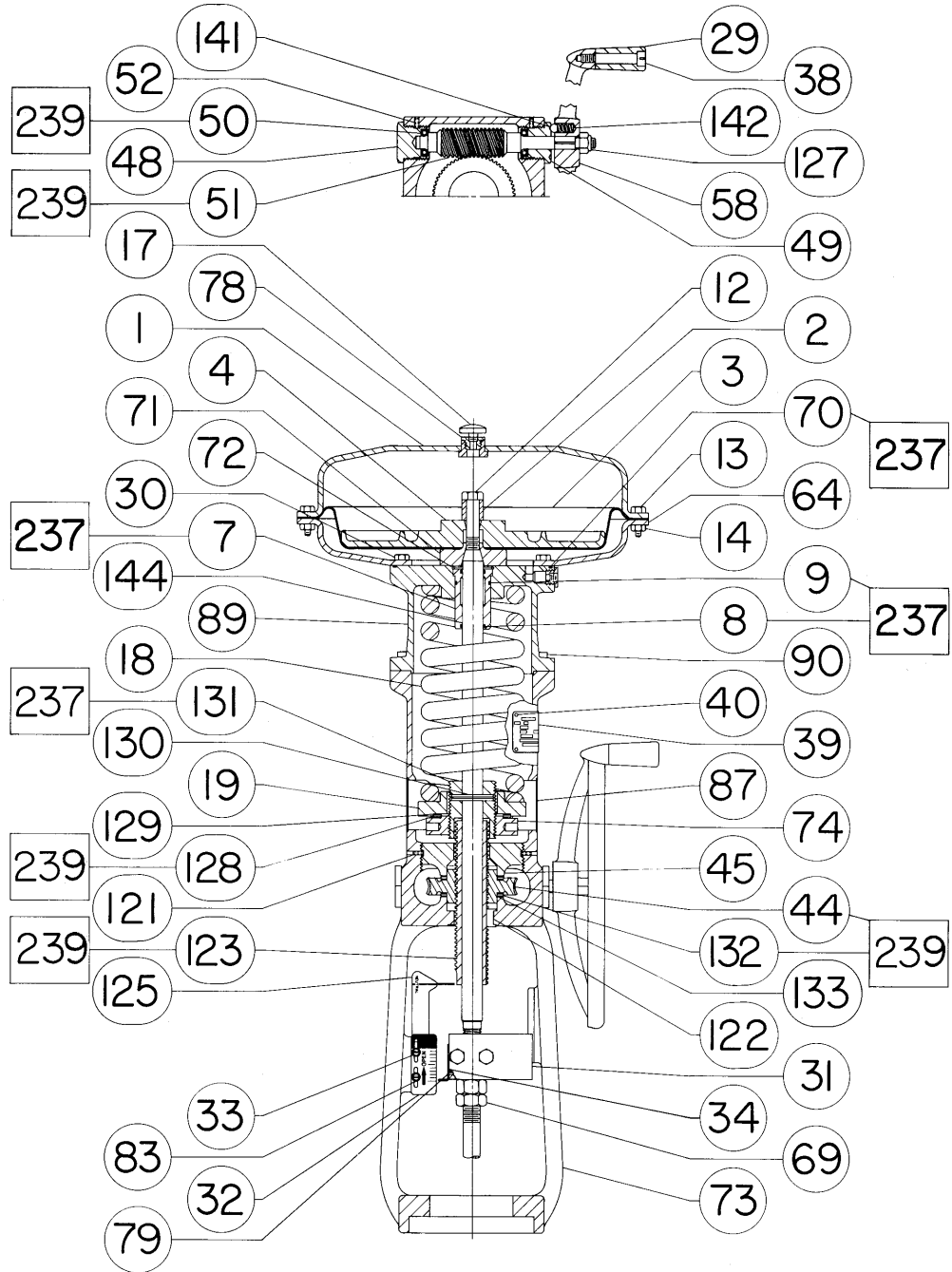
□ APPLY LUBRICANT  
40A8779-D / IL

Figure 14. Side-Mounted Handwheel Assembly for Size 45 and 60 Actuators

Key	Description	Part Number	Key	Description	Part Number
162	INDICATOR PLATE (ALUMINUM) SIZE 34 & 40 SIZE 45 TO 60	1F936411992 1 1D357411992 1	177	SPRING CAP (STEEL) SIZE 45 TO 60	1D385124092 1
163	CAP SCREW (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1C403824052 2 1A344424052 2	178	MACHINE SCREW (PL STEEL) SIZE 45 TO 60	1A331928982 2
166	U-BOLT (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1F657724092 1 1F155524092 1	241	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
167	GUIDE BOLT (416 SST) SIZE 34 & 40 SIZE 45 TO 60	1F657535132 2 1F155235132 2	244	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---
168	SET SCREW (STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A344724182 1 1A341528992 1	<b>Side-Mounted Handwheel, Size 70, 76 &amp; 87 (Figure 15)</b>		
169	GREASE FITTING	1H306199012 1	29	HANDGRIP (STEEL)	0U075624092 1
170	HEX NUT (PL STEEL) SIZE 34 & 40 SIZE 45 TO 60	1A341224112 2 1A343324122 2	38	HANDGRIP BOLT (STEEL)	0U077424092 1
			44	WORM GEAR (BRONZE)	2N886212052 1
			45	BEARING RETAINER FLANGE CAST IRON	1N889219042 1



# Type 667 Size 30-76 & 87



PART NOT SHOWN: 57  
 APPLY LUBRICANT  
 50A8604-F / IL

Figure 15. Size 70, 76, and 87 Actuator with Side Mounted Handwheel Assembly

# Type 667 Size 30-76 & 87

Key	Description	Part Number	
48	BACK WORM RETAINER (STEEL, ZN PL)	1N888324492	1
49	FRONT WORM RETAINER (STEEL, ZN PL)	1N888424092	1
50	BALL BEARING (STEEL)	1A339228992	2
51	WORM SHAFT (STEEL)	2N886331092	1
52	SET SCREW (STEEL)	1A710328992	2
57	GREASE FITTING	1A926728982	2
58	HANDWHEEL (CAST IRON)	3H734319052	1
87	COVER BAND ASS'Y	1N8879X00A2	1
89	SPRING CASE ADAPTOR (CAST IRON)		
	SIZE 70 & 87	2N889419042	1
	SIZE 76	33B8000X012	1
90	CAP SCREW (STEEL, ZN PL)	1N872428992	12
121	SET SCREW (PL STEEL)	1A712228992	2
122	KEY (STEEL)	1N888025092	1
123	LOWER SLEEVE (STEEL)		
	SIZE 70 & 87		
	3 IN. (76 mm) TRAVEL	2N888224092	1
	4 IN. (102 mm) TRAVEL	21A8262X012	1
	SIZE 76	2N888224092	1
125	HANDWHEEL INDICATOR (SST)	10A2446X012	1
127	STOP NUT (STEEL, ZN PL)	1A780528992	1
128	NEEDLE BEARING (STEEL)	1N888599012	1
129	NEEDLE BEARING RACE (STEEL)	1N888699012	2
130	ROLL PIN (STEEL)	1N889828992	1
131	SPRING ADJUSTING SCREW (STEEL, ZN PL)		
	SIZE 70 & 87		
	3/4 TO 3 IN (19 TO 76 mm) TRAVEL	1N889724092	1
	4 IN. (102 mm) TRAVEL	11A9817X012	1
	SIZE 76	1N889724092	1
132	NEEDLE BEARING (STEEL)	1N888799012	2
133	NEEDLE BEARING RACE (STEEL)	1N888899012	4
141	BALL (STEEL)	1A342732992	1
142	SPRING (BRONZE)	0D005916012	1
237	LUBRICANT, LUBRIPLATE MAG-1 OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	
239	LUBRICANT, ANTI-SEIZE LUB-3 NEVER-SEEZ OR EQUIVALENT NOT FURNISHED WITH HANDWHEEL	---	

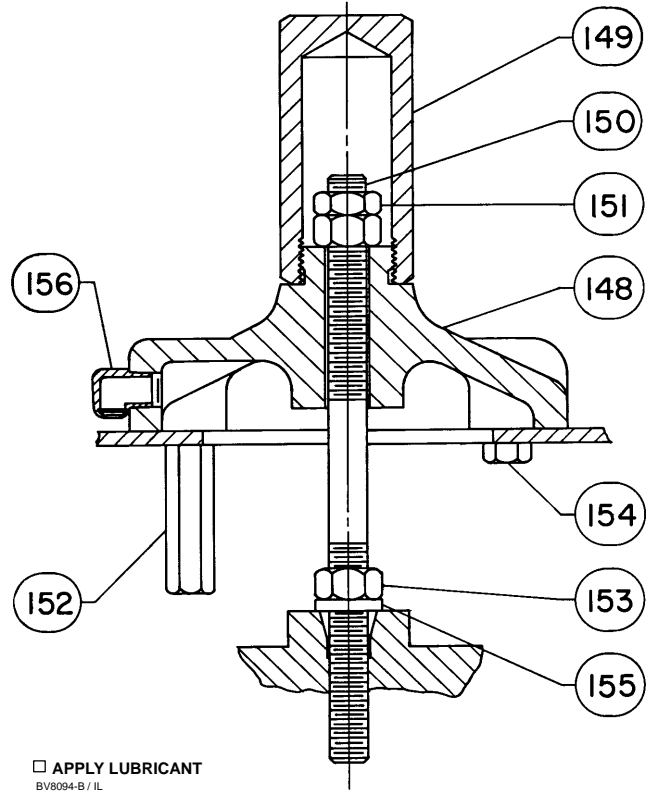


Figure 16. Style 10 Down Travel Stop (Casing Mounted)

Key	Description	Part Number
<b>Casing-Mounted Travel Stops (Figures 16 Through 20)</b>		
58	HANDWHEEL CAST IRON STYLE 13 UP TRAVEL STOP	
	SIZE 30	1F143819052 1
	SIZE 34 THROUGH 60	1F118119042 1
102	PLUG, PIPE STYLE 12 UP TRAVEL STOP	
	SIZE 70 & 87	1D754828982 1
127	HEX NUT (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A353724122 1
148	TRAVEL STOP BODY (CAST IRON)	
	STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 40	1K723519012 1
	SIZE 45 THROUGH 60	2K723019012 1
	SIZE 70 & 87	2U141819022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9446X012 1
	SIZE 45 THROUGH 60	27A9444X012 1
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	37A9437X012 1
	SIZE 45 THROUGH 60	37A9432X012 1
	SIZE 70 & 87	37A9661X012 1

# Type 667 Size 30-76 & 87

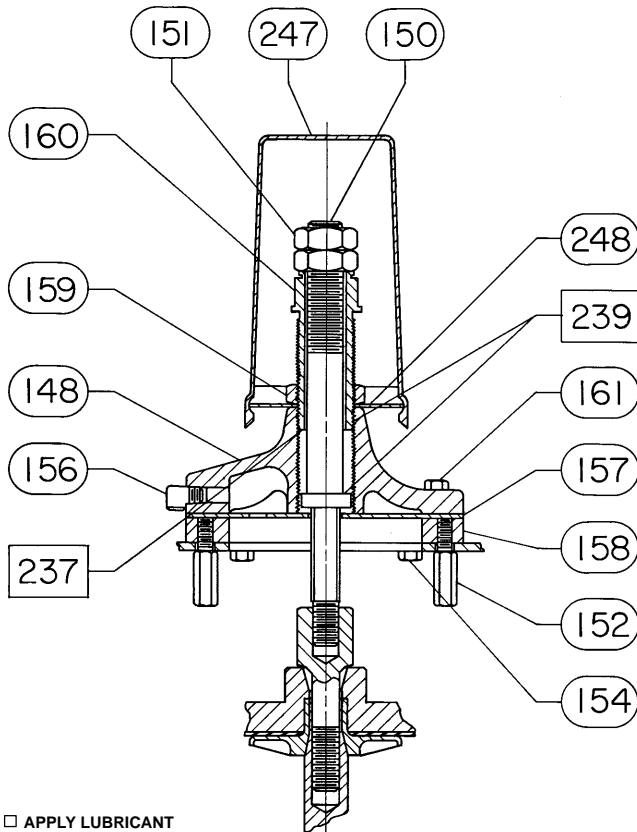


Figure 17. Style 11 Up Or Down Travel Stop (Casing Mounted)

Key	Description	Part Number	
148	TRAVEL STOP BODY (CAST IRON) (Cont'd)		
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 W/ 1/4 NPT CONNECTION	37A9437X012	1
	STYLE 13 UP TRAVEL STOP (CONT.)		
	SIZE 30 W/ 1/2 NPT CONNECTION	37A9438X012	1
	SIZE 34 & 40 W/ 1/4 NPT CONNECTION	37A9439X012	1
	SIZE 34 & 40 W/ 1/2 NPT CONNECTION	37A9440X012	1
	SIZE 45 THROUGH 60 W/ 1/4 NPT CONNECTION	37A9432X012	1
	SIZE 45 THROUGH 60 W/ 1/2 NPT CONNECTION	37A9434X012	1
149	TRAVEL STOP CAP (BRASS)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1H111114012	1
	SIZE 70 & 87	1R387614012	1
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597814012	1
	SIZE 45 THROUGH 60	1F839614012	1
	SIZE 70 & 87	1R387614012	1
	STEEL		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	1F597824092	1
150	EXTENSION ROD		
	S41600 (416 SST)		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	28A1267X022	1
	STEEL, ZN PL		
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 45 THROUGH 60	28A1266X012	1

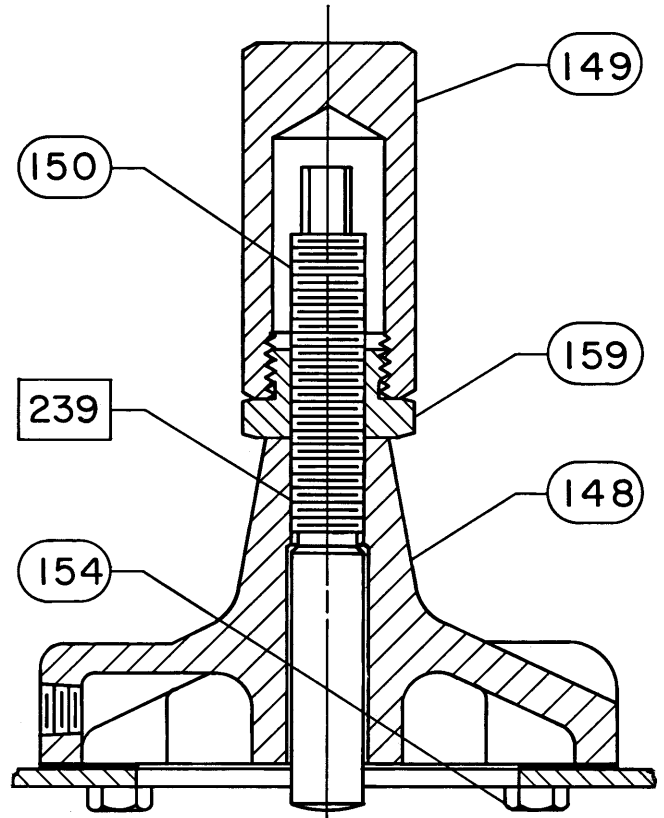
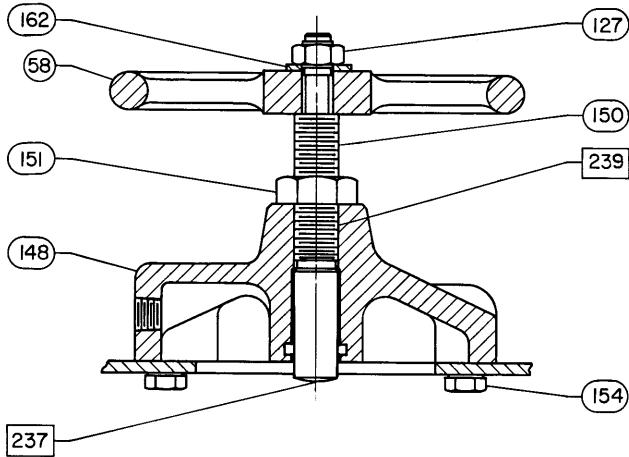


Figure 18. Style 12 Up Travel Stop (Casing Mounted)

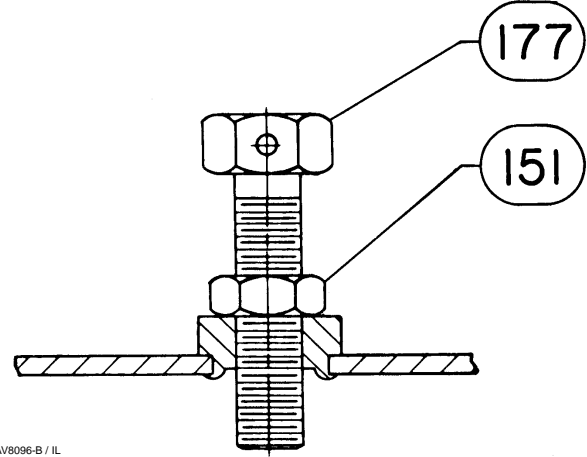
Key	Description	Part Number	
150	TRAVEL STOP STEM		
	S30300 (303 SST)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30	1H330735032	1
	SIZE 34 & 40	1F753635032	1
	SIZE 45 THROUGH 60	1J232735032	1
	SIZE 70 & 87	1V7764X00A2	1
	BRONZE		
	STYLE 12 UP TRAVEL STOP		
	SIZE 30 THROUGH 40	27A9655X012	1
	SIZE 45 THROUGH 60	27A9656X012	1
	SIZE 70 & 87	27A9763X012	1
	STYLE 13 UP TRAVEL STOP		
	SIZE 30	27A9652X012	1
	SIZE 34 & 40	27A9653X012	1
	SIZE 45 THROUGH 60	27A9654X012	1
151	HEX JAM NUT (STEEL, ZN PL)		
	STYLE 10 DOWN TRAVEL STOP		
	SIZE 30 THROUGH 40	1A353724122	1
	SIZE 45 THROUGH 87	1A351124122	1
	STYLE 11 UP & DOWN TRAVEL STOP		
	SIZE 34 & 40	1K130824122	2
	SIZE 45 THROUGH 60	1K130424122	2
	STYLE 13 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	18A2300X012	1
	STYLE 14 UP TRAVEL STOP		
	SIZE 30 THROUGH 60	1A319224122	1
	SIZE 70, 87	1F118724122	1

# Type 667 Size 30-76 & 87



□ APPLY LUBRICANT  
28A1204-B / IL

Figure 19. Style 13 Up Travel Stop  
(Casing Mounted), size 30 shown



AV8096-B / IL

Figure 20. Style 14 Up Travel Stop  
(Casing Mounted)

Key	Description	Part Number
152	TRAVEL STOP STYLE 10 AND 11 TRAVEL STOPS	SEE TABLE
153	NUT, HEX (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP (TOTAL OF 2 REQ'D FOR SIZE 30)	
	SIZE 30	1A413224122 1
	SIZE 30	1A346524122 1
	SIZE 34 & 40	1A413224122 2
	SIZE 45 THROUGH 87	1A375424122 2
154	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	1A368424052 4
	SIZE 70 & 87	1N129328992 9
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1D529824052 3
	SIZE 45 THROUGH 60	1A368424052 4
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
	SIZE 70 & 87	1N129328992 12
	STYLE 13 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1A368424052 6
	SIZE 45 THROUGH 60	1A368424052 8
155	WASHER, LOCK, SPLIT (STEEL) STYLE 10 DOWN TRAVEL STOP	
	SIZE 30	1D716228982 1
	SIZE 34 & 40	1A487828992 1
	SIZE 45 THROUGH 60	1A873228992 1
	SIZE 70 & 87	1A549328982 1
156	VENT STYLE 10 & 12 TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	SIZE 70 & 87	17A6572X022 1
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 30 THROUGH 60	27A5516X012 1
	STYLE 13 UP TRAVEL STOP	
	1/4 NPT CONNECTION	27A5516X012 1
	1/2 NPT CONNECTION	17A6572X022 1

Key	Description	Part Number
157	GUIDE PLATE (STEEL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116428992 1
	SIZE 45 THROUGH 60	1F119528992 1
158	MOUNTING PLATE (CAST IRON) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1F116519042 1
	SIZE 45 THROUGH 60	1F119319042 1
159	NUT, TRAVEL STOP BRONZE	
	STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	18A2301X012 1
	SIZE 45 THROUGH 60	18A2302X012 1
	BRASS	
	STYLE 12 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	18A2303X012 1
	STEEL	
	SIZE 30 THROUGH 40	18A2303X022 1
159	TRAVEL STOP NUT (BRASS) STYLE 12 UP TRAVEL STOP	
	SIZE 45 THROUGH 60	18A1272X012 1
160	SCREW, HANDWHEEL (BRONZE) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	27A9640X012 1
	SIZE 45 THROUGH 60	27A9638X012 1
161	SCREW, CAP, HEX HD (STEEL, ZN PL) STYLE 11 UP & DOWN TRAVEL STOP	
	SIZE 34 & 40	1A336924052 6
	SIZE 45 THROUGH 60	1A341824052 8
162	WASHER (PL STEEL) STYLE 13 UP TRAVEL STOP	
	ALL SIZES	1A518925072 1
177	TRAVEL STOP SCREW S41600 (416 SST) STYLE 14 UP TRAVEL STOP	
	SIZE 30 THROUGH 40	1F753735132 1
	SIZE 45 THROUGH 60	1K131135132 1
	SIZE 70 & 87	13A2133X012 1

# Type 667 Size 30-76 & 87

Key	Description	Part Number	Key	Description	Part Number
184	NIPPLE, PIPE, NPT (STEEL ZN PL)		239	LUBRICANT, ANTI-SEIZE LUB-3	
	STYLE 10 & 12 TRAVEL STOP			NEVER-SEEZ OR EQUIVALENT	
	SIZE 70 & 87	1K201526022 1		NOT FURNISHED WITH HANDWHEEL	---
	STYLE 13 UP TRAVEL STOP		247	TRAVEL STOP CAP, PLASTIC	
	W/ 1/2-IN NPT CONNECTION			STYLE 11	
	SIZE 30	1A473526012 1		SIZE 34 THROUGH 60	37A8623X012 1
	SIZE 34 & 40	1C782526012 1			
	SIZE 45 THROUGH 60	1H392826012 1	284	MOUNTING PLATE (STEEL, ZN PL)	
237	LUBRICANT, LUBRIPLATE MAG-1			STYLE 11 UP & DOWN TRAVEL STOP	
	OR EQUIVALENT			SIZE 34 & 40	17A9360X012 1
	NOT FURNISHED WITH TRAVEL STOP	---		SIZE 45 THROUGH 60	17A9361X012 1

# Type 667 Size 30-76 & 87

Key 2. Spacer, Steel, and Key 12 Travel Stop Cap Screw, Steel

TRAVEL		KEY	ACTUATOR SIZE					
Inches	mm		30	34	40	45 Through 60	76	70 & 87
3/16	5	2	---	1U721324092	1U721324092	---	---	---
		12	---	1R4088X0022	1R4088X0022	---	---	---
1/4	6	2	1R737024092	1U145024092	1U145024092	1U417824092	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	1R4098X0022	---	---
5/16	8	2	1R773024092	1U569824092	1U569824092	---	---	---
		12	1A8678X0012	1R4088X0022	1R4088X0022	---	---	---
11/32	9	2	1U437224052	---	---	---	---	---
		12	1A8678X0012	---	---	---	---	---
3/8	10	2	1R767724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
7/16	11	2	1R408724092	1R409324092	1R409324092	1R410324092	---	---
		12	1A6857X0032	1R4088X0022	1R4088X0022	1R4098X0022	---	---
1/2	13	2	1U328924092	1R782324092	1R782324092	1R411424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
9/16	14	2	1J830724092	---	---	---	---	---
		12	1A6857X0032	---	---	---	---	---
5/8	16	2	1R408624092	1R409424092	1R409424092	1R410424092	---	---
		12	1A6857X0032	1R4089X0042	1R4089X0042	1R4098X0022	---	---
11/16	17	2	1U726324092	1U726224092	1U726224092	---	---	---
		12	1B2275X0022	1R4089X0042	1R4089X0042	---	---	---
3/4	19	2	1R408524092	1R409524092	1R409524092	1R410524092	1R410524092	1R411624092
		12	1B2275X0022	1R4089X0042	1R4089X0042	1R4098X0022	1R4110X0012	1R411624092
7/8	22	2	---	---	1R927624092	17A4720X012	17A4720X012	---
		12	---	---	1U8659X0022	1R4099X0022	1R4099X0022	---
1	25	2	---	1U866024092	1U866024092	1R411324092	1R411324092	1U803124092
		12	---	1U8659X0022	1U8659X0022	1R4099X0022	1R4099X0022	1R4111X0012
1-1/8	29	2	---	1R409624092	1R409624092	1R410824092	1R410824092	1R411524092
		12	---	1R4091X0032	1R4091X0032	1R4099X0022	1R4099X0022	1R4111X0012
1-3/16	30	2	---	---	1U137724092	1U164824092	---	---
		12	---	---	1R4092X0022	1R4099X0022	---	---
1-1/4	32	2	---	---	11A2680X012	1U143224092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-3/8	35	2	---	---	1U176124092	1U276824092	---	---
		12	---	---	1R4092X0022	1R4101X0022	---	---
1-1/2	38	2	---	---	1R409724092	1R410624092	1R410624092	1R411424092
		12	---	---	1R4092X0022	1R4101X0022	1R4101X0022	1R4098X0022
1-5/8	41	2	---	---	---	1R712924092	---	1R410424092
		12	---	---	---	1R4101X0022	---	1R4098X0022
1-7/8	48	2	---	---	---	1U256124092	---	---
		12	---	---	---	1R4102X0012	---	---
2	51	2	---	---	---	1R410724092	1R410724092	1R411324092
		12	---	---	---	1R4102X0012	1R4102X0012	1R4099X0022
2-1/8	54	2	---	---	---	---	---	1R410824092
		12	---	---	---	---	---	1R4099X0022
2-1/2	64	2	---	---	---	---	---	1R410624092
		12	---	---	---	---	---	1R4101X0022
3	76	2	---	---	---	---	---	1R410724092 <sup>(1)</sup>
		12	---	---	---	---	---	1R4102X0012
4	102	2	---	---	---	---	---	10A2426X012
		12	---	---	---	---	---	1E7246X0022

1. For Type 667-4, part number is 17A2270X012.

# Type 667 Size 30-76 & 87

Key 18. Actuator Spring, Steel<sup>(1)</sup>

ACTUATOR SIZE	DIAPHRAGM PRESSURE RANGE		TRAVEL, INCHES (mm)					
			7/16 (11)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (38)	2 (51)
	Psig	Bar						
30	3-15	0.2-1.0	1E795327082 Light Blue	1E795527092 Brown	1E792327092 Dark Gray	---	---	---
	6-30	0.4-2.0	1E795627082 White	1E795427082 Light Gray	1E792427082 Light Green	---	---	---
34 <sup>(2)</sup> & 40	3-15	0.2-1.0	1E805127082 Aluminum	1E804927082 Yellow	1E805827082 Light Gray	1E805327092 Dark Gray	1E805627092 <sup>(3)</sup> Dark Green	---
	6-30	0.4-2.0	1E805027082 Purple	1E804827082 Light Blue	1E805227082 Orange	1E805527082 Dark Blue	1E805827082 <sup>(3)</sup> Light Gray	---
45 & 50	3-15	0.2-1.0	---	1E826727082 Purple	1E826227082 Light Green	1E826127082 Dark Gray	1E826627082 Orange	1E826927082 Dark Green
	6-30	0.4-2.0	---	1E825627082 Light Blue	1E825527082 Aluminum & Red	1E826427082 Light Gray	1E826227082 Light Green	1E826527082 Red
46 & 60	3-15	0.2-1.0	---	1E825827082 Yellow	1E825727082 Brown	1E826227082 Light Green	1E826527082 Red	1E827027082 Aluminum & Dark Blue
	6-30	0.4-2.0	---	---	1E826027082 Bronze	1E825527082 Aluminum & Red	1E825727082 Brown	1E826327082 Aluminum & Dark Green
			<b>3/4 (19)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102)</b>
70 & 87	3-15	0.2-1.0	1N127927082 Red	1N719327082 White	1N128727082 Yellow	1N128427082 Light Green	1N128627082 Dark Gray	---
	6-30	0.4-2.0	---	1N128127082 Brown	1N127927082 Red	1N128527082 Light Blue	1N128727082 Yellow	1R67607082 <sup>(4)</sup> Black

1. Other spring selections are available by contacting your Fisher Controls sales office or sales representative.  
2. 1-1/8 inch travel is available for size 34, and 1-1/2 inch travel is available for size 40 only.  
3. For size 40 only.  
4. Diaphragm pressure range for this spring and travel combination is 3-30 psig (0.2-2.0 bar).

Key 32. Travel Indicator Scale, Stainless Steel

SIZE	TRAVEL, INCHES (mm) <sup>(1)</sup>								
	7/16 (11)	1/2 (12)	5/8 (16)	3/4 (19)	1-1/8 (29)	1-1/2 (28)	2 (51)	3 (76)	4 (102)
30	1E793438992	1E793538992	1E793538992	1E793638992	---	---	---	---	---
34	1E793438992	1E807738982	1E807738982	1E793638992	17A9814X012	---	---	---	---
40	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(2)</sup>	1E808238992	1E808338992	---	---	---
45	1E807638992	1E807738982	1E807738982	1E808138992 <sup>(3)</sup>	1E808238992	1E808338992	1R444538982	---	---
46	1E807638992	1E807738982	1E807738982	1E808138992	1E808238992	1E808338992	1R444538982	---	---
50	1E833038982	1E833038982	1E833038982	1E833138992 <sup>(4)</sup>	1E833238992	1E833338992	1E833438992	---	---
60	1F535238982	1E833038982	1E833138992	1E833138992	1E833238992	1E833338992	1E833428992	---	---
70	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012
76	---	---	---	1H745738992	1H745838992	1H745938992	1H746038992	---	---
87	---	---	---	1H745738992 <sup>(5)</sup>	1H745838992	1H745938992	1H746038992	1H746138992	13A5660X012

1. 2-inch maximum travel for size 76 actuator.  
2. 1U356138982 is for 1-inch (25 mm) travel.  
3. 1H147938992 is for 7/8-inch (22 mm) travel.  
4. 1U356238982 is for 1-inch (25 mm) travel.  
5. 1H745838992 is for 7/8-inch (22 mm) travel.

# Type 667 Size 30-76 & 87

Key 152. Travel Stop for Top-Mounted Handwheels and Style 10 and 11 Adjustable Travel Stops, Steel

ACTUATOR SIZE	TRAVEL INCHES (mm)							
	7/16 (11)	5/8 (16)	3/4 (19)	7/8 (22)	1 (25)	1-1/8 (29)	1-1/2 (38)	2 (51)
30 (3 req'd)	1F393224092 <sup>(1)</sup>	1E797924092 <sup>(1)</sup>	1E792524092 <sup>(1)</sup>	---	---	---	---	---
34 & 40 (4 req'd)	1E806424092 <sup>(2)</sup>	1E806524092	1E806624092	1F424624092	1H797624092	1E806724092	1E806824092	---
45 thru 60 & 76 (4 req'd)	---	1E827324092	1E831924092	1H1912X0012	1H355824092	1E831924092	1E806424092	1E832124092 <sup>(1)</sup>
	<b>3/4 (19)</b>	<b>7/8(22)</b>	<b>1 (25)</b>	<b>1-1/8 (29)</b>	<b>1-1/2 (38)</b>	<b>2 (51)</b>	<b>3 (76)</b>	<b>4 (102) (3)</b>
70 & 87 <sup>(1)</sup> (3 req'd)	1N128824092	18A0351X012	---	1N128924092	1N129024092	1N12914092	1N129224092	11A8131X012

1. For top-mounted handwheels and style 10 travel stops.  
 2. For style 11 travel stops.  
 3. Type 667-4.

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# Design ED and EAD easy-e<sup>®</sup> Valves Class 125 through 600

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W1916-2/L

Figure 1. Design ED Valve with Type 667 Actuator

## Introduction

### Scope of Manual

This instruction manual includes installation, maintenance, and parts information for 1- through 8-inch Design ED valves, and 1- through 6-inch Design EAD valves, through Class 600 ratings. Refer to separate manuals for instructions covering the actuator and accessories.



# ED Valve

Table 1. Specifications

<p><b>End Connection Styles</b></p> <p><b>Cast Iron Valves</b>  <i>Flanged:</i> Class 125 flat-face or 250 raised-face flanges per ASME B16.1  <i>Screwed:</i> Consistent with ASME B16.4</p> <p><b>Steel and Stainless Steel Valves</b>  <i>Flanged:</i> Class 150, 300, and 600 raised-face or ring-type joint flanges per ASME B16.5  <i>Screwed or Socket Welding:</i> All available ASME B16.11 schedules that are consistent with Class 600 per ASME B16.34  <i>Buttwelding:</i> 1- through 8-inch Schedules 40 or 80 consistent with ASME B16.25</p> <p><b>Maximum Inlet Pressure<sup>(1)</sup></b></p> <p><b>Cast Iron Valves</b>  <i>Flanged:</i> Consistent with Class 125B or 250B pressure-temperature ratings per ASME B16.1  <i>Screwed:</i> Consistent with Class 125 or 250 pressure-temperature ratings per ASME B16.4</p> <p><b>Steel and Stainless Steel Valves</b>  <i>Flanged:</i> Consistent with Class 150, 300, and 600<sup>(2)</sup> pressure-temperature ratings per ASME B16.34  <i>Screwed or Welding:</i> Consistent with Class 600 pressure-temperature ratings per ASME B16.34</p> <p><b>Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4</b></p> <p><b>Standard:</b> Class II  <b>Optional:</b> Class III—For valves with graphite</p>	<p>piston ring and 87 mm (3-7/16 inch) or larger port diameter; Class IV—For valves with multiple graphite piston rings and 111 mm (4-3/8 inch) or larger port diameter</p> <p><b>C-seal trim:</b> High-temperature, Class V. See table 2</p> <p><b>Flow Characteristics</b></p> <p><b>Standard Cages:</b> ■ Linear, ■ quick opening, or ■ equal percentage  <b>Whisper Trim® and WhisperFlo® Cages:</b> Linear</p> <p><b>Flow Directions</b></p> <p><b>Linear, Quick Opening, or Equal Percentage Cage:</b> Normally down  <b>Whisper Trim and WhisperFlo Cages:</b> Always up</p> <p><b>Approximate Weights</b></p> <p><b>1 &amp; 1-1/4-inch valves:</b> 14 kg (30 lb)  <b>1-1/2 inch valves:</b> 20 kg (45 lb)  <b>2-inch valves:</b> 30 kg (67 lb)  <b>2-1/2 inch valves:</b> 45 kg (100 lb)  <b>3-inch valves:</b> 57 kg (125 lb)  <b>4-inch valves:</b> 77 kg (170 lb)  <b>6-inch valves:</b> 159 kg (350 lb)  <b>8-inch valves:</b> 408 kg (900 lb)</p>
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1. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.  
 2. Some flanged Class 600 valve bodies in 316 stainless steel do not comply with ASME B16.34.

No person may install, operate, or maintain a Design ED or EAD valve without first (1) being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance, and (2) carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher sales office before proceeding.

## Description

These single-port valves have cage guiding, quick-change trim, and balanced push-down-to-close valve plug action. Valve configurations are as follows:

**Design ED**—Globe-style valve (figure 1) with metal-to-metal seating for all general applications over a wide variety of pressure drops and temperatures.

**Design EAD**—Angle version of Design ED, used to facilitate piping or in applications where a self-draining valve is required.

C-seal trim is available for Design ED valves, Class 150, 300, and 600, in sizes 2-1/2, 3, 4, 6, and 8. C-seal trim is available for Design EAD valves, Class 150, 300, and 600, in sizes 3, 4, and 6.

With C-seal trim, a balanced valve can achieve high-temperature, Class V shutoff. Because the C-seal plug seal is formed from metal (N07718 nickel alloy, Inconel 718) rather than an elastomer, a valve equipped with the C-seal trim can be applied in

processes with a fluid temperature of up to 593°C (1100°F), provided other material limits are not exceeded.

## Specifications

Typical specifications for these valves are shown in table 1.

## Installation



### WARNING

**Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.**

**Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.**

**Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

### CAUTION

**When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other**

**conditions to the valve without first contacting your Fisher sales office.**

**Fisher does not assume final responsibility for the selection, use, or maintenance of any product. Final responsibility for the selection, use, and maintenance of any Fisher product remains with the purchaser and end-user.**

1. Before installing the valve, inspect the valve and associated equipment for any damage and any foreign material.
2. Make certain the valve body interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.
3. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve. Other positions may result in uneven valve plug and cage wear, and improper operation. With some valves, the actuator may also need to be supported when it is not vertical. For more information, consult your Fisher sales office.
4. Use accepted piping and welding practices when installing the valve in the line. For flanged valves, use a suitable gasket between the valve and pipeline flanges.

### Note

**Depending on valve body materials used, post weld heat treating may be required. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrink-fit pieces and threaded connections may also loosen. In general, if post weld heat treating is to be performed, all trim parts should be removed. Contact your Fisher sales office for additional information.**

5. With a leak-off bonnet construction, remove the pipe plugs (keys 14 and 16, figure 18) to hook up the leak-off piping. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.
6. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

Table 2. Additional Shutoff Classification

Valve Design (Class)	Valve Size, Inches	Port Diameter, Inches	Cage Style	Leakage Class
Design ED (Class 150-600)	2-1/2	2-7/8	Equal Percentage, Linear, Whisper I, Cavitrol III, 1 stage	V (for port diameters from 2-7/8 through 8-inch with optional C-seal trim)
	3	3-7/16		
	3	2-7/8	Cavitrol III, 2 stage	
	4	2-7/8		
	4	4-3/8	Equal Percentage, Linear, Whisper I, Cavitrol III, 1 stage	
	6	5-3/8	Whisper III (A3, B3, D3, D3), Cavitrol III, 2 stage	
		7	Equal Percentage, Linear, Whisper I, Cavitrol III, 1 stage	
	8	7	Cavitrol III, 2 stage	
8		8	Equal Percentage, Linear, Whisper I, Cavitrol III, 1 stage	



### WARNING

**Personal injury could result from packing leakage. Valve packing was tightened before shipment; however, the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Valves with ENVIRO-SEAL live-loaded packing or HIGH-SEAL™ live-loaded packing will not require this initial re-adjustment. See the Fisher instruction manuals, ENVIRO-SEAL Packing System for Sliding-Stem Valves or HIGH-SEAL Live-Loaded Packing System (as appropriate), for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the Parts Kit sub-section near the end of this manual.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and ENVIRO-SEAL bellows seal bonnet replacement. All maintenance operations may be performed with the valve in the line.



### WARNING

**Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, even when the valve has been removed from the pipeline. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**

- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

**Note**

Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket during reassembly. This ensures a good gasket seal because the used gasket may not seal properly.

**Packing Lubrication**

**Note**

**ENVIRO-SEAL or HIGH-SEAL packing does not require lubrication.**

If a lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in place of the pipe plug (key 14, figure 18). Use a good quality silicon-based lubricant. Do not lubricate packing used in oxygen service or in processes with temperatures over 260°C (500°F). To operate the lubricator, simply turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except open the isolating valve before turning the cap screw and then close the isolating valve after lubrication is completed.

**Packing Maintenance**

**Note**

**For valves with ENVIRO-SEAL packing, see the Fisher instruction manual, ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306, for packing instructions.**

**For valves with HIGH-SEAL packing, see the Fisher instruction manual, HIGH-SEAL Live-Loaded Packing System, Form 5263, for packing instructions.**

Key numbers refer to figure 3 for PTFE V-ring packing and to figure 4 for PTFE/composition packing, unless otherwise indicated.

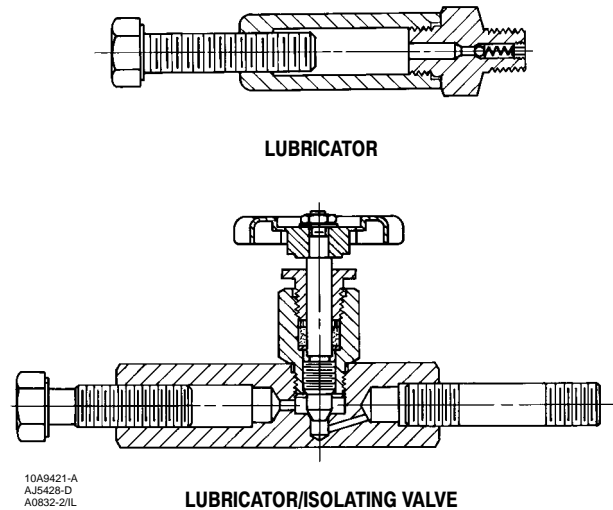
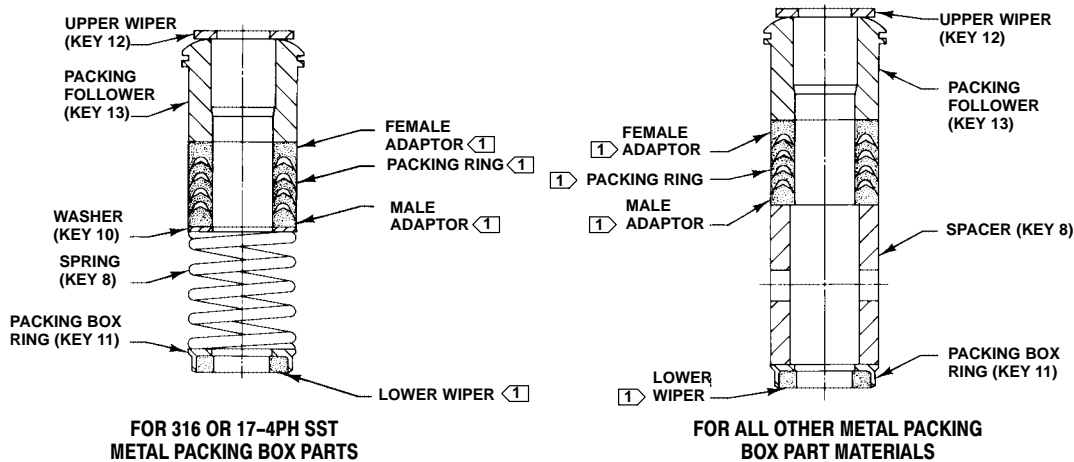


Figure 2. Lubricator and Lubricator/Isolating Valve (optional)

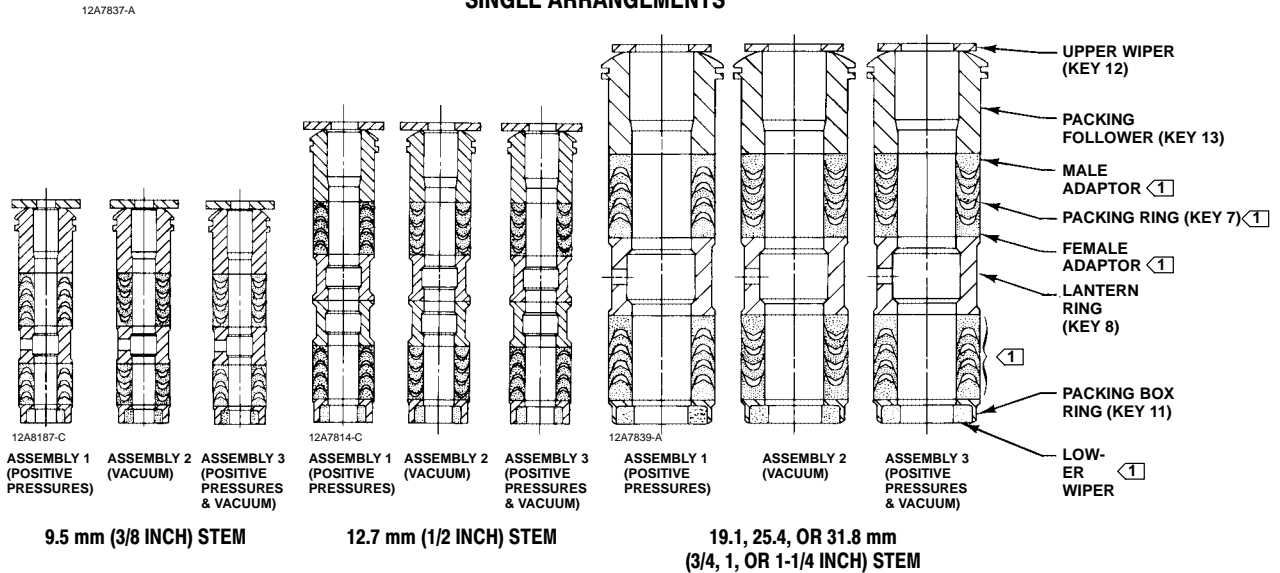
For spring-loaded single PTFE V-ring packing, the spring (key 8, figure 3) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13, figure 3), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5, figure 18) until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed to the Replacing Packing procedure.

If there is undesirable packing leakage with other than spring-loaded packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, the valve stem may be worn or nicked so that a seal cannot be made. The surface finish of a new valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, the leakage may be caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.



### SINGLE ARRANGEMENTS



### DOUBLE ARRANGEMENTS

**NOTES:**

- 1 MALE ADAPTOR, PACKING RING, FEMALE ADAPTOR, AND LOWER WIPER ARE PART OF PACKING SET (KEY 6).
- 2 REQ'D FOR DOUBLE ARRANGEMENTS, EXCEPT LOWER WIPER.

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Figure 3. PTFE V-Ring Packing Arrangements for Plain or Extension Bonnets

## Replacing Packing

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector, then remove the actuator from the valve by unscrewing the yoke locknut (key 15, figure 18) or the hex nuts (key 26, figure 18).

3. Loosen the packing flange nuts (key 5, figure 18) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

Table 3. Body-to-Bonnet Bolt Torque Guidelines

Valve Size, Inches		Bolt Torques <sup>(1)</sup>			
Design ED	Design EAD	SA193-B7		SA193-B8M <sup>(2)</sup>	
		N•m	Lbf•ft	N•m	Lbf•ft
1-1/4 or less	1	129	95	64	47
1-1/2, 1-1/2 x 1, 2, or 2 x 1	2 or 2 x 1	96	71	45	33
2-1/2 or 2-1/2 x 1-1/2	3 or 3 x 1-1/2	129	95	64	47
3, 3 x 2, or 3 x 2-1/2	4 or 4 x 2	169	125	88	65
4, 4 x 2-1/2, or 4 x 3	6 or 6 x 2-1/2	271	200	156	115
6	---	549	405	366	270
8	---	746	550	529	390

1. Determined from laboratory tests.  
2. SA193-B8M annealed.



**WARNING**

To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet.

**Note**

The following step also provides additional assurance that the valve body fluid pressure has been relieved.

**CAUTION**

Avoid damaging the seating surface caused by the valve plug and stem assembly dropping from the bonnet (key 1, figure 18) after being lifted part way out. When lifting the bonnet, temporarily install a valve stem locknut on the valve stem. This locknut will prevent the valve plug and stem assembly from dropping out of the bonnet.

If the cage starts to lift with the bonnet, tap it with a plastic mallet, or other soft material, to be sure it stays in the valve.

- Hex nuts (key 16, figure 19, 20, or 21) or cap screws (not shown) attach the bonnet (key 1, figure 18) to the valve body (key 1, figure 19, 20, or 21). Loosen these nuts or cap screws approximately 3 mm (1/8 inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve. Work the prying tool around the bonnet until the bonnet loosens. If no fluid leaks from the joint, remove the nuts or cap screws completely and carefully lift the bonnet off the valve.
- Remove the locknut and separate the valve plug and stem from the bonnet. Set the parts on a protective surface to prevent damage to gasket or seating surfaces.
- Remove the bonnet gasket (key 10, figure 19, 20, or 21) and cover the opening in the valve to protect the gasket surface and prevent foreign material from getting into the valve body cavity.
- Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 18). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.
- Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box

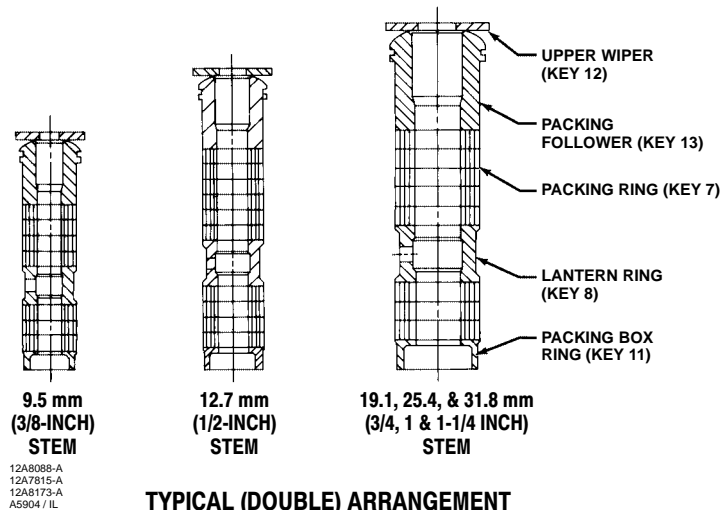


Figure 4. PTFE/Composition Packing Arrangements for Plain or Extension Bonnets

leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts by following the appropriate steps in the Trim Maintenance procedure.

9. Remove the cover protecting the valve body cavity and install a new bonnet gasket (key 10, figure 19 through 21), making sure the gasket seating surfaces are clean and smooth. Place the valve plug and stem into the valve body, making sure it is properly centered on the seat ring. Then slide the bonnet over the stem and onto the stud bolts (key 16, figure 19, 20, or 21) or onto the valve body cavity if cap screws (not shown) will be used instead.

#### Note

**Proper performance of the bolting procedures in step 10 compresses the spiral wound gasket (key 12, figure 19 or 20) or load ring (key 26, figure 21) enough to both load and seal the seat ring gasket (key 13, figure 19, 20, or 21). It also compresses the outer edge of the bonnet gasket (key 10, figure 19 through 21) enough to seal the body-to-bonnet joint.**

**The bolting procedures in step 10 include—but are not limited to—ensuring that bolting threads are clean, and evenly tightening the cap screws, or the nuts onto the studs, in a crisscross pattern. Tightening one cap**

**screw or nut may loosen an adjacent cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made. When the operating temperature has been reached, perform the torquing procedure once again.**

10. Install bolting, using accepted bolting procedures during tightening, so that the body-to-bonnet joint will withstand test pressures and application service conditions. Use the bolt torques in table 3 as guidelines.

11. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3, 4, or 5. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box.

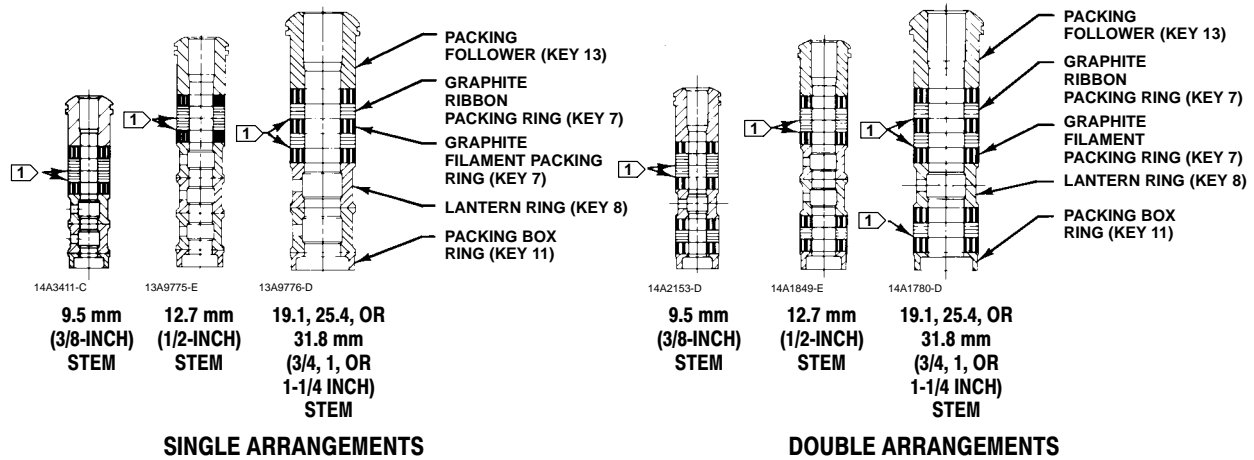
12. Slide the packing follower, upper wiper, and packing flange (keys 13, 12, and 3, figure 18) into position. Lubricate the packing flange studs (key 4, figure 18) and the faces of the packing flange nuts (key 5, figure 18). Install the packing flange nuts.

13. **For spring-loaded PTFE V-ring packing,** tighten the packing flange nuts until the shoulder on the packing follower (key 13, figure 18) contacts the bonnet.

**For graphite packing,** tighten the packing flange nuts to the maximum recommended torque shown in table 4. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 4.

**For other packing types,** tighten the packing flange nuts alternately in small equal increments until one





NOTES:  
 1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS;  
 USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.  
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Figure 5. Graphite Ribbon/Filament Packing for Plain or Extension Bonnets

of the nuts reaches the minimum recommended torque shown in table 4. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

For ENVIRO-SEAL or HIGH-SEAL live-loaded packing, refer to the note at the beginning of Packing Maintenance.

14. Mount the actuator on the valve assembly and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

### Trim Maintenance

For C-seal construction, see the appropriate C-seal sections in this instruction manual.

Except where indicated, key numbers in this section are referenced in figure 19 for standard 1-through 6-inch constructions, figure 20 for Whisper Trim III cage detail, figure 21 for the 8-inch Design ED valve, and figures 22 and 23 for WhisperFlo trim. Some valve plug constructions require three piston rings (key 6).

### Disassembly

1. Remove the actuator and the bonnet according to steps 1 through 5 of the Replacing Packing procedure in the Maintenance section.

### WARNING

The graphite piston rings in a Design ED or EAD valve are brittle and in two pieces. Use care to avoid damage to the piston rings caused by dropping or rough handling.

Any damage to the gasket sealing surfaces could cause the valve to leak. The surface finish of the valve stem (key 7) is critical for making a good packing seal. The inside surface of the cage or cage/baffle assembly (key 3), or cage retainer (key 31), is critical for smooth operation of the valve plug and for making a seal with the piston rings (key 6). The seating surfaces of the valve plug (key 2) and seat ring (key 9) are critical for proper shutoff. Unless inspection reveals otherwise, assume all these parts are in good condition and protect them accordingly.

# ED Valve

Table 4. Recommended Torque for Packing Flange Nuts

VALVE STEM DIAMETER		CLASS	GRAPHITE TYPE PACKING				PTFE TYPE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inches		N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in
9.5	3/8	125, 150	3	27	5	40	1	13	2	19
		250, 300	4	36	6	53	2	17	3	26
		600	6	49	8	73	3	23	4	35
12.7	1/2	125, 150	5	44	8	66	2	21	4	31
		250, 300	7	59	10	88	3	28	5	42
		600	9	81	14	122	4	39	7	58
19.1	3/4	125, 150	11	99	17	149	5	47	8	70
		250, 300	15	133	23	199	7	64	11	95
		600	21	182	31	274	10	87	15	131
25.4	1	300	26	226	38	339	12	108	18	162
		600	35	310	53	466	17	149	25	223
31.8	1-1/4	300	36	318	54	477	17	152	26	228
		600	49	437	74	655	24	209	36	314

2. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 18). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.

3. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.

4. Remove the load ring (key 26) from an 8-inch Design ED valve, or the cage adaptor (key 4) from any restricted-trim valve through 4 inches, and wrap it for protection.

5. On a 6-inch Design ED valve with a Whisper Trim III cage or WhisperFlo trim, remove the bonnet spacer (key 32) and bonnet gasket (key 10) on top of the spacer. Then on any construction with a cage retainer (key 31), remove the cage retainer and its associated gaskets. A Whisper Trim III and WhisperFlo cage retainer has two 3/8-inch-16 NPT tappings in which screws or bolts can be installed for lifting.

6. Remove the cage or cage/baffle assembly (key 3) and the associated gaskets (keys 10, 11, and 12), and shim (key 51 for the Design ED valve, key 27 for the Design EAD valve). If the cage is stuck in the valve, use a rubber mallet to strike the exposed portion of the cage at several points around its circumference.

7. Remove the seat ring or liner (key 9), seat ring gasket (key 13), and the seat ring adaptor (key 5) and adaptor gasket (key 14) where used in a restricted-trim seat ring construction.

8. Inspect parts for wear or damage which would prevent proper operation of the valve. Replace or repair trim parts according to the following procedure for Lapping Metal Seats or other valve plug maintenance procedures as appropriate.

### Lapping Metal Seats

## CAUTION

**To avoid damaging the ENVIRO-SEAL bellows seal bonnet assembly, do not attempt to lap the metal seating surfaces. The design of the assembly prevents rotation of the stem and any forced lapping rotation will damage internal components of the ENVIRO-SEAL Bellows Seal bonnet.**

With metal-seat constructions, seating surfaces of the valve plug and seat ring or liner (keys 2 and 9, figure 19, 20, or 21) can be lapped for improved shutoff. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply compound to the bottom of the valve plug.

Assemble the valve to the extent that the cage and the cage retainer and bonnet spacer (if used) are in place and the bonnet is bolted to the valve. A simple handle can be made from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction to lap the seats.

After lapping, remove the bonnet and clean the seat surfaces. Completely assemble as described in the Assembly portion of the Trim Maintenance procedure and test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

### Valve Plug Maintenance

Except where indicated, key numbers in this section are referenced in figure 19 for standard 1- through 6-inch constructions, figure 20 for Whisper Trim III detail, figure 21 for the 8-inch Design ED valve, and figures 22 and 23 for WhisperFlo trim. Some valve plug constructions require three piston rings (key 6).

## CAUTION

**To avoid the piston ring (key 6) not sealing properly, be careful not to scratch the surfaces of the ring groove in the valve plug or any of the surfaces of the replacement ring.**

1. With the valve plug (key 2) removed according to the Disassembly portion of the Trim Maintenance procedure, proceed as appropriate:

**For the carbon-filled PTFE piston ring,** The ring is split in one place. If there is visible damage, spread the ring slightly and remove it from the groove in the valve plug.

**To install a carbon-filled PTFE piston ring,** Spread the ring apart slightly at the split and install it over the stem and into the groove in the valve plug. The open side must face along the stem, depending on flow directions, as shown in view A of figure 19.

**For the graphite piston ring,** The ring can be easily removed since it is in two pieces. A new graphite piston ring is furnished as a complete ring. Use a vise with smooth or taped jaws to break this replacement ring into halves. Place the new ring in the vise so that the jaws will compress the ring into an oval. Slowly compress the ring until it snaps on both sides. If one side snaps first, do not try to tear or cut the other side. Instead, keep compressing the ring until the other side snaps. Be sure to match the broken ends when installing the ring in the valve plug groove.

## CAUTION

**Never reuse an old stem or adaptor with a new valve plug. Using an old**

**stem or adaptor with a new plug requires drilling a new pin hole in the stem (or adaptor in case an ENVIRO-SEAL bellows seal bonnet is being used). This drilling weakens the stem or adaptor and may cause failure in service. However, a used valve plug may be reused with a new stem or adaptor.**

### Note

**For plain bonnets and style 1 extension bonnets, the valve plug (key 2), valve stem (key 7), and pin (key 8) are available completely assembled. Refer to the Key 2, 7, and 8 Valve Plug and Stem Assembly tables in the Parts List.**

2. To replace the valve stem (key 7), drive out the pin (key 8). Unscrew the valve plug from the stem or adaptor.

3. To replace the adaptor (key 24, figure 18) on ENVIRO-SEAL bellows seal bonnets, place the plug stem assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out the pin (key 36, figure 18). Reverse the plug stem assembly and valve plug in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the valve plug/adaptor assembly (key 24, figure 18) from the valve stem assembly (key 20, figure 18).

4. Screw the new stem or adaptor into the valve plug. Tighten to the torque value given in table 5. Refer to table 5 to select the proper drill size. Drill through the stem or adaptor, using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin to lock the assembly.

5. For ENVIRO-SEAL bellows seal bonnets, grip the flats of the stem extending out of the top of the bellows shroud with a soft-jaw chuck or other type of vise. Screw the valve plug/adaptor assembly onto the valve stem. Tighten as necessary to align the pin hole in the stem with one of the holes in the adaptor. Secure the adaptor to the stem with a new pin.

### Assembly

Except where indicated, key numbers are referenced in figure 19 for standard 1-through 6-inch constructions, figure 20 for Whisper Trim III detail, figure 21 for the 8-inch Design ED valve, and figures 22 and 23 for WhisperFlo trim.

# ED Valve

Table 5. Valve Stem Connection Torque and Pin Replacement

VALVE STEM CONNECTION (VSC)		TORQUE, MINIMUM TO MAXIMUM		DRILL SIZE, INCH
mm	Inch	N•m	Lbf•ft	
9.5	3/8	40 to 47	25 to 35	3/32
12.7	1/2	81 to 115	60 to 85	1/8
19.1	3/4	237 to 339	175 to 250	3/16
25.4	1	420 to 481	310 to 355	1/4
31.8	1-1/4	827 to 908	610 to 670	1/4

1. With a restricted-trim seat ring construction, install the adaptor gasket (key 14) and seat ring adaptor (key 5).
2. Install the seat ring gasket (key 13), seat ring or liner (key 9).
3. Install the cage or cage/baffle assembly (key 3). Any rotational orientation of the cage or assembly with respect to the valve is acceptable. A Whisper Trim III cage designated by level A3, B3, or C3 may be installed with either end up. The level D3 cage/baffle assembly, however, must be installed with the hole pattern end next to the seat ring. If a cage retainer (key 31) is to be used, place it on top of the cage.
4. Slide the valve plug (key 2) and stem assembly, or valve plug and ENVIRO-SEAL bellows seal assembly, into the cage until the piston ring(s) is level with the top of the cage (key 3) or cage retainer (key 31).
5. Installing piston rings (key 6):
  - a. **For valve plugs with a single piston ring:** Make sure the piston ring is evenly engaged into the entrance chamfer at the top of the cage or cage retainer ring. Carefully press the piston ring into the cage or cage retainer ring.
  - b. **For valve plugs with multiple piston rings:** As each piston ring is slid into the cage, make sure the ring is evenly engaged in the entrance chamfer at the top of the cage or cage retainer. Also, make sure to offset the fracture in the rings to minimize leakage. Carefully press each piston ring into the cage or cage retainer ring.
6. Place the gaskets (keys 12, 11 or 14 if used, and 10) and the shim (key 27 or 51) if used on top of the cage or cage retainer. If there is a cage adaptor (key 4) or a bonnet spacer (key 32), set it on the cage or cage retainer gaskets and place another flat sheet gasket (key 10) on top of the adaptor or spacer. If there is only a cage retainer, place another flat sheet gasket on the retainer.

7. With an 8-inch Design ED valve, install the load ring (key 26).

8. Mount the bonnet on the valve and complete assembly according to steps 10 through 14 of the Replacing Packing procedure. Be sure to observe the note prior to step 10.

## Retrofit: Installing C-seal Trim

### Note

**Additional actuator thrust is required for a valve with C-seal trim. When installing C-seal trim in an existing valve, contact your Fisher sales office for assistance in determining new actuator thrust requirements.**

Assemble the new valve plug/retainer assembly (with C-seal plug seal) using the following instructions:

### CAUTION

**To avoid leakage when the valve is returned to service, use appropriate methods and materials to protect all sealing surfaces of the new trim parts while assembling the individual parts and during installation in the valve body.**

1. Apply a suitable high-temperature lubricant to the inside diameter of the C-seal plug seal. Also, lubricate the outside diameter of the valve plug where the C-seal plug seal must be pressed into the proper sealing position (figure 6).

2. Orient the C-seal plug seal for correct sealing action based on the process fluid flow direction through the valve.

- The open interior of the C-seal plug seal must face up in a valve with flow-up construction (figure 6).

- The open interior of the C-seal plug seal must face down in a valve with flow-down construction (figure 6).

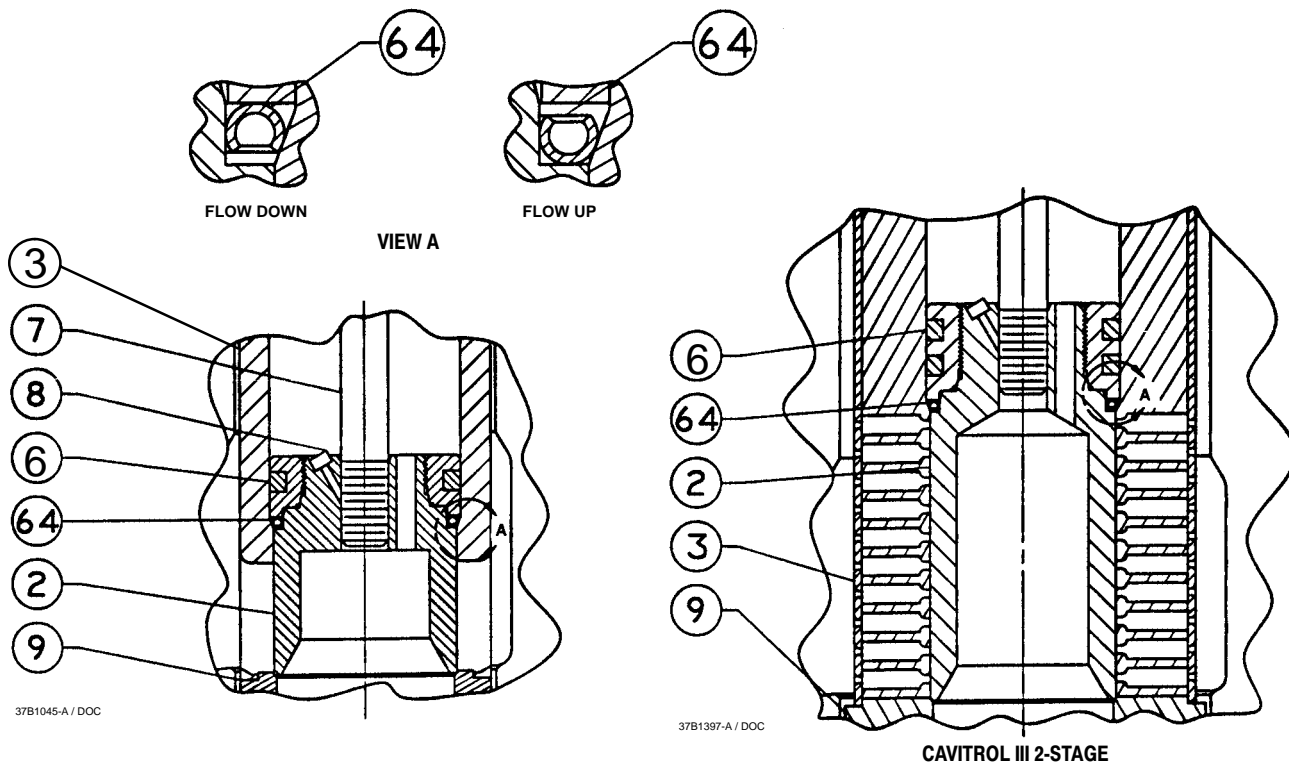


Figure 6. Design ED with C-seal Trim

**Note**

**An installation tool must be used to properly position the C-seal plug seal on the valve plug. A tool is available as a spare part from Fisher or a tool could be manufactured following the dimensions given in Figure 7.**

3. Place the C-seal plug seal over the top of the valve plug and press the C-seal plug seal onto the plug using the C-seal installation tool. Carefully press the C-seal plug seal onto the plug until the installation tool contacts the horizontal reference surface of the valve plug (figure 8).
4. Apply a suitable high-temperature lubricant to the threads on the plug. Then, place the C-seal retainer onto the plug and tighten the retainer using an appropriate tool such as a strap wrench.
5. Using an appropriate tool such as a center punch, stake the threads on top of the plug in one place (figure 9) to secure the C-seal retainer.
6. Install the new plug/retainer assembly with C-seal plug seal on the new stem following the appropriate instructions in the Trim Replacement section of this manual.

7. Install piston rings by following instructions in the Trim Replacement section of this manual.
8. Remove the existing valve actuator and bonnet following the appropriate instructions in the Replacing Packing section of this manual.

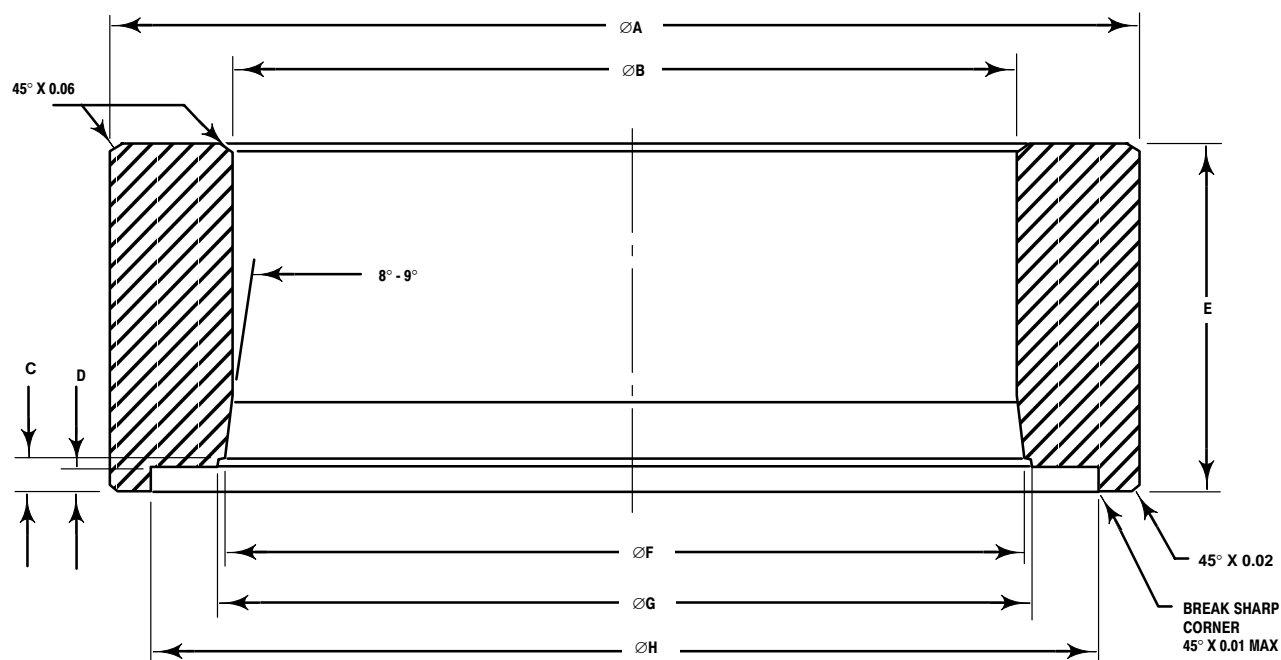
**CAUTION**

**Do not remove the existing valve stem from the valve plug unless you are planning to replace the valve stem.**

**Never reuse an old valve stem with a new plug or reinstall a valve stem after it has been removed. Replacing a valve stem requires drilling a new pin hole in the stem. This drilling weakens the stem and may cause failure in service. However, a used valve plug may be reused with a new valve stem.**

9. Remove the existing valve stem and plug, cage, and seat ring from the valve body following the appropriate instructions in the Trim Removal section of this manual.

FOR VALVE PLUGS FITTING PORT SIZE (Inches)	DIMENSIONS, INCHES (See Drawing Below)								PART NUMBER (To Order A Tool)
	A	B	C	D	E	F	G	H	
2-7/8	3.25	2.060 - 2.070	0.196 - 0.198	0.146 - 0.148	1.62	2.074 - 2.078	2.170 - 2.190	2.791 - 2.797	24B9816X012
3-7/16	4.00	2.310 - 2.320	0.196 - 0.198	0.146 - 0.148	2.00	2.402 - 2.406	2.498 - 2.518	3.353 - 3.359	24B5612X012
3-5/8	4.11	2.560 - 2.570	0.196 - 0.198	0.146 - 0.148	2.00	2.714 - 2.718	2.810 - 2.830	3.541 - 3.547	24B3630X012
4-3/8	4.96	3.285 - 3.295	0.196 - 0.198	0.146 - 0.148	2.00	3.439 - 3.443	3.535 - 3.555	4.291 - 4.297	24B3635X012
5-3/8	5.62	3.940 - 3.950	0.196 - 0.198	0.146 - 0.148	1.81	4.088 - 4.092	4.184 - 4.204	5.048 - 5.054	23B9193X012
7	7.25	5.566 - 5.576	0.196 - 0.198	0.146 - 0.148	2.37	5.714 - 5.718	5.810 - 5.830	6.674 - 6.680	23B9180X012
8	8.25	6.566 - 6.576	0.196 - 0.198	0.146 - 0.148	2.20	6.714 - 6.718	6.810 - 6.830	7.674 - 7.680	24B9856X012



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Figure 7. C-seal Plug Seal Installation Tool

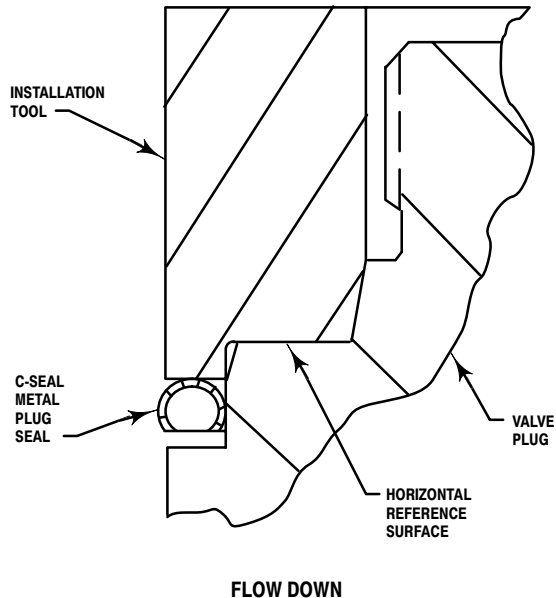
- Replace all gaskets according to appropriate instructions in the Trim Replacement section of this manual.
- Install the new seat ring, cage, valve plug/retainer assembly, and stem into the valve body and completely reassemble the valve package following the appropriate instructions in the Trim Replacement section of this manual.

**overcome the resistance of the C-seal plug seal and contact the seat ring. You can correctly seat the valve plug by applying the full actuator load. This force will adequately drive the valve plug to the seat ring, thus giving the C-seal plug seal a predetermined permanent set. Once this is done, the plug/retainer assembly, the cage, and the seat ring become a matched set.**

### CAUTION

**To avoid excessive leakage and seat erosion, the valve plug must be initially seated with sufficient force to**

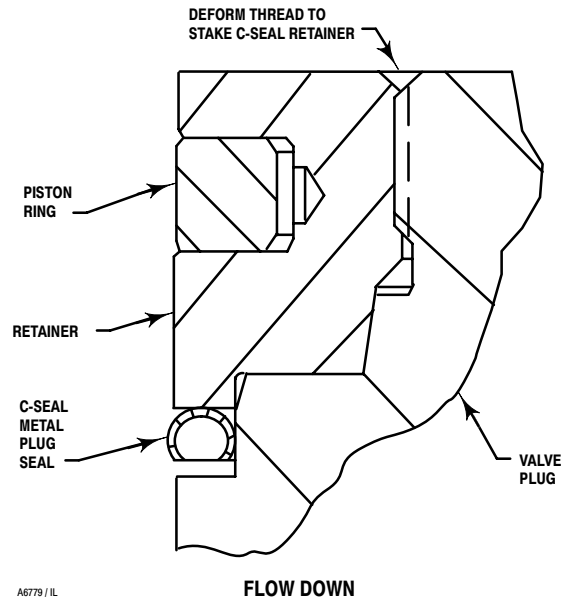
With full actuator force applied and the valve plug fully seated, align the actuator travel indicator scale with the lower end of valve travel. Refer to the appropriate actuator instruction manual for information on this procedure.



NOTE:  
PRESS INSTALLATION TOOL OVER VALVE PLUG  
UNTIL THE TOOL CONTACTS THE HORIZONTAL REFERENCE SURFACE OF THE VALVE PLUG.

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Figure 8. Installing the C-seal Plug Seal Using the Installation Tool



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Figure 9. Stake the Threads of the C-seal Retainer

## Replacement of Installed C-seal Trim

### Trim Removal (C-seal Constructions)

1. Remove the valve actuator and bonnet following the appropriate instructions in the Replacing Packing section of this manual.

### CAUTION

To avoid leakage when the valve is returned to service, use appropriate methods and materials to protect all sealing surfaces of the trim parts during maintenance.

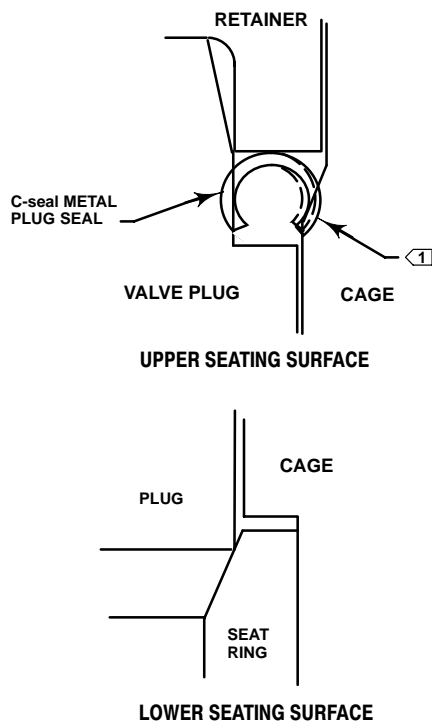
Use caution when removing piston ring(s) and C-seal plug seal to avoid scratching any sealing surface.

### CAUTION

Do not remove the valve stem from the plug/retainer assembly unless you are planning to replace the valve stem.

Never reuse an old valve stem with a new plug or reinstall a valve stem after it has been removed. Replacing a valve stem requires drilling a new pin hole in the stem. This drilling weakens the stem and may cause failure in service. However, a used valve plug may be reused with a new valve stem.

2. Remove the plug/retainer assembly (with C-seal plug seal), cage, and seat ring from the valve body following the appropriate instructions in the Trim Removal section of this manual.
3. Locate the staked thread on top of the valve plug (figure 9). The staked thread secures the retainer. Use a drill with a 1/8-inch bit to drill out the staked area of the thread. Drill approximately 1/8-inch into the metal to remove the staking.
4. Locate the break between sections of the piston ring(s). Using an appropriate tool such as a flat-blade screwdriver, carefully pry out the piston ring(s) from the groove(s) in the C-seal retainer.
5. After removing the piston ring(s), locate the 0.25-inch diameter hole in the groove. In a retainer with two piston ring grooves, the hole will be found in the upper groove.
6. Select an appropriate tool such as a punch and place the tip of the tool into the hole with the body of the tool held tangent to the outside diameter of the



**NOTE:**

1 UPPER SEATING SURFACE IS THE AREA OF CONTACT BETWEEN THE C-seal METAL PLUG SEAL AND THE CAGE.

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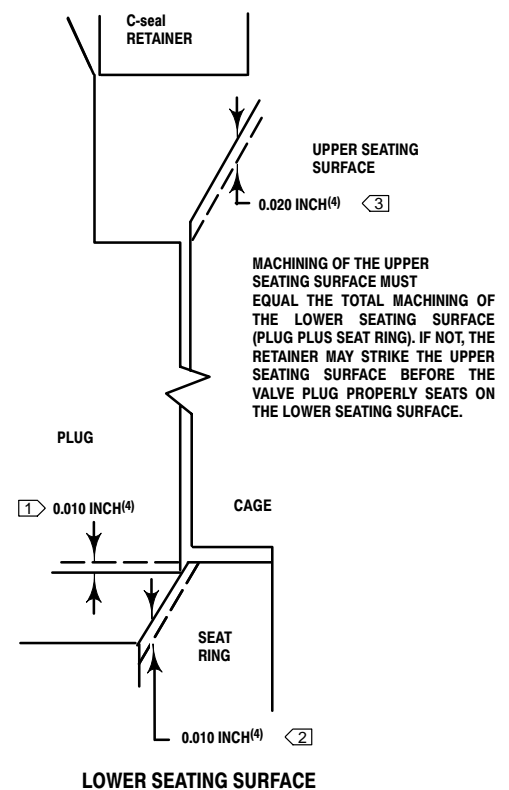
Figure 10. Lower (Valve Plug to Seat Ring) and Upper (C-seal Plug Seal to Cage) Seating Surfaces

retainer. Strike the tool with a hammer to rotate the retainer and free it from the valve plug. Remove the retainer from the plug.

7. Use an appropriate tool such as a flat-blade screwdriver to pry the C-seal plug seal off the plug. Use caution to avoid scratches or other damage to the sealing surfaces where the C-seal plug seal makes contact with the valve plug (figure 10).

8. Inspect the lower seating surface where the valve plug contacts the seat ring for wear or damage which would prevent proper operation of the valve. Also, inspect the upper seating surface inside the cage where the C-seal plug seal contacts the cage, and inspect the sealing surface where the C-seal plug seal makes contact with the plug (figure 10).

9. Replace or repair trim parts according to the following procedure for Lapping Metal Seats, Remachining Metal Seats, or other valve plug maintenance procedures as appropriate.



**NOTE:**

1 REMOVAL OF 0.010 INCH FROM THE VALVE PLUG PLUS 2 REMOVAL OF 0.010 INCH FROM THE SEAT RING MUST EQUAL 3 REMOVAL OF 0.020 INCH FROM THE UPPER SEATING SURFACE IN THE CAGE  
4. THESE VALUES ARE FOR EXAMPLE ONLY. REMOVE ONLY THE MINIMUM AMOUNT OF MATERIAL REQUIRED TO REFURBISH THE SEATS.

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Figure 11. Example of Machining the Lower (Valve Plug to Seat Ring) and Upper (C-seal Plug Seal to Cage) Seating Surfaces

### Lapping Metal Seats (C-seal Constructions)

Before installing a new C-seal plug seal, lap the lower seating surface (valve plug to seat ring, figure 10) following appropriate procedures in the Lapping Metal Seats section of this manual.

### Remachining Metal Seats (C-seal Constructions)

See figure 11. A valve plug with a C-seal metal plug seal features two seating surfaces. One seating surface is found where the valve plug contacts the seat ring. The second seating surface is found where the C-seal plug seal contacts the upper seating surface in the cage. If you machine the seats



on the seat ring and/or plug, you must machine an equal dimension from the seating area in the cage.

### CAUTION

**If metal is removed from the seat ring and plug and a corresponding amount is not removed from the cage seating area, the C-seal plug seal will be crushed as the valve closes and the C-seal retainer will strike the seating area of the cage, preventing the valve from closing.**

### Trim Replacement (C-seal Constructions)

1. Apply a suitable high-temperature lubricant to the inside diameter of the C-seal plug seal. Also, lubricate the outside diameter of the valve plug where the C-seal plug seal must be pressed into the proper sealing position (figure 6).
2. Orient the C-seal plug seal for correct sealing action based on the process fluid flow direction through the valve.
  - The open interior of the C-seal plug seal must face up in a valve with flow-up construction (figure 6).
  - The open interior of the C-seal plug seal must face down in a valve with flow-down construction (figure 6).

#### Note

**An installation tool must be used to properly position the C-seal plug seal on the valve plug. A tool is available as a spare part from Fisher or a tool could be manufactured following the dimensions given in Figure 7.**

3. Place the C-seal plug seal over the top of the valve plug and press it onto the plug using the installation tool. Carefully press the C-seal plug seal onto the plug until the installation tool contacts the horizontal reference surface of the valve plug (figure 8).
4. Apply a suitable high-temperature lubricant to the threads on the plug. Then, place the C-seal retainer onto the plug and tighten the retainer using an appropriate tool such as a strap wrench.

5. Using an appropriate tool such as a center punch, stake the threads on top of the plug in one place (figure 9) to secure the C-seal retainer.
6. Replace the piston ring(s) following instructions in the Trim Replacement section of this manual.
7. Return the seat ring, cage, plug/retainer assembly, and stem to the valve body and completely reassemble the valve package following the appropriate instructions in the Trim Replacement section of this manual.

### CAUTION

**To avoid excessive leakage and seat erosion, the valve plug must be initially seated with sufficient force to overcome the resistance of the C-seal plug seal and contact the seat ring. You can correctly seat the valve plug by applying the full actuator load. This force will adequately drive the valve plug to the seat ring, thus giving the C-seal plug seal a predetermined permanent set. Once this is done, the plug/retainer assembly, the cage, and the seat ring become a matched set.**

With full actuator force applied and the valve plug fully seated, align the actuator travel indicator scale with the lower end of valve travel. Refer to the appropriate actuator instruction manual for information on this procedure.

## ENVIRO-SEAL Bellows Seal Bonnet

### Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure in the Maintenance section.
2. Lift out the cage.
3. Remove and discard the existing bonnet gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

#### Note

**The ENVIRO-SEAL stem/bellows assembly for Design E valves is available only with a threaded and**

# ED Valve

**drilled plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed.**

4. Inspect the existing valve plug. If the plug is in good condition, it can be reused with the new ENVIRO-SEAL stem/bellows assembly. To remove the existing valve plug from the stem, first, place the existing plug stem assembly in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8).

5. Then, reverse the plug stem assembly in the soft-jaw chuck or vise. Grip the valve stem in an appropriate place and unscrew the existing plug from the valve stem.

## CAUTION

**When installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.**

**Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.**

### Note

**The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.**

6. To attach the valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, it is necessary to first attach the plug to the adaptor (key 24). Locate the adaptor. Notice that a hole has not been drilled in the threads where the plug screws onto the adaptor. Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the appropriate torque value.

7. Select the proper size of drill bit and drill through the adaptor using the hole in the valve plug as a guide. Remove any metal chips or burrs and drive in a new pin (key 8, figures 19, 20, and 21) to lock the plug/adaptor assembly together.

Table 6. Recommended Torque for ENVIRO-SEAL Bellows Seal Bonnet Packing Flange Nuts

VALVE SIZE, INCHES	VALVE STEM DIAMETER THROUGH PACKING	MINIMUM TORQUE		MAXIMUM TORQUE	
		N•m	Lbf•in	N•m	Lbf•in
1/2 - 2	1/2	2	22	4	33
3 - 8	1	5	44	8	67

8. Attach the plug/adaptor assembly to the ENVIRO-SEAL stem/bellows assembly by first securing the stem/bellows assembly in a soft-jaw chuck or other type of vise so that the jaws of the chuck or vise grip the flats of the stem extending out of the top of the bellows shroud. Screw the valve plug/adaptor assembly onto the valve stem. Tighten the plug/adaptor assembly until it is snug. Then turn the plug/adaptor assembly to the next pin hole in the valve stem. Drive in new pin (key 36, figure 18) to lock the assembly.

9. Inspect the seat ring (key 9). Replace, if necessary.

10. Place a new gasket (key 10) into the valve body in place of the bonnet gasket. Install the new stem/bellows assembly with valve plug/adaptor by placing it into the valve body on top of the new bellows gasket.

11. Place a new gasket (key 22) over the stem/bellows assembly. Place the new ENVIRO-SEAL bonnet over the stem/bellows assembly.

12. Properly lubricate the bonnet stud bolts. Install and tighten the bonnet hex nuts to the proper torque.

13. Install the new packing and the metal packing box parts according to the appropriate arrangement in figure 12 or 13.

14. Install the packing flange. Properly lubricate the packing flange stud bolts and the faces of the packing flange nuts.

**For graphite packing**, tighten the packing flange nuts to the maximum recommended torque shown in table 6. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 6.

**For other packing types**, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 6. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

15. Install the travel indicator parts and stem locknuts; mount the actuator on the valve body according to the procedure in the appropriate actuator instruction manual.

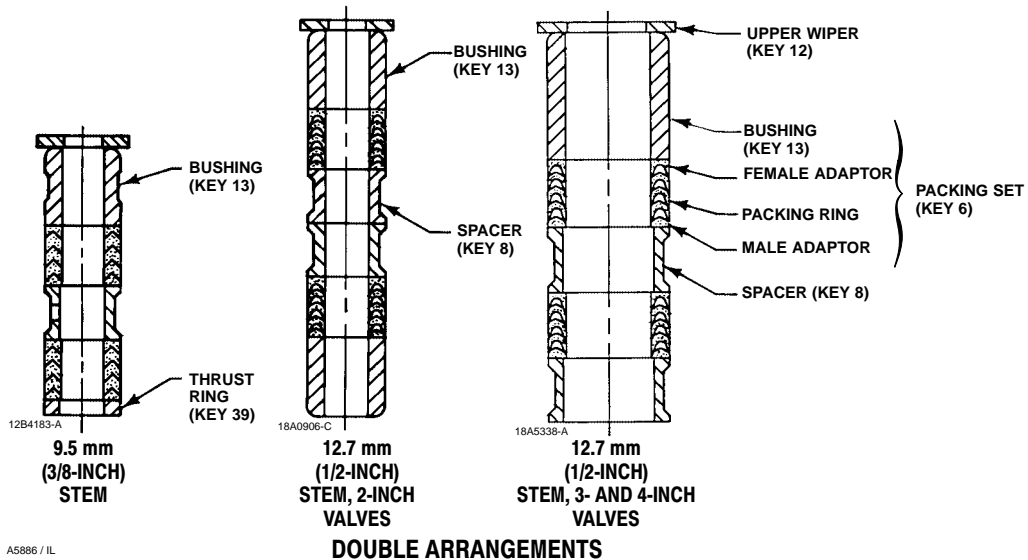
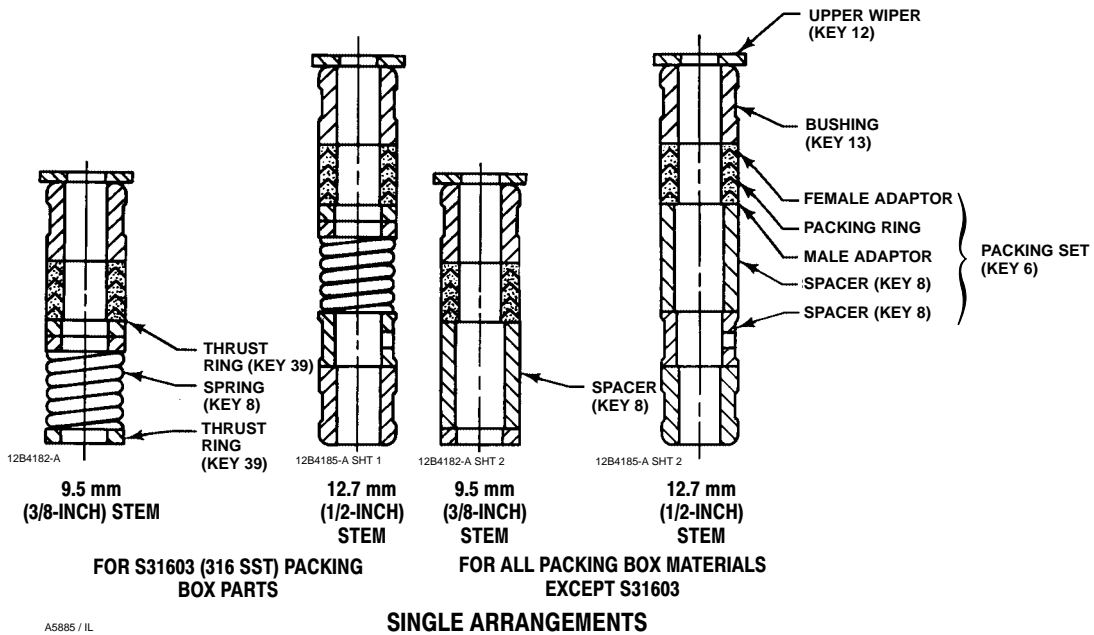
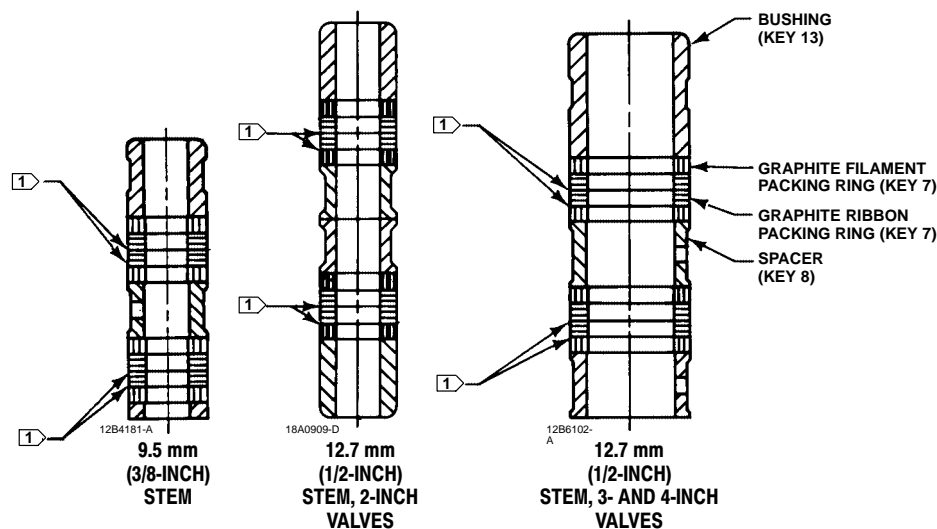


Figure 12. PTFE Packing Arrangement for Use in ENVIRO-SEAL Bellows Seal Bonnets

**Replacement of an Installed ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)**

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure of the Maintenance section.

2. Lift out the cage. Remove and discard the existing bonnet gasket and bellows gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.



**NOTES:**

1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS; USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.

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Figure 13. Double Graphite Ribbon/Filament Arrangements for Use in ENVIRO-SEAL Bellows Seal Bonnets

**Note**

The ENVIRO-SEAL stem/bellows assembly for Design E valves is available only with a threaded and pinned plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed. If the existing valve plug is reused, and the adaptor is in good condition, it may be reused also. However, never reuse an old adaptor with a new valve plug. Using an old adaptor with a new valve plug requires drilling a new pin hole in the adaptor. This drilling weakens the adaptor and may cause failure in service. However, a used valve plug may be reused with a new adaptor.

- Inspect the existing valve plug and adaptor. If they are in good condition, they can be reused with the new stem/bellows assembly and they do not need to be separated.

**CAUTION**

When removing/installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

**Note**

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

- If the valve plug and adaptor are not in good condition and must be replaced, the valve plug/adaptor assembly must first be removed from the stem/bellows assembly and then the valve plug removed from the adaptor. First, place the stem/bellows assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8, figure 19, 20, or 21). Drive out the pin (key 36, figure 18).
- Then, reverse the stem/bellows and plug/adaptor assembly in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the plug/adaptor assembly from the stem/bellows assembly. Unscrew the valve plug from the adaptor.

6. To attach either the existing or a new valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, first attach the plug to the adaptor (if the valve plug was removed from the adaptor) as follows:

- Locate the adaptor. Notice that a hole has not been drilled in the new adaptor threads where the plug screws onto the adaptor.
- Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor.
- Thread the adaptor into the valve plug and tighten to the appropriate torque value.

7. Complete the installation by following steps 7 through 15 of the ENVIRO-SEAL Bellows Seal Bonnet installation instructions given above.

### ***Purging the ENVIRO-SEAL Bellows Seal Bonnet***

The ENVIRO-SEAL bellows seal bonnet has been designed so that it can be purged or leak tested. Refer to figure 18 for an illustration of an ENVIRO-SEAL bellows seal bonnet. Perform the following steps for purging or leak testing.

1. Remove the two diametrically opposed pipe plugs (key 16).
2. Connect a purging fluid to one of the pipe plug connections.
3. Install appropriate piping or tubing in the other pipe plug connection to pipe away the purging fluid

or to make a connection to an analyzer for leak testing.

4. When purging or leak testing has been completed, remove the piping or tubing and reinstall the pipe plugs (key 16).

## **Parts Ordering**

Each valve body-bonnet assembly is assigned a serial number which can be found on the valve. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly. Refer to the serial number when contacting your Fisher representative for technical assistance. When ordering replacement parts, refer to the serial number and to the eleven-character part number for each part required from the following Parts Kit or Parts List information.

Components that are not manufactured by Fisher should not, under any circumstances, be used in any Fisher valve. The use of parts not manufactured by Fisher may adversely affect the performance of the valve as well as worker and workplace safety.

### **Note**

**Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.**

# ED Valve

## Parts Kits

### Note

Kits do not apply to Hastelloy, alloy 20, or Monel trims.

## Gasket Kits

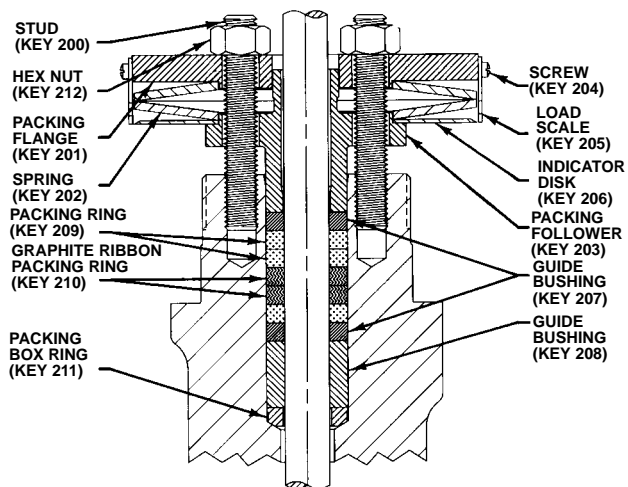
Gasket Kits (includes keys 10, 12, 13, and 51; plus 11, 14, and 20 on some restricted capacity valves)

DESCRIPTION	PART NUMBER
<b>Full Capacity Valves</b>	<b>-198° to 593°C (-325° to 1100°F)</b>
1 & 1-1/4 inch (1-inch EAD)	RGASKETX162
1-1/2 inch (2-inch EAD)	RGASKETX172
2-inch	RGASKETX182
2-1/2 inch (3-inch EAD)	RGASKETX192
3-inch (4-inch EAD)	RGASKETX202
4-inch (6-inch EAD)	RGASKETX212
6-inch	RGASKETX222
8-inch	RGASKETX232
<b>Restricted Capacity Valves</b>	
1-1/2 x 1-inch (2 x 1-inch EAD)	RGASKETX242
2 x 1-inch	RGASKETX252
2-1/2 x 1-1/2 inch (3 x 1-1/2 inch EAD)	RGASKETX262
3 x 2-inch (4 x 2-inch EAD)	RGASKETX272
4 x 2-1/2 inch (6 x 2-1/2 inch EAD)	RGASKETX282

## Packing Kits

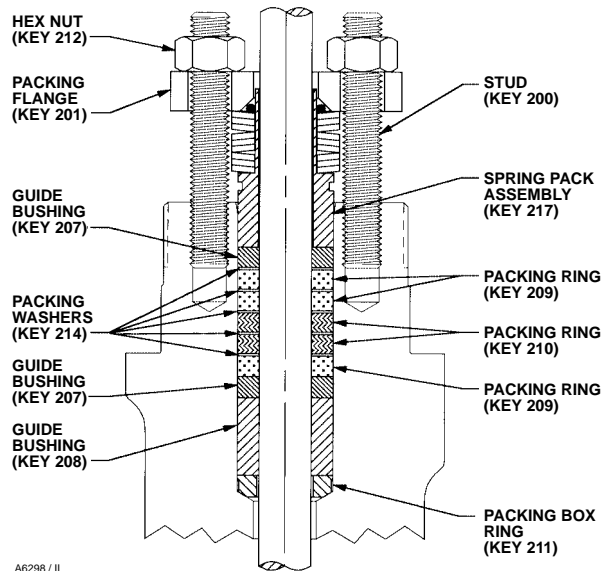
Standard Packing Repair Kits (Non Live-Loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032
Double PTFE (Contains keys 6, 8, 11, and 12)	RPACKX00042	RPACKX00052	RPACKX00062
PTFE/Composition (Contains keys 7, 8, 11, and 12)	RPACKX00072	RPACKX00082	RPACKX00092
Single Graphite Ribbon/Filament [Contains keys 7 (ribbon ring), 7 (filament ring), 8, and 11]	RPACKX00102	RPACKX00112	RPACKX00122
Double Graphite Ribbon/Filament [Contains keys 7 (ribbon ring), 7 (filament ring), 8, and 11]	RPACKX00162	RPACKX00172	RPACKX00182



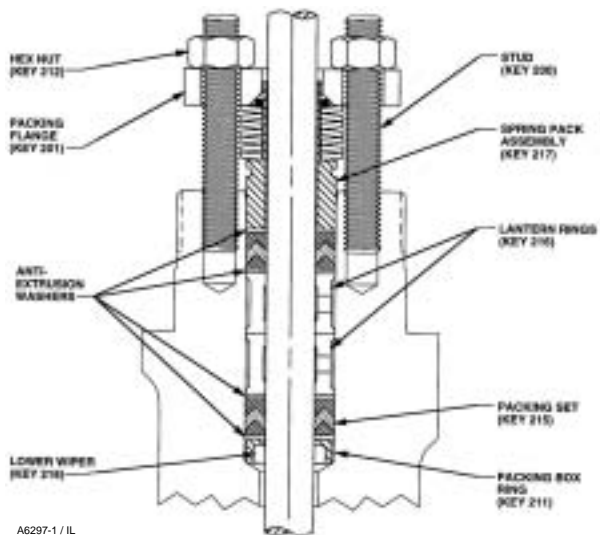
A6138 / IL

Figure 14. Typical HIGH-SEAL Packing System



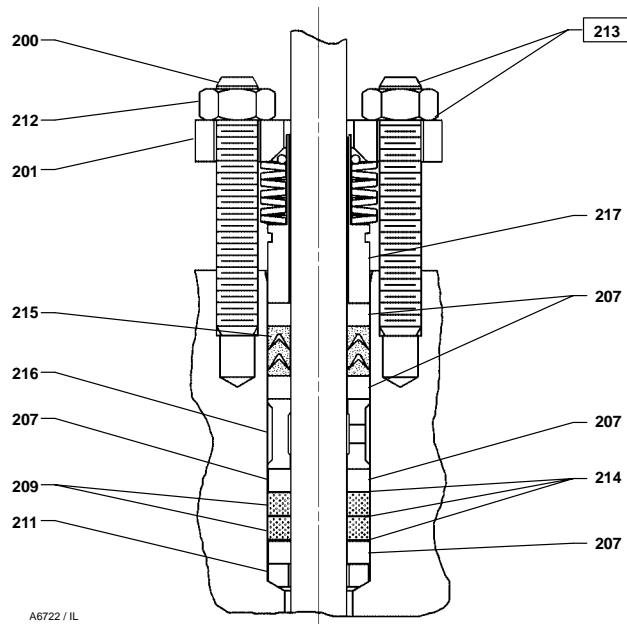
A6298 / IL

Figure 16. Typical ENVIRO-SEAL Packing System with Graphite Packing



A6297-1 / IL

Figure 15. Typical ENVIRO-SEAL Packing System with PTFE Packing



A6722 / IL

Figure 17. Typical ENVIRO-SEAL Packing System with Duplex Packing

# ED Valve

## ENVIRO-SEAL Packing Retrofit Kits

Retrofit kits include parts to convert valves with existing standard bonnets to the ENVIRO-SEAL packing box construction. Refer to figure 15 for key numbers for PTFE packing, figure 16 for key numbers for graphite packing, and figure 17 for key numbers for duplex packing. PTFE kits include keys 200, 201, 211, 212, 214, 215, 217, 218, tag, and cable tie. Graphite kits include keys 200, 201, 207, 208, 209, 210, 211, 212, 214, 216, 217, tag, and

cable tie. Duplex kits include keys 200, 201, 207, 209, 211, 212, 214, 215, 216, 217, tag, and cable tie.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306.

ENVIRO-SEAL Packing Retrofit Kits

PACKING MATERIAL	STEM DIAMETER AND YOKE BOSS DIAMETER, mm (INCH)				
	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE	RPACKXRT012	RPACKXRT022	RPACKXRT032	RPACKXRT042	RPACKXRT052
Single Graphite	RPACKXRT062	RPACKXRT072	RPACKXRT082	RPACKXRT092	RPACKXRT102
Duplex	RPACKXRT212	RPACKXRT222	RPACKXRT232	RPACKXRT242	RPACKXRT252

## ENVIRO-SEAL Packing Repair Kits

Repair kits include parts to replace the “soft” packing materials in valves that already have ENVIRO-SEAL packing arrangements installed or in valves that have been upgraded with ENVIRO-SEAL retrofit kits. Refer to figure 15 for key numbers for PTFE packing, figure 16 for key numbers for graphite packing, and figure 17 for key numbers for duplex packing. PTFE repair kits include keys 214, 215, and 218. Graphite repair kits include keys 207,

208, 209, 210, and 214. Duplex repair kits include keys 207, 209, 214, and 215.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, Form 5306.

ENVIRO-SEAL Packing Repair Kits

PACKING MATERIAL	STEM DIAMETER AND YOKE BOSS DIAMETER, mm (INCH)				
	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE (contains keys 214, 215, & 218)	RPACKX00192	RPACKX00202	RPACKX00212	RPACKX00222	RPACKX00232
Single Graphite (contains keys 207, 208, 209, 210, and 214)	RPACKX00242	RPACKX00252	RPACKX00262	RPACKX00272	RPACKX00282
Duplex (contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312	RPACKX00322	RPACKX00332

## Parts List

**Note**

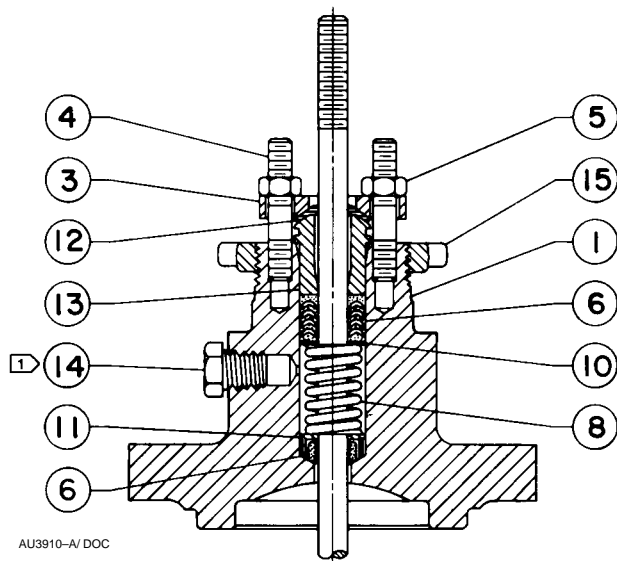
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

### Bonnet (figure 18)

Key	Description	Part Number
1	Bonnet If you need a bonnet and/or an ENVIRO-SEAL bellows seal bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Extension Bonnet Baffle	

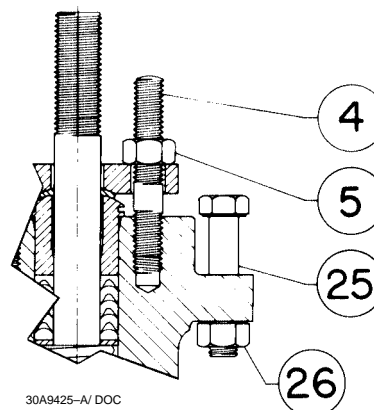
Key	Description	Part Number
3	Packing Flange	
3	ENVIRO-SEAL bellows seal packing flange	
4	Packing Flange Stud	
4	ENVIRO-SEAL bellows seal stud bolt	
5	Packing Flange Nut	
5	ENVIRO-SEAL bellows seal packing flange nut	
6*	Packing set, PTFE	See following table
6*	ENVIRO-SEAL bellows seal packing set PTFE (1 req'd for single, 2 req'd for double)	
	9.5 mm (3/8-inch) stem	12A9016X012
	Size 2 w/ 12.7 mm (1/2-inch) stem	12A9016X012
	Sizes 3 & 4 w/ 12.7 mm (1/2-inch) stem (For double PTFE only)(2 req'd)	12A8832X012
7*	Packing Ring, PTFE	See following table





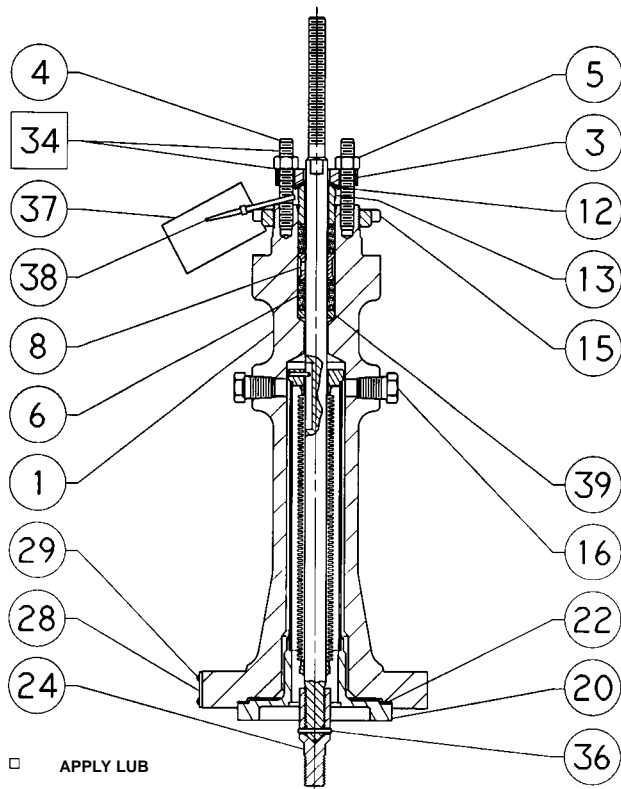
AU3910-A/DOC

PLAIN BONNET



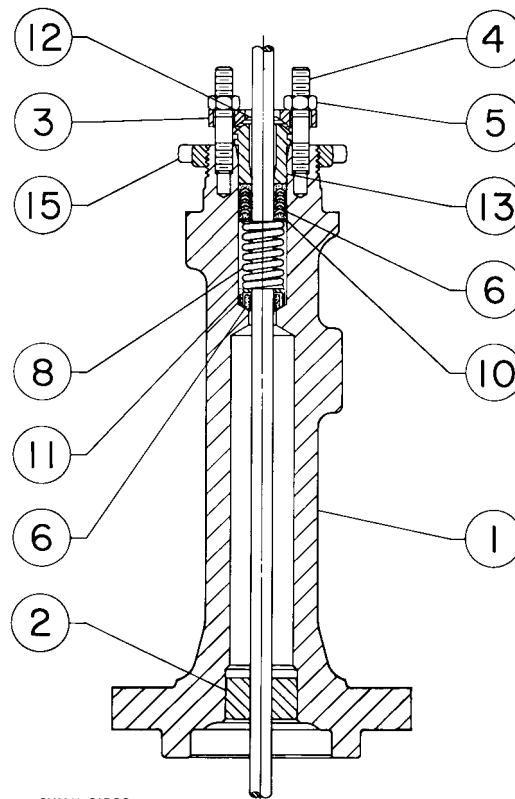
30A9425-A/DOC

DETAIL OF 127 mm (5-INCH) YOKE  
BOSS ACTUATOR BOLTING



42B3947-A/DOC

ENVIRO-SEAL  
BELLOWS SEAL BONNET



CU3911-C/DOC

STYLE 1 OR 2  
EXTENSION BONNET

NOTE:

1 PIPE PLUG (KEY 14) INCLUDED ONLY IF BONNET IS DRILLED AND TAPPED FOR PACKING LUBRICATOR AND LUBRICATOR IS NOT INSTALLED.

Figure 18. Typical Bonnets

Key	Description	Part Number	Key	Description	Part Number
7*	ENVIRO-SEAL bellows seal packing ring Double packing graphite filament (4 req'd) 9.5 mm (3/8-inch) stem	1P3905X0172	15	Yoke Locknut	
	Size 2 w/ 12.7 mm (1/2-inch) stem	1P3905X0172	15	ENVIRO-SEAL bellows seal yoke locknut	
	Sizes 3 & 4 w/ 12.7 mm (1/2-inch) stem	14A0915X042	16	Pipe Plug for 1/2-inch NPT tapped extension bonnets	
7*	ENVIRO-SEAL bellows seal packing ring Double packing graphite ribbon (4 req'd) 9.5 mm (3/8-inch) stem	18A0908X012	16	ENVIRO-SEAL bellows seal pipe plug	
	Size 2 w/ 12.7 mm (1/2-inch) stem	18A0908X012	20*	ENVIRO-SEAL bellows seal stem/bellows assembly	
	Sizes 3 & 4 w/ 12.7 mm (1/2-inch) stem	18A0918X012		1 ply bellows	
8	Spring			S31603 (316L SST) trim, N06625 (Inconel 625) bellows	
8	Lantern Ring			1 or 1-1/4 inch valve w/ 9.5 mm (3/8-inch) stem	32B4224X012
8	ENVIRO-SEAL bellows seal spring			1-1/2 inch valve w/ 9.5 mm (3/8-inch) stem	32B4225X012
8	ENVIRO-SEAL bellows seal spacer			Size 2 w/ 12.7 mm (1/2-inch) stem	32B4226X012
10	Special Washer			Size 3 w/ 12.7 mm (1/2-inch) stem	32B4227X012
11*	Packing Box Ring			Size 4 w/ 12.7 mm (1/2-inch) stem	32B4228X012
	9.5 mm (3/8-inch) stem, 316 stainless steel	1J873135072		N06022 (Hastelloy C22) trim, N06022 bellows	
	12.7 mm (1/2-inch) stem, 316 stainless steel	1J873235072		1 or 1-1/4 inch valve w/ 9.5 mm (3/8-inch) stem	32B4224X022
	19.1 mm (3/4-inch) stem, 316 stainless steel	1J873335072		1-1/2 inch valve w/ 9.5 mm (3/8-inch) stem	32B4225X022
	25.4 mm (1-inch) stem, 17-4PH stainless steel	1J873435072		Size 2 w/ 12.7 mm (1/2-inch) stem	32B4226X022
	31.8 mm (1-1/4inch) stem, 17-4PH stainless steel	1J873535072		Size 3 w/ 12.7 mm (1/2-inch) stem	32B4227X022
12*	Upper Wiper, felt			Size 4 w/ 12.7 mm (1/2-inch) stem	32B4228X022
	9.5 mm (3/8-inch) stem	1J872606332		2 ply bellows	
	12.7 mm (1/2-inch) stem	1J872706332		S31603 (316L SST) trim, N06625 (Inconel 625) bellows	
	19.1 mm (3/4-inch) stem	1J872806332		1 or 1-1/4 inch valve w/ 9.5 mm (3/8-inch) stem	32B4224X032
	25.4 mm (1-inch) stem	1J872906332		1-1/2 inch valve w/ 9.5 mm (3/8-inch) stem	32B4225X032
	31.8 mm (1-1/4 inch) stem	1J873006332		Size 2 w/ 12.7 mm (1/2-inch) stem	32B4226X032
12*	ENVIRO-SEAL bellows seal upper wiper, felt			Size 3 w/ 12.7 mm (1/2-inch) stem	32B4227X032
	9.5 mm (3/8-inch) stem	18A0868X012		Size 4 w/ 12.7 mm (1/2-inch) stem	32B4228X032
	Size 2 w/ 12.7 mm (1/2-inch) stem	18A0868X012		N06022 (Hastelloy C22) trim, N06022 bellows	
	Sizes 3 & 4 w/ 12.7 mm (1/2-inch) stem	18A0870X012		1 or 1-1/4 inch valve w/ 9.5 mm (3/8-inch) stem	32B4224X042
13	Packing Follower			1-1/2 inch valve w/ 9.5 mm (3/8-inch) stem	32B4225X042
13*	ENVIRO-SEAL bellows seal bushing For 9.5 mm (3/8-inch) stem (1 req'd), size 2 w/ 12.7 mm (1/2-inch) stem (2 req'd)			Size 2 w/ 12.7 mm (1/2-inch) stem	32B4226X042
	S31600 (316 SST)	18A0820X012		Size 3 w/ 12.7 mm (1/2-inch) stem	32B4227X042
	R30006 (alloy 6)	18A0819X012		Size 4 w/ 12.7 mm (1/2-inch) stem	32B4228X042
	S31600 chrome coated	11B1155X012	22*	ENVIRO-SEAL bellows seal bonnet gasket, graphite/laminate	
	For size 3 & 4 w/ 12.7 mm (1/2-inch) stem (1 req'd)			1 or 1-1/4 inch valve	12B6316X022
	S31600 (316 SST)	18A0824X012		1-1/2 inch valve	12B6317X022
	R30006 (alloy 6)	18A0823X012		2-inch valve	12B6318X022
	S31600 chrome coated	11B1157X012		3-inch valve	12B6319X022
13*	ENVIRO-SEAL bellows seal bushing/liner For 9.5 mm (3/8-inch) stem (1 req'd), size 2 w/ 12.7 mm (1/2-inch) stem (2 req'd)			4-inch valve	12B6320X022
	N10276 bushing, PTFE/glass liner	12B2713X012	24	ENVIRO-SEAL bellows seal adaptor	
	N10276 bushing, PTFE/carbon liner	12B2713X042	25	Cap Screw	
	For size 3 & 4 w/ 12.7 mm (1/2-inch) stem (1 req'd)		26	Hex Nut	
	N10276 bushing, PTFE/glass liner	12B2715X012	27	Pipe Nipple for lubricator/isolating valve	
	N10276 bushing, PTFE/carbon liner	12B2715X042	28	Warning Nameplate for ENVIRO-SEAL bellows	
14	Pipe Plug, for 1/4-inch NPT tapping in packing box		29	Drive Screw for ENVIRO-SEAL bellows	
14	Lubricator		34	Lubricant, Never Seez Nickel Special (not furnished with valve)	
14	Lubricator/Isolating Valve		36*	ENVIRO-SEAL bellows seal pin, N06022 (Hastelloy C22)	12B3951X012
			37	Warning Tag for ENVIRO-SEAL bellows	
			38	Tie for ENVIRO-SEAL bellows	
			39	ENVIRO-SEAL bellows seal thrust ring	



# ED Valve

Keys 2\*, 7\*, and 8\* Valve Plug and Stem Assembly for Plain Bonnet

VALVE SIZE, INCHES		STEM DIAMETER & VSC SIZE		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE HIGH TEMPERATURE <sup>(2)</sup>
Design ED	Design EAD	mm	Inches					
1 or 1-1/4	1	9.5 12.7	3/8 1/2	1V6571X0032 1V6572X0022	1V6571X0052 1V6572X0062	11A5315X032 11A5316X022	11A5317X042 11A5318X042	11A5319X022 11A5320X022
1-1/2	2	9.5 12.7	3/8 1/2	1V6573X0042 1V6574X0012	1V6573X0052 1V6574X0032	11A5321X022 ---	10A4438X022 10A4611X042	11A5322X022 11A5323X022
1-1/2 x 1	2 x 1	9.5 12.7	3/8 1/2	1V6571X0042 1V6572X0042	1V6571X0092 ---	---	11A5317X072 11A5318X032	---
2 or 3 x 2	4 x 2	12.7 19.1	1/2 3/4	1V6575X0052 1V6576X0012	1V6575X0062 ---	11A5324X022 ---	11A5326X022 11A5327X032	11A5328X022 ---
2 x 1	---	12.7	1/2	1V6572X0022	1V6572X0062	11A5316X022	11A5318X042	11A5320X022
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7 19.1	1/2 3/4	1V6577X0042 1V6578X0012	1V6577X0062 1V6578X0022	11A5330X022 11A5331X022	11A5332X022 ---	11A5334X042 11A5335X022
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0012	1V6574X0032	---	10A4611X042	11A5323X022
3	4	12.7	1/2	1V6579X0092	1V6579X0112	11A5336X032	11A5337X082	11A5339X022
4	6	12.7 19.1	1/2 3/4	1V6581X0042 1V6582X0022	1V6581X0052 1V6582X0072	11A5341X032 ---	11A5344X022 11A5345X042	11A5347X022 11A5348X092
6	---	19.1	3/4	1V6584X0042	1V6584X0062	11A5350X032	21A5351X062	21A5353X042
8	---	19.1	3/4	21A5356X052	21A5356X132	---	21A5362X062	21A5365X052

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F) or CoCr-A cages above 427°C (800°F); use high temperature valve plugs for these applications.  
 2. For use with 17-4PH stainless steel cages between 210°C (410°F) and 427°C (800°F) and with CoCr-A cages over 427°C (800°F) (the letter "H" is stamped on top for identification).

Keys 2\*, 7\*, and 8\* Valve Plug and Stem Assembly for Style 1 Extension Bonnet

VALVE SIZE, INCHES		STEM DIAMETER & VSC SIZE		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE HIGH TEMPERATURE <sup>(2)</sup>
Design ED	Design EAD	mm	Inches					
1 or 1-1/4	1	9.5 12.7	3/8 1/2	1V6571X0072 1V6572X0032	1V6571X0062 ---	---	11A5317X082 ---	---
1-1/2	2	9.5 12.7	3/8 1/2	1V6573X0072 1V6574X0052	---	11A5321X042 ---	10A4438X032 10A4611X112	11A5322X032 ---
1-1/2 x 1	2 x 1	9.5 12.7	3/8 1/2	1V6571X0102 1V6572X0152	---	---	11A5317X052 ---	11A5319X072 ---
2 or 3 x 2	4 x 2	12.7	1/2	1V6575X0182	1V6575X0122	11A5324X042	11A5326X062	11A5328X032
2 x 1	---	12.7	1/2	1V6572X0032	---	11A5316X032	---	11A5320X032
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V6577X0052	---	---	11A5332X202	11A5334X062
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0052	---	---	10A4611X112	---
3	4	12.7	1/2	1V6579X0082	1V6579X0072	---	11A5337X062	11A5339X032
4	6	12.7	1/2	1V6581X0072	1V6581X0062	---	11A5344X052	11A5347X032
6	---	19.1	3/4	1V6584X0052	1V6584X0112	---	21A5351X052	21A5353X032
8	---	19.1	3/4	21A5356X082	21A5356X262	---	---	21A5365X022

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F) or CoCr-A cages above 427°C (800°F); use high temperature valve plugs for these applications.  
 2. For use with 17-4PH stainless steel cages between 210°C (410°F) and 427°C (800°F) and with CoCr-A cages over 427°C (800°F) (the letter "H" is stamped on top for identification).

# Instruction Manual

Form 5032

July 2002

# ED Valve

## Key 2\* Standard Valve Plug

VALVE SIZE, INCHES		STEM DIAMETER & VSC SIZE		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE <sup>(1)</sup>	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE HIGH TEMPERATURE <sup>(2)</sup>
Design ED	Design EAD	mm	Inches					
1 or 1-1/4 or 1-1/2 x 1	1 or 2 x 1	9.5	3/8	1V657146172	1V657135072	11A5315X012	11A5317X012	11A5319X012
		12.7	1/2	1V657246172	1V657235072	11A5316X012	11A5318X012	11A5320X012
1-1/2	2	9.5	3/8	1V657346172	1V637335072	11A5321X012	10A4438X012	11A5322X012
		12.7	1/2	1V657446172	1V657435072	10A4439X012	10A4611X012	11A5323X012
2 or 3 x 2	4 x 2	12.7	1/2	1V657546172	1V657535072	11A5324X012	11A5326X012	11A5328X012
		19.1	3/4	1V657646172	1V657635072	11A5325X012	11A5327X012	11A5329X012
2 x 1	---	12.7	1/2	1V657246172	1V657235072	11A5316X012	11A5318X012	11A5320X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V657746172	1V657735072	11A5330X012	11A5332X012	11A5334X012
		19.1	3/4	1V657846172	1V657835072	11A5331X012	11A5333X012	11A5335X012
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V657446172	1V657435072	10A4439X012	10A4611X012	11A5323X012
3	4	12.7	1/2	1V657946172	1V657935072	11A5336X012	11A5337X012	11A5339X012
		19.1	3/4	1V658046172	1V658035072	10A5104X012	11A5338X012	11A5340X012
4	6	12.7	1/2	1V658146172	1V658135072	11A5341X012	11A5344X012	11A5347X012
		19.1	3/4	1V658246172	1V658235072	11A5342X012	11A5345X012	11A5348X012
		25.4	1	1V658346172	1V658335072	11A5343X012	11A5346X012	11A5349X012
6	---	19.1	3/4	1V658446172	1V658435072	11A5350X012	21A5351X012	21A5353X012
		25.4	1	1V658546172	1V658535072	10A5107X012	20A0103X012	21A5354X012
		31.8	1-1/4	1V658646172	1V658635072	10A5108X012	20A4608X012	21A5355X012
8	---	19.1	3/4	21A5356X012	21A5356X022	21A5359X012	21A5362X012	21A5365X012
		25.4	1	21A5357X012	21A5357X022	21A5360X012	21A5363X012	21A5366X012
		31.8	1-1/4	21A5358X012	21A5358X022	21A5361X012	21A5364X012	21A5367X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F) or CoCr-A cages above 427°C (800°F); use high temperature valve plugs for these applications.
2. For use with 17-4PH stainless steel cages between 210°C (410°F) and 427°C (800°F) and with CoCr-A cages over 427°C (800°F) (the letter "H" is stamped on top for identification).

## Key 2\* Valve Plug (Multiple Piston Rings) for Class IV Shutoff (Design ED Only)

VALVE SIZE, INCHES	STEM DIAMETER & VSC SIZE		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE HIGH TEMPERATURE <sup>(2)</sup>
	mm	Inches		
4	12.7	1/2	27A3932X012	27A3941X012
	19.1	3/4	27A3933X012	27A3942X012
6	19.1	3/4	27A3944X012	27A3953X012
	25.4	1	27A3945X012	27A3954X012
8	19.1	3/4	27A3956X012	27A3965X012
	25.4	1	27A3957X012	27A3966X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F) or CoCr-A cages above 427°C (800°F); use high temperature valve plugs for these applications.
2. For use with 17-4PH stainless steel cages between 210°C (410°F) and 427°C (800°F) and with CoCr-A cages over 427°C (800°F) (the letter "H" is stamped on top for identification).

## Key 2\* Whisper Trim III Valve Plug (6-Inch Design ED Only)

STEM DIAMETER & VSC SIZE		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL	316 STAINLESS STEEL w/ CoCr-A ON SEAT	316 STAINLESS STEEL w/ CoCr-A ON SEAT & GUIDE	316 STAINLESS STEEL w/ CoCr-A ON SEAT & GUIDE <sup>(1)</sup>
mm	Inches					
19.1	3/4	22A3259X012	22A3259X022	22A3260X012	22A3261X012	22A3267X012
25.4	1	22A3262X012	22A3262X022	22A3263X012	22A3264X012	22A3268X012

1. High temperature.

# ED Valve

C-seal Parts for Design ED Valve (Keys 3\*, 2\*, 9\*, 64\*, 6\*, and 7\*)

VALVE SIZE	PORT DIA	TRAVEL	TRIM	STEM DIA	CHARACTER-ISTIC	CAGE	PLUG/RETAINER	SEAT RING	C-seal	PISTON RING	STEM																
Inch	Inch	Inch		mm (Inch)		Key 3	Key 2	Key 9	Key 64	Key 6	Key 7																
2-1/2 (Design ED) and 3 (Design EAD)	2-7/8	1-1/2	1	12.7 (1/2)	Linear	37B9140X012	27B2795X012	21B3687X012	24B3621X012	14B3620X012	1U3891X0102 <sup>(3)</sup> 10A8840XU22 <sup>(4)</sup>																
					Equal %	37B3920X012																					
					Whisper I	37B2792X012																					
			37H	19.1 (3/4)	Linear	37B9140X012	27B4524X022	21B3687X012	24B3621X012	14B3620X012	1U3894X0022 <sup>(3)</sup> 1K5880X0262 <sup>(4)</sup>																
					Equal %	37B3920X012																					
					Whisper I	37B2792X012																					
3 (Design ED) and 4 (Design EAD)	3-7/16	1-1/2	1	12.7 (1/2)	Linear	34B5616X012	34B9832X012	23B6127X012	23B9196X012	13B9199X012	1K5869X0102 <sup>(3)</sup> 1U2306X0192 <sup>(4)</sup>																
					Equal %	34B9857X012																					
					Whisper I	37B2277X012																					
				19.1 (3/4)	Linear	34B5616X012						34B9832X032	23B6127X012	23B9196X012	13B9199X012	1U3894X0022 <sup>(3)</sup> 1K5880X0262 <sup>(4)</sup>											
					Equal %	34B9857X012																					
					Whisper I	37B2277X012																					
			37H	12.7 (1/2)	Linear	34B5616X012	34B5615X022	23B6127X022	23B9196X012	13B9199X012	1K5869X0102 <sup>(3)</sup> 1U2306X0192 <sup>(4)</sup>																
					Equal %	34B9857X012																					
					Whisper I	37B2277X012																					
				19.1 (3/4)	Linear	34B5616X012						34B5615X012	23B6127X022	23B9196X012	13B9199X012	1U3894X0022 <sup>(3)</sup> 1K5880X0262 <sup>(4)</sup>											
					Equal %	34B9857X012																					
					Whisper I	37B2277X012																					
4 (Design ED) and 6 (Design EAD)	4-3/8	2	1	12.7 (1/2)	Linear	34B5346X022	37B2279X012	23B6128X012	23B9197X012	14B5341X012	1U2305X0142 <sup>(3)</sup> 1U2306X0192 <sup>(4)</sup>																
					Equal %	37B3194X012																					
					Whisper I	34B9852X012																					
				19.1 (3/4)	Linear	34B5346X022						37B2279X022	23B6128X012	23B9197X012	14B5341X012	1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>											
					Equal %	37B3194X012																					
					Whisper I	34B9852X012																					
				25.4 (1)	Linear	34B5346X022											37B2279X032	23B6128X012	23B9197X012	14B5341X012	1K7796X0062 <sup>(3)</sup> 1K7891X0242 <sup>(4)</sup>						
					Equal %	37B3194X012																					
					Whisper I	34B9852X012																					
				3H	12.7 (1/2)	Linear																34B5346X012	34B5345X032	23B6128X022	23B9197X012	14B5341X012	1U2305X0142 <sup>(3)</sup> 1U2306X0192 <sup>(4)</sup>
						Equal %																37B3194X022					
						Whisper I																---					
			19.1 (3/4)		Linear	34B5346X012	34B5345X012	23B6128X022	23B9197X012	14B5341X012	1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>																
					Equal %	37B3194X022																					
					Whisper I	---																					
			25.4 (1)	Linear	34B5346X012	34B5345X022						23B6128X022	23B9197X012	14B5341X012	1K7796X0062 <sup>(3)</sup> 1K7891X0242 <sup>(4)</sup>												
				Equal %	37B3194X022																						
				Whisper I	---																						
			37H	12.7 (1/2)	Linear		34B5346X022	34B5345X032	23B6128X022	23B9197X012	14B5341X012					1U2305X0142 <sup>(3)</sup> 1U2306X0192 <sup>(4)</sup>											
					Equal %		37B3194X012																				
					Whisper I		34B9852X012																				
					19.1 (3/4)	Linear	34B5346X022					34B5345X012	23B6128X022	23B9197X012	14B5341X012		1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>										
						Equal %	37B3194X012																				
						Whisper I	34B9852X012																				
25.4 (1)	Linear	34B5346X022		34B5345X022	23B6128X022	23B9197X012	14B5341X012											1K7796X0062 <sup>(3)</sup> 1K7891X0242 <sup>(4)</sup>									
	Equal %	37B3194X012																									
	Whisper I	34B9852X012																									
4 (Design ED)	4-3/8	2										37H	19.1 (3/4)	Cavitrol III 1-Stage	34B1847X012		34B8993X012		24B8994X012	23B9197X012	14B5341X012	1K5877X0132 <sup>(3)</sup>					
														2-7/8	4		76		19.1 (3/4)	Cavitrol III 2-Stage	34B8990X012	24B8988X032	24B8995X012	24B3621X012	14B3620X012 (2 req'd)	(1)(3)	

1. Plug/retainer/stem assembly used.
2. Requires bonnet spacer 34B9846X012.
3. For Standard Bonnet.
4. For Style 1 Extension Bonnet.
5. Requires bonnet spacer 34B1369X012.

-continued-

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# ED Valve

C-seal Parts for Design ED Valve (Keys 3\*, 2\*, 9\*, 64\*, 6\*, and 7\*) (continued)

VALVE SIZE	PORT DIA	TRAVEL	TRIM	STEM DIA	CHARACTER-ISTIC	CAGE	PLUG/RETAINER	SEAT RING	C-seal	PISTON RING	STEM
				mm (Inch)		Key 3	Key 2	Key 9	Key 64	Key 6	Key 7
6 (Design ED)	7	2	1	19.1 (3/4)	Linear	33B9178X012	33B9195X012	29A9703X012	23B9182X012	13B9176X012	1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>
					Equal %	34B3628X012					
					Whisper I	34B9828X022					
				25.4 (1)	Linear	33B9178X012	33B9195X022	29A9703X012	23B9182X012	13B9176X012	1N7047X0052 <sup>(3)</sup> 1L8776X0032 <sup>(4)</sup>
					Equal %	34B3628X012					
					Whisper I	34B9828X022					
			3H	19.1 (3/4)	Linear	33B9178X022	34B7699X022	29A9703X022	23B9182X012	13B9176X012	1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>
					Equal %	34B3628X022					
					Whisper I	34B9828X012					
				25.4 (1)	Linear	33B9178X022	34B7699X012	29A9703X022	23B9182X012	13B9176X012	1N7047X0052 <sup>(3)</sup> 1L8776X0032 <sup>(4)</sup>
					Equal %	34B3628X022					
					Whisper I	34B9828X012					
		37H	19.1 (3/4)	Linear	33B9178X012	34B7699X022	29A9703X022	23B9182X012	13B9176X012	1K5877X0132 <sup>(3)</sup> 1U4446X0102 <sup>(4)</sup>	
				Equal %	34B3628X012						
				Whisper I	34B9828X022						
			25.4 (1)	Linear	33B9178X012	34B7699X012	29A9703X022	23B9182X012	13B9176X012	1N7047X0052 <sup>(3)</sup> 1L8776X0032 <sup>(4)</sup>	
				Equal %	34B3628X012						
				Whisper I	34B9828X022						
5-3/8	4	76	25.4 (1)	Cavitrol III 2-Stage	33B9185X012	37B1413X0A2	24B9858X012	24B2191X012	13B9186X012 (2 req'd)	(1)(3)	
				Linear	37B1663X022	37B6392X022	29A9704X012	34B9827X012	24B9826X012	1K5880X0262 <sup>(3)</sup>	
3	1	19.1 (3/4)	Equal %	37B5635X022							
			25.4 (1)	Linear	37B1663X022	37B6392X012	29A9704X012	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup>	
Equal %	37B5635X022										
2	3.5 <sup>(5)</sup>	1	31.8 (1-1/4)	Linear	37B1663X022	---	29A9704X012	34B9827X012	24B9826X012	1L2298X0202 <sup>(4)</sup>	
					Equal %	37B5635X022					
2	3.5 <sup>(5)</sup>	1	25.4 (1)	Whisper I	47B6378X012	37B6389X012	29A9704X012	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup> 1K7783X0032 <sup>(4)</sup>	
					Whisper I						47B5214X012
2	3.5 <sup>(5)</sup>	1	31.8 (1-1/4)	Whisper I	47B6378X012	37B6379X012	29A9704X012	34B9827X012	24B9826X012	10A6073X072 <sup>(4)</sup> --(4)	
					Whisper I						47B5214X012
3	3H	19.1 (3/4)	Linear	37B1663X012	37B1665X032	29A9704X022	34B9827X012	24B9826X012	1K5880X0262 <sup>(3)</sup>		
				Equal %						37B5635X012	
				Whisper I						37B1663X012	
		25.4 (1)	Linear	37B1663X012	37B1665X012	29A9704X022	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup>		
				Equal %						37B5635X012	
				Whisper I						37B1663X022	
31.8 (1-1/4)	Equal %	37B5635X022	37B1665X022	29A9704X012	34B9827X012	24B9826X012	1L2298X0202 <sup>(4)</sup>				
		Whisper I						---			
		Whisper I						---			
2	3.5 <sup>(5)</sup>	3H	25.4 (1)	Whisper I	---	34B9848X012	29A9704X012	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup> 1K7783X0032 <sup>(4)</sup>	
					Whisper I						---
2	3.5 <sup>(5)</sup>	3H	31.8 (1-1/4)	Whisper I	---	---	29A9704X012	34B9827X012	24B9826X012	10A6073X072 <sup>(4)</sup> --(4)	
					Whisper I						---
3	37H	19.1 (3/4)	Linear	37B1663X022	37B1665X032	29A9704X022	34B9827X012	24B9826X012	1K5880X0262 <sup>(3)</sup>		
				Equal %						37B5635X022	
				Whisper I						37B1663X022	
		25.4 (1)	Linear	37B1663X022	37B1665X012	29A9704X022	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup>		
				Equal %						37B5635X022	
				Whisper I						37B1663X022	
31.8 (1-1/4)	Equal %	37B5635X022	37B1665X022	29A9704X012	34B9827X012	24B9826X012	1L2298X0202 <sup>(4)</sup>				
		Whisper I						47B6378X012			
		Whisper I						47B5214X012			
2	3.5 <sup>(5)</sup>	37H	25.4 (1)	Whisper I	47B6378X012	34B9848X012	29A9704X012	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup> 1K7783X0032 <sup>(4)</sup>	
					Whisper I						47B5214X012
2	3.5 <sup>(5)</sup>	37H	31.8 (1-1/4)	Whisper I	47B6378X012	---	29A9704X012	34B9827X012	24B9826X012	10A6073X072 <sup>(4)</sup> --(4)	
					Whisper I						47B5214X012
8 (Design ED)	8	4 <sup>(2)</sup>	318	25.4 (1)	Whisper III-A1	44B9847X012	34B9848X012	29A9704X022	34B9827X012	24B9826X012	10A3282X222 <sup>(4)</sup>

1. Plug/retainer/stem assembly used.
2. Requires bonnet spacer 34B9846X012.
3. For Standard Bonnet.
4. For Style 1 Extension Bonnet.
5. Requires bonnet spacer 34B1369X012.

# ED Valve

### Key 3\* Quick Opening Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		Alloy 6
Design ED	Design EAD		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215033272	2U691146102	2U740348932	2U215039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219233272	2U691846102	2U725448932	2U219239102
2 or 3 x 2	4 x 2	2U223433272	2U692146102	2U740448932	2U223439102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227633272	2U692446102	2U740548932	2U227639102
3	4	2U231833272	2U692746102	2U740648932	2U231839102
4	6	2U236033272	2U693046102	2U740748932	2U236039102
6	---	2U506333272	2U693546102	2U806948932	2U506339102
8	---	20A3249X012	20A4350X012	20A5469X012	20A3249X092

### Key 3\* Linear Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		Alloy 6
Design ED	Design EAD		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215633272	2U691746102	2U741448932	2U215639102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219833272	2U692046102	2U741548932	2U219839102
2 or 3 x 2	4 x 2	2U224033272	2U692346102	2U741648932	2U224039102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U228233272	2U692646102	2U741748932	2U228239102
3	4	2U232433272	2U692946102	2U741848932	2U232439102
4	6	2U236633272	2U693346102	2U741948932	2U236639102
6	---	2U506133272	2U693846102	2U806848932	2U506139102
8	---	20A3247X012	20A4349X012	20A5468X012	20A3247X092

### Key 3\* Equal Percentage Cage

VALVE SIZE, INCHES		17-4PH STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL		Alloy 6
Design ED	Design EAD		Chrome Plated	Nickel Coated	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215333272	2U691346102	2U740848932	2U215339102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219533272	2U691946102	2U740948932	2U219539102
2 or 3 x 2	4 x 2	2U223733272	2U692246102	2U741048932	2U223739102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227933272	2U692546102	2U741148932	2U227939102
3	4	2U232133272	2U692846102	2U741248932	2U232139102
4	6	2U236333272	2U693146102	2U741348932	2U236339102
6	---	2U505933272	2U693746102	2U806748932	2U505939102
8	---	20A3245X012	20A4348X012	20A5467X012	20A3245X092

### Key 3\* Whisper Trim I Cage, 17-4PH stainless steel (hardened)

VALVE SIZE, INCHES		PART NUMBER
Design ED	Design EAD	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2V502333272
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2V502433272
2 or 3 x 2	4 x 2	2V502533272
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2V502633272
3	4	2V502733272
4	6	23A8915X032
6	---	23A8913X032

### Key 3\* Whisper Trim III Cage (6-Inch Design ED only)

LEVEL	416 STAINLESS STEEL	316 STAINLESS STEEL (NICKEL COATED)	316 STAINLESS STEEL (ELECTROLIZED)
A3	32A3248X012	32A3251X012	32A3336X012
B3	32A3249X012	32A3252X012	32A3337X012
C3	32A3250X012	32A3253X012	32A3338X012
D3	32A6217X012	32A6220X012	32A6741X012



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# ED Valve

Key 6\* Standard Piston Ring

VALVE SIZE, INCHES		TO 427°C (800°F) (OXIDIZING) TO 482°C (900°F) (NON-OXIDIZING) GRAPHITE	482 TO 593°C (901 TO 1100°F) GRAPHITE
Design ED	Design EAD		
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	1U2174X0012	1U2174X0022
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1U2216X0012	1U2216X0022
2 or 3 x 2 2-1/2 or 4 x 2-1/2	4 x 2 3 or 6 x 2-1/2	1U2258X0012 1U2300X0012	1U2258X0022 1U2300X0022
3	4	1U2342X0012	1U2342X0022
4	6	1U2392X0012	1U2392X0022
6	---	1U5069X0012	1U5069X0022
8	---	10A3262X022	10A3262X032

Key 6\* Multiple Piston Rings for Class IV Shutoff (Design ED Only)

VALVE SIZE, INCHES	NUMBER REQUIRED	TO 427°C (800°F) (OXIDIZING) TO 482°C (900°F) (NON-OXIDIZING) GRAPHITE	482 TO 593°C (901 TO 1100°F) GRAPHITE
4	3	17A3988X012	17A3988X022
6	3	17A3990X012	17A3990X022
8	2	17A3991X012	17A3991X022

Key 6\* Whisper Trim III Piston Ring (6-Inch Design ED only)

GRAPHITE	
TO 427°C (800°F) (OXIDIZING) TO 482°C (900°F) (NON-OXIDIZING)	482 TO 593°C (901 TO 1100°F)
11A9727X022	11A9727X032

Key 7\* Design ED Valve Plug Stem for Class IV Shutoff (Design ED only)

VALVE SIZE, INCHES	STEM DIAMETER & VSC SIZE		PLAIN BONNET			EXTENSION BONNET		
			Stem Length		Part Number	Style 1		Part Number
			mm	Inches		mm	Inches	
4	12.7	1/2	318	12-1/2	1U230535162	421	16-9/16	1U230635162
	19.1	3/4	394	15-1/2	1K587735162	502	19-3/4	1U444635162
6	19.1	3/4	394	15-1/2	1K587735162	502	19-3/4	1U444635162
	25.4 <sup>(1)</sup>	1 <sup>(1)</sup>	260	10-1/4	1K7119X0012	---	---	---

1. Type 667 actuator only.

Key 7\* Whisper Trim III Valve Stem, 316 Stainless Steel (6-inch Design ED Only)

STEM DIAMETER & VSC SIZE		PLAIN BONNET			EXTENSION BONNET					
		Stem Length		Part Number	Style 1			Style 2		
		mm	Inches		mm	Inches	Part Number	mm	Inches	Part Number
19.1	3/4	443	17-7/16	1U294135162	533	21	1U928235162	616	24-1/4	1U6276X0012
25.4	1	505	19-7/8	1P847635162	635	25	1U627735162	---	---	---

Key 7\* Design ED Valve Plug Stem, 316 Stainless Steel (not for Whisper Trim III cage)

VALVE SIZE, INCHES		STEM DIAMETER & VSC SIZE		PLAIN BONNET <sup>(3)</sup>			EXTENSION BONNET					
				Stem Length		Part Number	Style 1 <sup>(4)</sup>			Style 2		
							Stem Length		Part Number	Stem Length		Part Number
							mm	Inches		mm	Inches	
Full Capacity	1, 1-1/4, or 1-1/2	9.5	3/8	225	8-7/8	1U388835162	311	12-1/4	1U217735162	405	15-15/16	10A8823X022
		12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	473	18-5/8	1U218035162
	2	12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	614	24-3/16	1U226435162
		19.1	3/4	372	14-5/8	1U226535162	483	19	1L400135162	---	---	---
	2-1/2 or 3	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	---	---	---
	4	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	394	15-1/2	1K587735162	502	19-3/4	1U444635162	694	27-5/16	1U240035162
		25.4 <sup>(1)</sup>	1 <sup>(1)</sup>	464	18-1/4	1K759035162	---	---	---	---	---	---
	25.4 <sup>(2)</sup>	1 <sup>(2)</sup>	489	19-1/4	1U217535162	---	---	---	---	---	---	---
		19.1	3/4	403	15-7/8	1K588035162	511	20-1/8	1U507135162	699	27-1/2	1U524435162
	25.4	1	499	19-5/8	1N704735162	630	24-13/16	1K7891X0012	---	---	---	---
31.8		1-1/4	508	20	1K415435162	656	25-13/16	1L268835162	---	---	---	
8	19.1	3/4	492	19-3/8	1K588035162	533	21	1U928235162	---	---	---	
	25.4	1	614	24-3/16	1K7891X0012	614	24-3/16	1K7891X0012	---	---	---	
31.8	1-1/4	705	27-7/16	1L268835162	705	29-7/16	1L268835162	---	---	---		
Restricted Capacity	1-1/2 x 1	9.5	3/8	241	9-3/8	1U223635162	324	12-3/4	1U227035162	418	16-7/16	1U227235162
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	486	19-1/8	1U227335162
	2 x 1 or 2-1/2 x 1-1/2	12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	605	23-13/16	1U389335162
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	614	24-3/16	1U226435162
	3 x 2	19.1	3/4	372	14-5/8	1U226535162	483	19	1L400135162	---	---	---
		12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
	4 x 2-1/2	19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	681	26-13/16	1U232335162

1. Type 667 actuator.  
 2. Type 657 or 585C size 60-130 actuator.  
 3. Plain bonnet is standard for 8-inch cast iron and WCC valve bodies.  
 4. Style 1 is standard for 8-inch 316 SST valve bodies.

Key 7\* Design EAD Valve Plug Stem for Plain and Extension Bonnets

VALVE SIZE, INCHES		STEM DIAMETER & VSC SIZE		PLAIN BONNET			EXTENSION BONNET					
				Stem Length		Part Number	Style 1			Style 2		
							Stem Length		Part Number	Stem Length		Part Number
							mm	Inches		mm	Inches	
Full Capacity	1 or 2	9.5	3/8	225	8-7/8	1U388835162	311	12-1/4	1U217735162	405	16	1U217835162
		12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	473	18-5/8	1U218035162
	3 or 4	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	---	---	---
	6	12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
		19.1	3/4	394	15-1/2	1K587735162	502	19-3/4	1U444635162	694	27-5/16	1U240035162
25.4 <sup>(1)</sup>	1 <sup>(1)</sup>	464	18-1/4	1K759035162	---	---	---	---	---	---		
25.4 <sup>(2)</sup>	1 <sup>(2)</sup>	489	19-1/4	1U217535162	---	---	---	---	---	---		
Restricted Capacity	2 x 1	9.5	3/8	241	9-3/8	1U223635162	324	12-3/4	1U227035162	418	16-1/2	1U227235162
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	486	19-1/8	1U227335162
	3 x 1-1/2	12.7	1/2	300	11-13/16	1U389035162	402	15-13/16	1U217935162	605	23-13/16	1U389335162
		12.7	1/2	311	12-1/4	1K586935162	413	16-1/4	1U226335162	614	24-3/16	1U226435162
	4 x 2	19.1	3/4	372	14-1/2	1U226535162	483	19	1L400135162	---	---	---
		12.7	1/2	321	12-5/8	1U230535162	421	16-9/16	1U230635162	624	24-9/16	1U230735162
	6 x 2-1/2	19.1	3/4	381	15	1U230835162	502	19-3/4	1U444635162	681	26-13/16	1U232335162

1. Type 667 actuator.  
 2. Type 657 or 585C size 60-130 actuator.

# Instruction Manual

Form 5032  
July 2002

# ED Valve

Key 9\* Seat Ring (not for Whisper Trim III cage)

VALVE SIZE, INCHES		416 STAINLESS STEEL (HARDENED)	316 STAINLESS STEEL	R30006
Design ED	Design EAD			
1, 1-1/4, or 2 x 1	1	1U222546172	1U222535072	1U222539102
1-1/2 x 1	2 x 1	1U222046172	1U222035072	1U222039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1U221946172	1U221935072	1U221939102
2 or 3 x 2	4 x 2	1U222646172	1U222635072	1U222639102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	1U222746172	1U222735072	1U222739102
3	4	1U222846172	1U222835072	1U222839102
4	6	1U222946172	1U222933092	1U222939102
6	---	1U508046172	1U508033092	1U508039102
8	---	20A3260X012	20A3260X022	20A3260X152

Key 9\* Design EAD Liner

LINER MATERIAL	VALVE SIZE, INCHES	CLASS 150 RF VALVE	CLASS 300 RF VALVE	CLASS 600 RF VALVE	SOCKET WELD VALVE	SCHEDULE 40 OR 80 BUTT WELD VALVE
416 stainless steel (hardened)	1	1V560146172	1U384246172	1V560246172	1V560146172	1V560146172
	2	1V560346172	1U384346172	1V560546172	1V560346172	1V560346172
	2 x 1	1V560646172	1U385146172	1V387646172	1V560646172	1V560646172
	3	2V561346172	2U384546172	2V561646172	---	2V561346172
	3 x 1-1/2	2V560946172	2U385346172	2V545946172	---	2V560946172
	4	2V562246172	2U384746172	2V561946172	---	2V562246172
	4 x 2	2V561846172	2U385546172	2V561246172	---	2V561846172
	6	2V563146172	2U384946172	2V562846172	---	2U384946172
316 stainless steel	6 x 2-1/2	2V562646172	2U385746172	2V562346172	---	2U385746172
	1	1V560135072	1U384235072	1V560235072	1V560135072	1V560135072
	2	1V560335072	1U384335072	1V560535072	1V560335072	1V560335072
	2 x 1	1V560635072	1U385135072	1V387635072	1V560635072	1V560635072
	3	2V561335072	2U384535072	2V561635072	---	2V561335072
	3 x 1-1/2	2V560935072	2U385335072	2V545935072	---	2V560935072
	4	2V562235072	2U384735072	2V561935072	---	2V562235072
	4 x 2	2V561835072	2U385535072	2V561235072	---	2V561835072
6	2V563135072	2U384935072	2V562835072	---	2U384935072	
6 x 2-1/2	2V562635072	2U385735072	2V562335072	---	2U385735072	

Key 9\* Whisper Trim III Seat Ring (6-Inch Design ED only)

410 SST	316 SST	316 SST w/ CoCr-A
21A9794X012	21A9794X022	21A9795X012

Gasket Descriptions

KEY NUMBER	DESCRIPTION	MATERIAL
		FGM -198° to 593° C (-325° to 1100° F)
10	Bonnet Gasket	Graphite/S31600
11	Cage Gasket	
13	Seat Ring or Liner Gasket	
14 or 20	Adapter Gasket	
12	Spiral-Wound Gasket	N06600 (Inconel 600)/Graphite
27 or 51	Shim	S31600 (316 SST)

# ED Valve

Keys 10\*, 11\*, 12\*, 13\*, 14\*, 20\*, 27\*, and 51\* Gaskets and Shims

VALVE SIZE, INCHES		KEY NUMBER	To 593°C (1100°F)	VALVE SIZE, INCHES		KEY NUMBER	To 593°C (1100°F)
Design ED	Design EAD			Design ED	Design EAD		
1 or 1-1/4	1	Set <sup>(1)</sup> 10 12 13 27 or 51	RGASKETX162 1R2859X0042 1R286099442 1R2862X0062 16A1936X012	3	4	Set <sup>(1)</sup> 10 12 13 27 or 51	RGASKETX202 1R3484X0042 1R348299442 1R3481X0052 16A1940X012
1-1/2	2	Set <sup>(1)</sup> 10 12 13 27 or 51	RGASKETX172 1R3101X0032 1R309999442 1R3098X0052 16A1937X012	3 x 2	4 x 2	Set <sup>(1)</sup> 10 11 12 13 14 27 or 51	RGASKETX272 1R3484X0042 1R3298X0032 1R329799442 1R3296X0042 1R3481X0052 16A1938X012
1-1/2 x 1	2 x 1	Set <sup>(1)</sup> 10 11 12 13 20 27 or 51	RGASKETX242 1R3101X0032 1R2861X0042 1R286099442 1R3098X0052 1U2152X0042 16A1936X012	4	6	Set <sup>(1)</sup> 10 12 13 27 or 51	RGASKETX212 1R3724X0042 1R372299442 1J5047X0062 16A1941X012
2	---	Set 10 12 13 51	RGASKETX182 1R3299X0042 1R329799442 1R3296X0042 16A1938X012	4 x 2-1/2	6 x 2-1/2	Set <sup>(1)</sup> 10 11 12 13 14 27 or 51	RGASKETX282 1R3724X0042 1R3846X0042 1R384599442 1R3844X0052 1J5047X0062 16A1939X012
2 x 1	---	Set 10 11 12 13 14 51	RGASKETX252 1R3299X0042 1R2861X0042 1R286099442 1R2862X0062 1R3296X0042 16A1936X012	6	---	Set <sup>(2)</sup> 10 12 13 51	RGASKETX222 1U5081X0052 1U508599442 1U5086X0032 16A1942X012
2-1/2	3	Set <sup>(1)</sup> 10 12 13 27 or 51	RGASKETX192 1R3847X0032 1R384599442 1R3844X0052 16A1939X012	8	---	Set 10 13	RGASKETX232 10A3265X112 10A3266X082
2-1/2 x 1-1/2	3 x 1-1/2	Set <sup>(1)</sup> 10 11 12 13 14 27 or 51	RGASKETX262 1R3847X0032 1R3100X0032 1R309999442 1R3098X0052 1R3844X0052 16A1937X012				

1. Set number good for both Design ED and EAD valve.
2. Whisper Trim III construction requires 2 bonnet gaskets (key 10) so order a set plus 1 extra bonnet gasket for that construction.

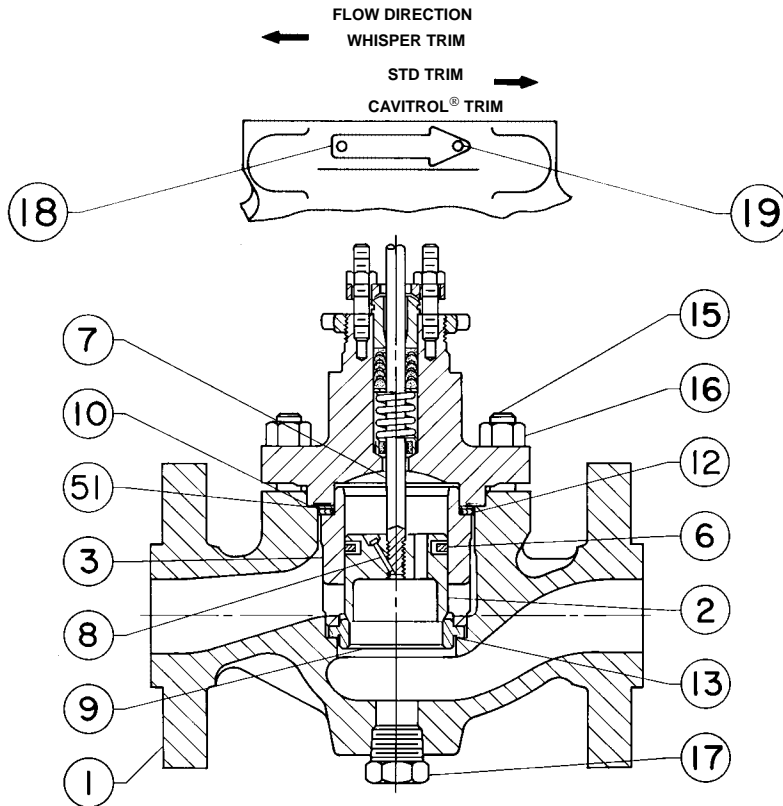
# Instruction Manual

Form 5032  
July 2002

# ED Valve

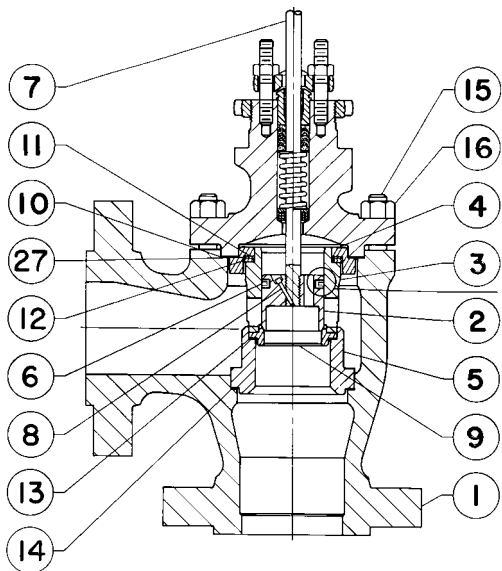
Actuator Groups (by Type Number)

<b>Group 1</b> <b>54 mm (2-1/8 inches),</b> <b>71 mm (2-13/16 inches)</b> <b>or 90 mm (3-9/16 inches) Yoke Boss</b>	<b>Group 100</b> <b>127 mm (5 inches) Yoke Boss</b>	<b>Group 403</b> <b>90.5 mm (3-9/16 inches) Yoke Boss</b>
350—71.4 mm (2-13/16 inches) yoke boss 422 & 424 585C 585 & 585R 603 & 1B 618 610 & 688 611 644 & 645 655	350 585C 657 1008	585C 1008
657 & 667—76.2 mm (3 inches) travel	<b>Group 101</b> <b>127 mm (5 inches) Yoke Boss</b>	
1008—71.4 mm (2-13/16 inches) yoke boss	667	

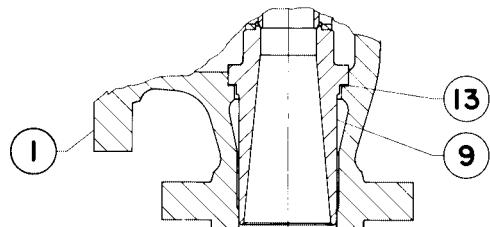


30A9542-F

**FULL-CAPACITY DESIGN ED**



VIEW A



40A9083-F

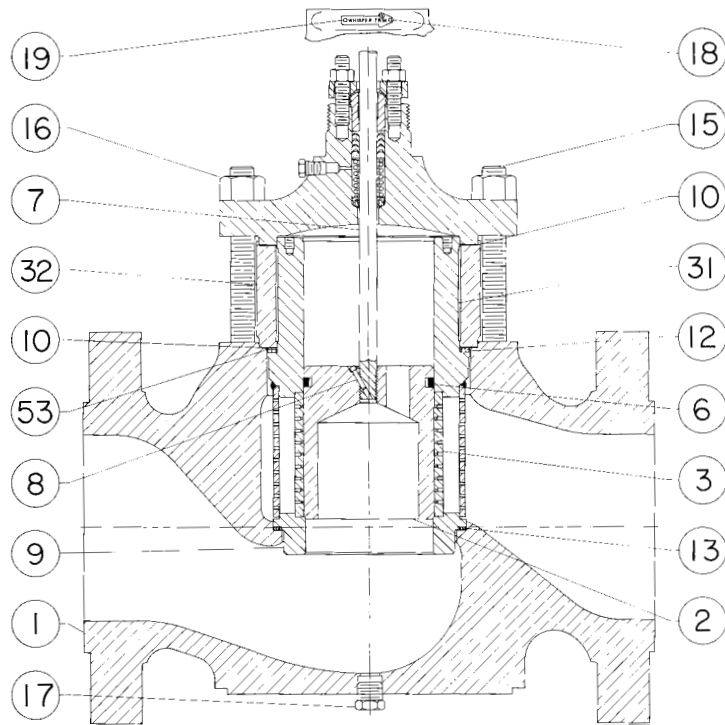
**DETAIL OF LINER-STYLE DESIGN EAD**

**SEAT-RING STYLE DESIGN EAD WITH RESTRICTED TRIM**

40A9082-E

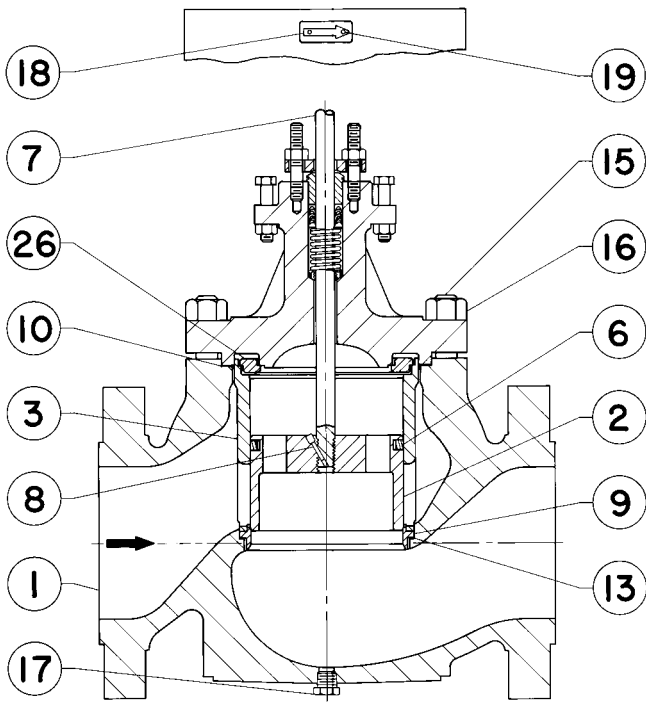
**NOTE:**  
KEY 54 NOT SHOWN

Figure 19. Standard 1- Through 6-Inch Design ED and EAD Valves



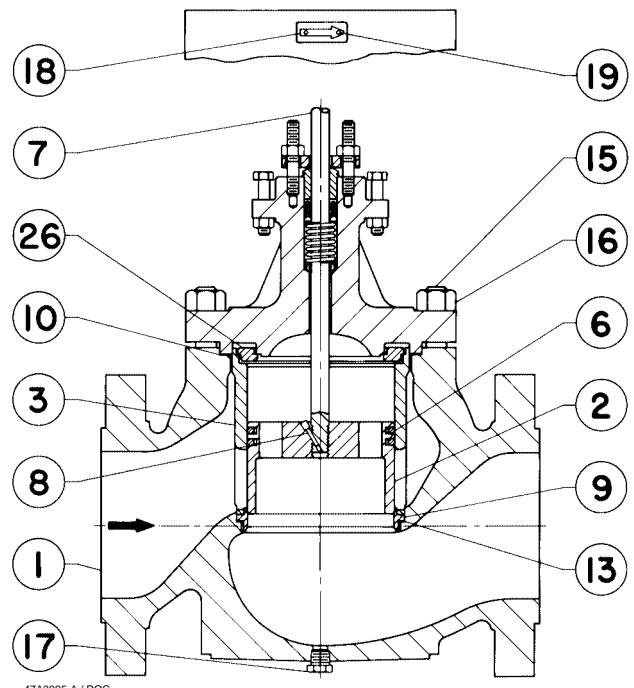
52A3328-C / DOC

Figure 20. Whisper Trim III Detail



40A3290-D / DOC

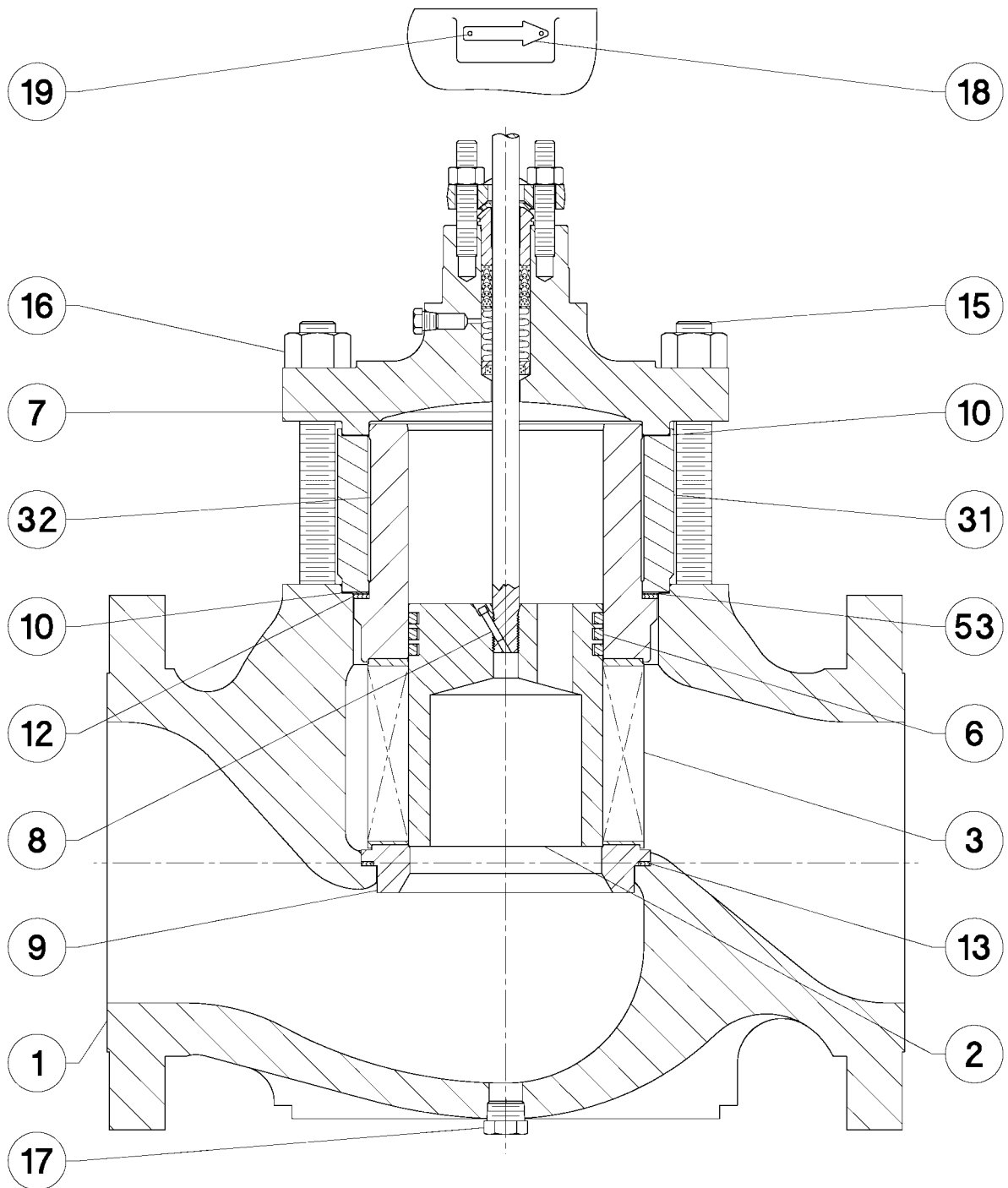
SINGLE PISTON RING ASSEMBLY



47A3995-A / DOC

TYPICAL MULTIPLE PISTON RING ASSEMBLY

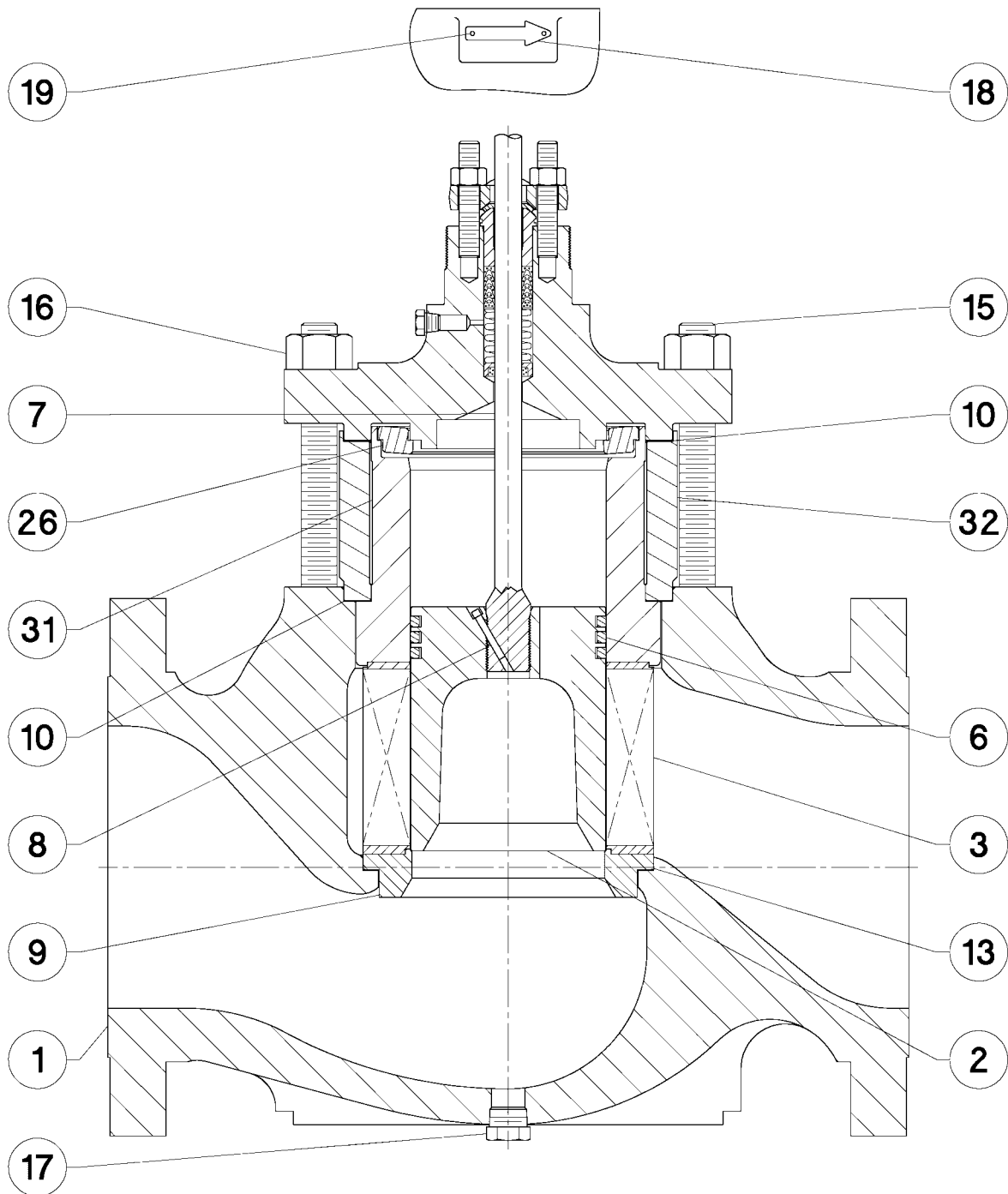
Figure 21. 8-Inch Design ED Valve with Graphite Piston Ring



58B2082-A

Figure 22. Design ED Valve Assembly with WhisperFlo Cage





58B2344-A

Figure 23. 8-Inch Design ED Valve Assembly with WhisperFlo Cage

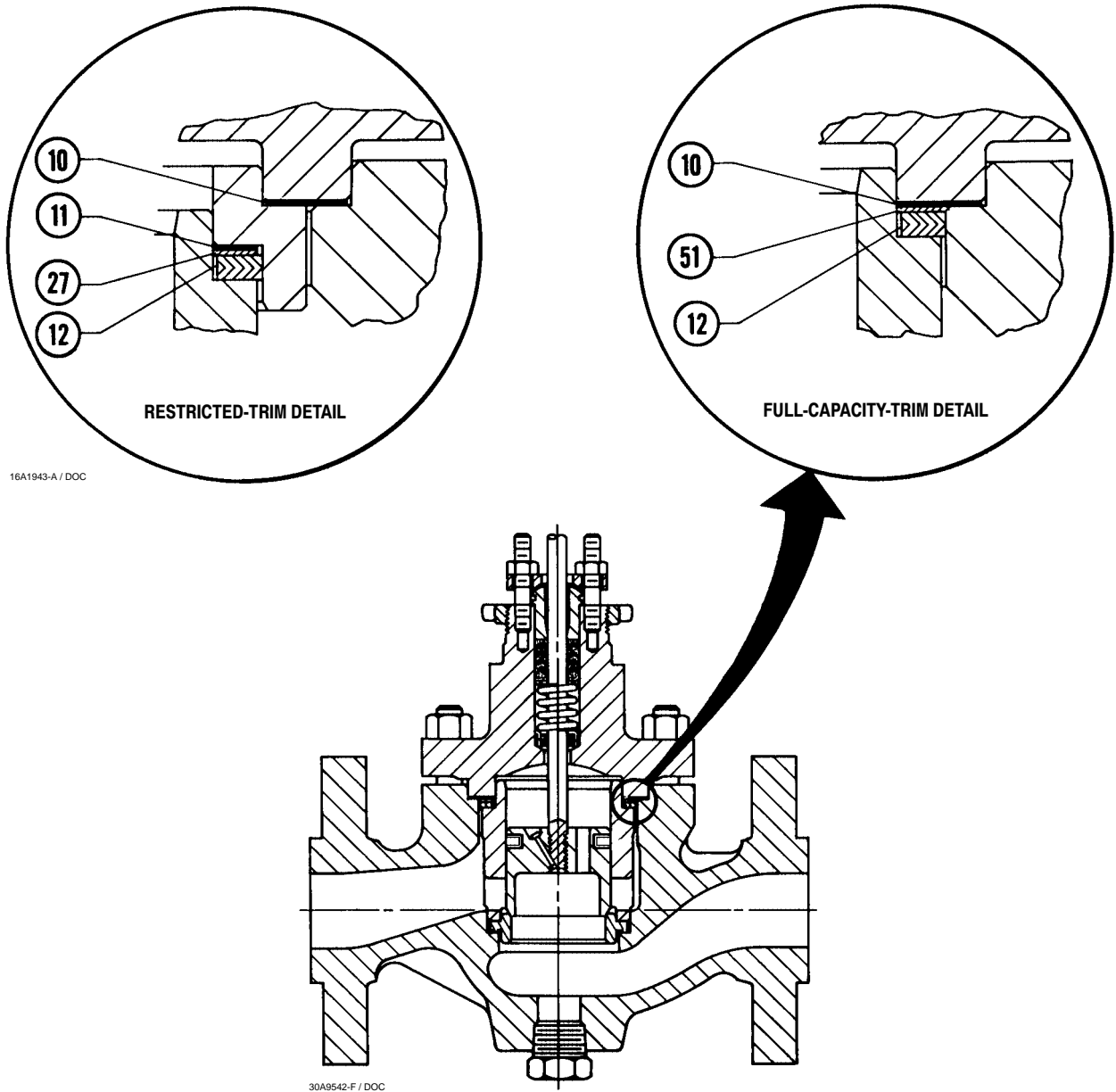


Figure 24. Gasket Set Detail



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**KIMRAY, Inc. MT DA5 MOTOR VALVES WITH REDUCED INNER VALVES** Okla. City, OK**APPLICATION:**

Liquid metering vessels where a 12 to 15 psig back pressure is desired.

Any system which requires a valve to receive a 30 psig maximum pilot signal on either or both sides of the main diaphragm operating at pressures up to 300 psig.

**FEATURES:**

- Tight shut-off
- Single soft seat
- Removable valve seat
- Ratio of diaphragm to seat area is:
  - 8:1 on 1"
  - 5:1 on 2", 3", 4", and 6"
- Controls 8 times signal pressure on 1"
- Controls 5 times signal pressure on 2", 3", 4" and 6"
- Minimum maintenance
- All internal parts can be removed with valve in line

**CAPACITY:**

- For liquid capacity refer to table of contents.
- For gas capacity refer to catalog section "A."

**CONSTRUCTION:**

Body and housings are available in cast iron, ductile iron or steel. Valve stem is 303 stainless steel. Spring is stainless steel. Diaphragm and seating materials are oil resistant synthetic rubber or polyurethane. After assembly each valve is given a complete operational test.

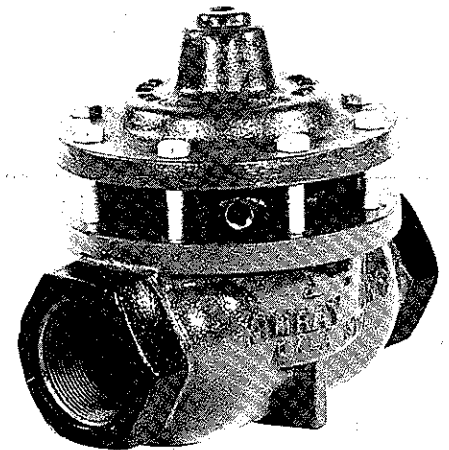
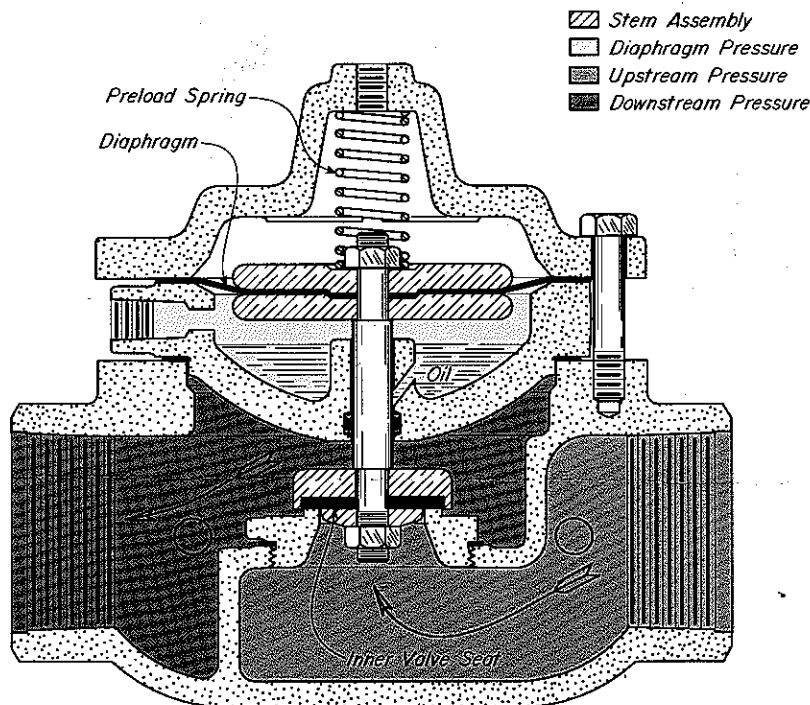
**OPERATION:**

The Stem Assembly is the only moving unit in the double acting motor valve. The PRELOAD SPRING loads the Stem assembly closing the valve if there is no Diaphragm Pressure (Yellow) and if Upstream Pressure (Green) minus Downstream Pressure (Blue) is 12 to 15 psig or less.

An increase in the Diaphragm Pressure (Yellow) and/or an increase in the differential pressure across the INNER VALVE SEAT overcomes the PRELOAD SPRING force, move the Stem Assembly upward, closing the valve.

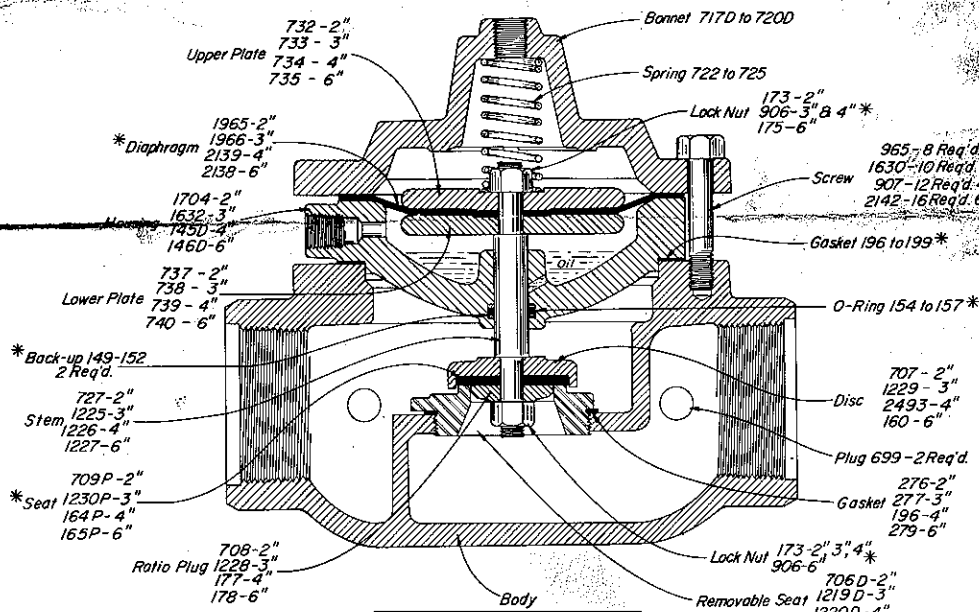
A decrease in the Diaphragm Pressure (Yellow) allows the PRELOAD SPRING to move the Stem Assembly downward and close the valve when Upstream Pressure (Green) minus Downstream Pressure (Blue) is 12 to 15 psig or less.

With an effective DIAPHRAGM area five times the INNER VALVE SEAT area, and the PRELOAD SPRING, a differential pressure greater than 12 to 15 psig and/or 3 psig or more Diaphragm Pressure (Yellow) will open the motor valve.



212 SMT DA5

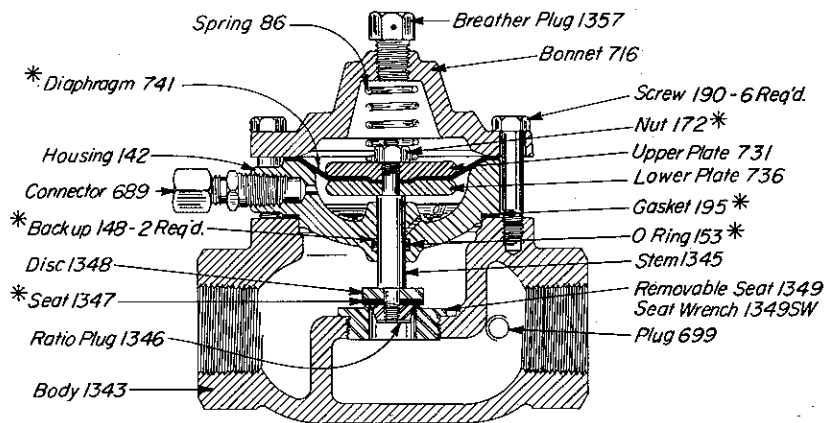
2", 3", 4" & 6" S/F/GMT DA5-D  
DUCTILE  
250-300 lbs. W.P.



LINE SIZE	SCREWED	FLANGED	GROOVED
2"	1709	1913	2364
3"	1634	1914	
4"	2001	2002	
6"		2466	

Seat Removal Wrench (Ductile only) 706SW, 1219SW, 1220SW, 1221SW.  
ALSO AVAILABLE ON REQUEST  
Stainless Steel Heat Treated  
2" 706SS 706 HT 706HTSW  
3" 1219 SS 1219 HT 1219HTSW  
4" 1220 SS 1220 HT 1220HTSW  
6" 1221 SS 1221 HT 1221HTSW

1" 130 SMT DAB-D  
DUCTILE  
300 lbs. W.P.



VALVES AVAILABLE: DUCTILE

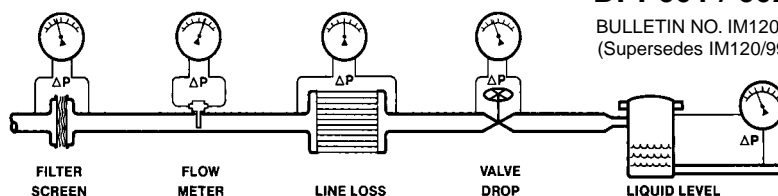
CAT. NO.	SIZE	TYPE	MOTOR VALVES	DES. PRESS.	OPER. PRESS.
EUA3	1"	SCRD.	130 SMT B-D	300	300
EUB3	2"	SCRD.	230 SMT 5-D	300	300
EUC3	2"	FLGD.	218 FMT 5-D	250	250
EUD3	2"	GRVD.	230 SMT 5-D	300	300
EUE3	3"	SCRD.	330 SMT 5-D	300	300
EUF3	3"	FLGD.	318 FMT 5-D	250	250
EUG3	4"	SCRD.	430 SMT 5-D	300	300
EUH3	4"	FLGD.	418 FMT 5-D	250	250
EUI3	6"	FLGD.	618 FMT 5-D	250	250

\*These are recommended spare parts and are stocked as repair kits. To order repair kit, specify: "1" MT DAB Repair Kit, RHE; 2" 230 MT DA5-D Repair Kit, ROJ; 3" 330 MT DA5-D Repair Kit, ROJ; 4" 430 MT DA5-D Repair Kit, ROK; 6" 618 MT DA5-D Repair Kit, ROL."

NOTE: The numbers of a series assigned to a part indicate different line sizes. For example: Gasket 195-1", 196-2", 197-3", 198-4", 199-6".

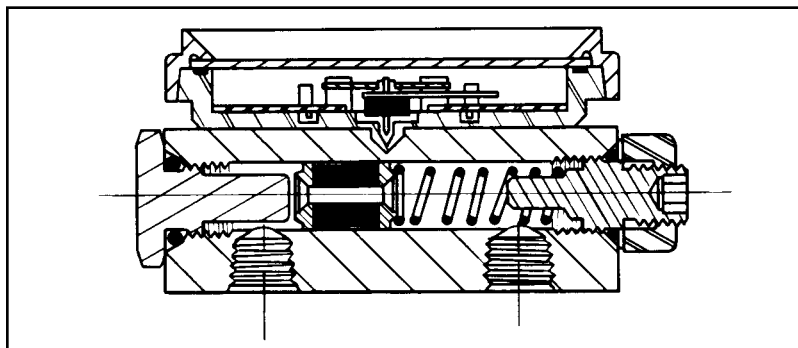
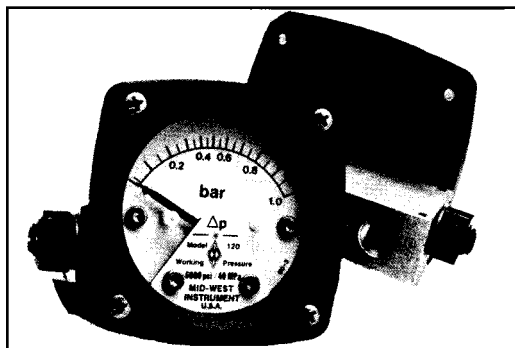
# Mid-West<sup>®</sup>

## Instrument



## Model 120 Series "Filter Minder"<sup>®</sup>

### Installation and Operating Instructions



#### INSPECTION

Before installation check the nameplate on each instrument against the receiving paperwork and the intended application for correct part number, materials of construction, working pressure, dial range, etc. If equipped with switches, check electrical rating, type of enclosure, etc. Inspect for shipping damage and, if damaged, report it immediately.

**NOTE - Before attempting repairs contact your local Mid-West Representative or our factory. Failure to do so will void any warranty.**

#### PRODUCT DESCRIPTION

The Model 120 Series "Filter Minder"<sup>®</sup> is a rugged, medium-range differential pressure instrument available as a switch, a gauge, or both. See "Part Numbering System". (Fig. 4) for available options.

Differential pressure is sensed by the movement of a floating piston magnet against a calibrated spring. The magnetically coupled gauge pointer outside the pressure housing follows the movement of the piston magnet and indicates differential pressure on the dial scale.

When equipped with switches, a contact is made or broken by the magnetic field of the piston magnet. See Bulletin ELECIM120/latest for gauges with switches.

The unit provides full over-range protection to the rated working pressure of the housing in either direction.

The precise piston/bore fit allows minimal leakage from high to low sides. This leakage is only 5 to 15 SCFH air at ambient conditions and a pressure differential of 100 PSID.

#### INSTALLATION

Model 120 Series "Filter Minder"<sup>®</sup> is calibrated and tested prior to shipment and is ready for immediate installation. Use of the following installation procedures should eliminate potential damage and provide optimum trouble-free operation.

##### **1. CONNECTIONS**

1/4" FNPT are provided as standard but check paperwork for connections ordered. There are two connections on the housing identified as "hi" and "lo" for high pressure and low pressure (Fig. 2). Be sure these get plumbed to the proper connections on your system. Improper connection will not damage the instrument, but it will not function properly. Flexible tubing is recommended to minimize the effect of any vibration that may exist.

##### **2. INSTRUMENT LOCATION**

On liquid service the instrument should be mounted **below** the process connections to facilitate self-bleeding. On gas service it should be located **above** the process connections to promote self-draining. If the process contains particulates, a "pigtail" loop or drop leg (manometer "U-tube" configuration) in the tubing will minimize the possibility of it migrating into the instrument.

### 3. PANEL MOUNTING

Gauges with 2-1/2" dials can **only** be mounted through the **rear** of the panel. Make the proper panel cutout as indicated in (Fig.1). Remove the (4) bezel screws. Insert the gauge front through the rear of the panel and reinstall the bezel screws through the **front** of the panel and into the gauge bezel. Tighten the screws securely, alternating in a **diagonal** pattern.

Gauges with 3-1/2" dial should be mounted from the front of the panel. Contact factory for mounting information and dimensional data.

Gauges with 4-1/2" dial should be mounted from the **front** of the panel. Make the cutout as indicated in (Fig. 1). Insert the (4) panel mounting studs, finger tight, into the metal inserts located in the rear of the bezel. Insert the gauge through the panel, aligning the panel mounting studs with the holes in the panel. Install the (4) #8-32 nuts onto the studs and tighten securely.

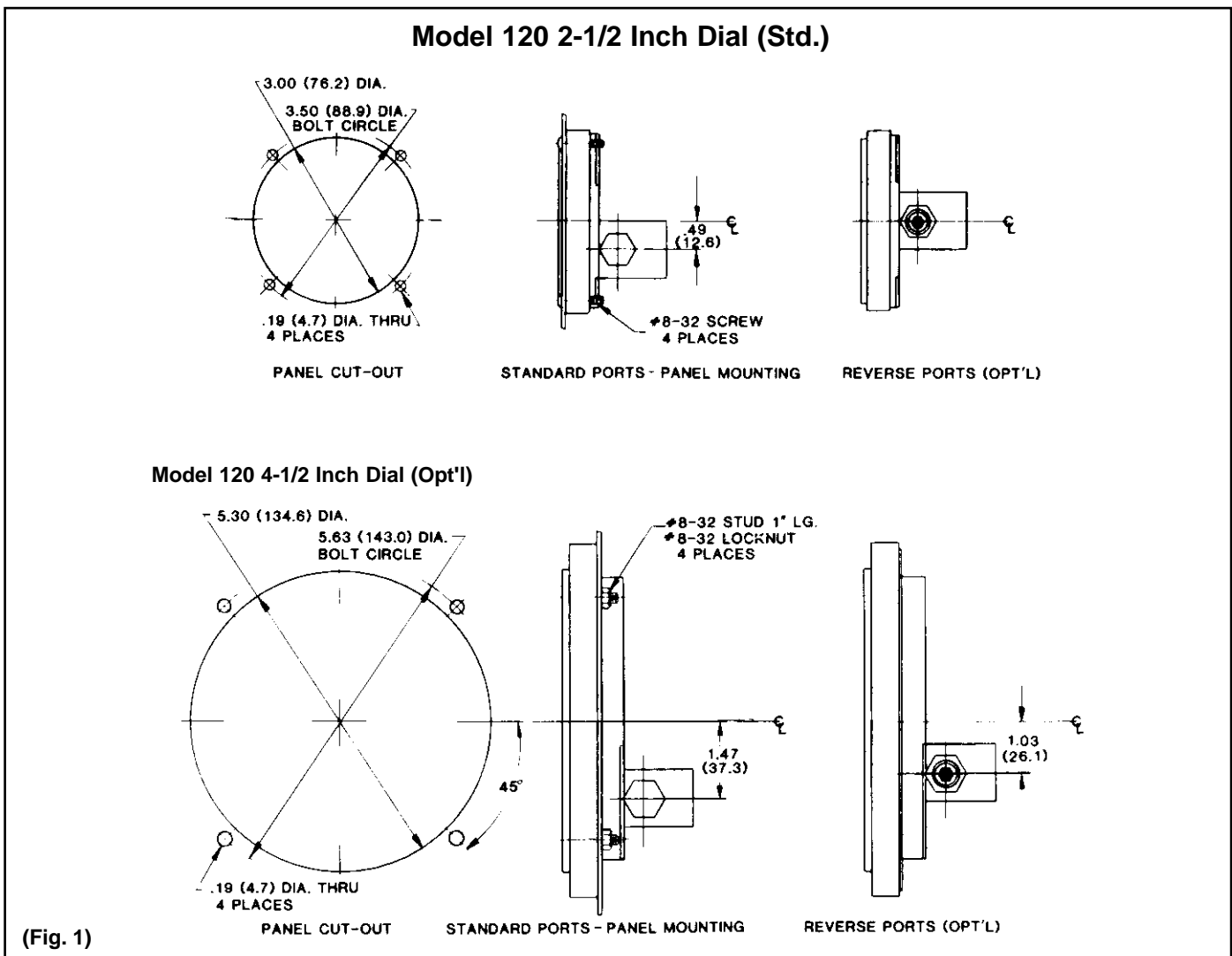
### 4. PIPE MOUNTING

An optional pipe mounting kit is available for mounting the gauge to a 2" vertical or horizontal pipe (Fig. 3).

### TROUBLE SHOOTING

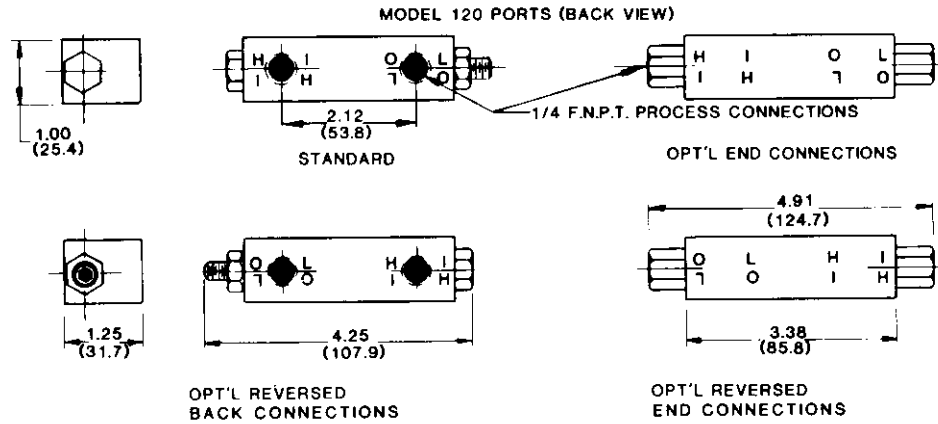
#### 1. Gauge does not indicate differential.

- A. Check for proper hook up, high to "hi" and low to "lo".
- B. Make certain block valves are open and, if using a 3-valve manifold, that the equalizer (balance) valve is closed.
- C. If A & B check out correctly, loosen or disconnect the high pressure line to determine if there is pressure to the instrument.
- D. If there is pressure to the instrument, check to determine that there is differential across the unit being monitored. If so, contact the factory for assistance and/or an "RGA" (return goods authorization) number to return the instrument for repair or replacement.





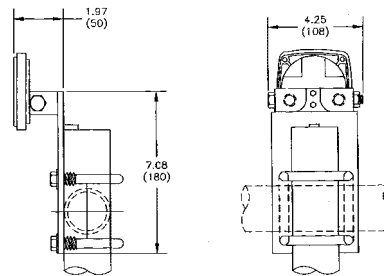
## Supplementary 120 Dimensional/Mounting Data



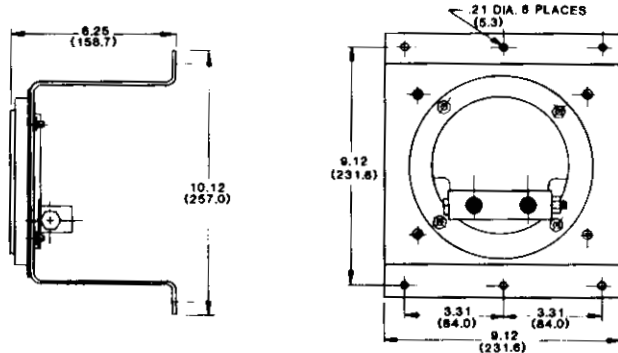
(Fig. 2)

**TYPICAL 2" PIPE MOUNTING (BACK CONNECTIONS ONLY)**

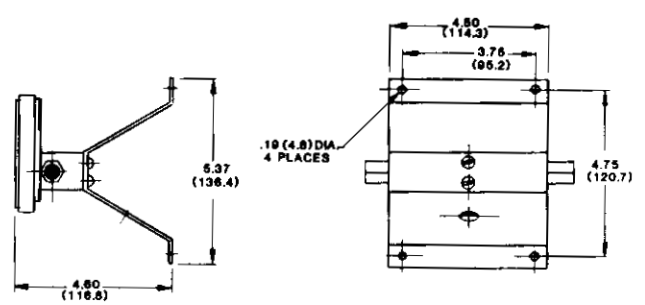
3.75 (95) FOR 2-1/2 INCH DIAL  
4.18 (106.1) FOR 4-1/2 INCH DIAL



**TYPICAL WALL MOUNTING 4-1/2 INCH DIAL (BACK OR END CONNECTIONS)**



**TYPICAL WALL MOUNTING 2-1/2 INCH DIAL (END CONNECTION OPTION ONLY)**



(Fig. 3)

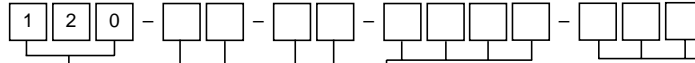
- NOTES: 1. Drawings show standard gauge nominal dimensions. (not to scale)  
 2. Dimensions shown in parentheses are in millimeters.  
 3. Manufacturer reserves the right to change specifications without prior notice.

# STANDARD MODEL SPECIFICATIONS

## 120-AA-00-00

6000 P.S.I.G. Working Pressure Aluminum Body, Stainless Steel Piston, Ceramic Magnets, Buna N Seals, 2-1/2" Engineering Plastic Case with Shatter-Resistant Lens. 1/4" FNPT Back Connections. Accuracy  $\pm 3-2-3\%$  Full Scale (Ascending).

### PART NUMBERING SYSTEM



**① BASIC MODEL NUMBER**

**② MATERIAL**

- A. Aluminum Body, S.S. Piston (Standard)
- S. 316 S.S. Body & S.S. Piston (Standard)
- Z. SPECIAL (Uncoded Options)

**③ DIAL TYPE**

- A. 2-1/2" Round Uni-Directional Engrd. Plastic Housing Assy. (Standard)
  - B. 2-1/2" Round Bi-Directional Engrd. Plastic Housing Assy.
  - C. 4-1/2" Round Uni-Directional Engrd. Plastic Housing Assy.
  - D. 4-1/2" Round Bi-Directional Engrd. Plastic Housing Assy.
  - E. 3-1/2" Round Uni-Directional Anod. Aluminum Housing Assy.
  - F. 3-1/2" Round Bi-Directional Anod. Aluminum Housing Assy.
  - G. 4-1/2" Round Uni-Directional Anod. Aluminum Housing Assy.
  - H. 4-1/2" Round Bi-Directional Anod. Aluminum Housing Assy.
  - T. Non-Indicating Differential Pressure Switch Only (Select Appropriate Electrical Option)
- DEDUCT From Base Price**
- Z. Special (Uncoded Options)

**④ SEALS**

- 0. Buna N (Standard)
  - 1. Viton\*
  - 2. Neoprene
  - 4. Teflon\*
  - 5. Ethylene Propylene
  - 6. Perfluoroelastomer
  - 9. Special (Uncoded Options)
- \*Viton® is a Registered Trademark of DuPont Dow Elastomers.  
\*\*Teflon® is a Registered Trademark of DuPont.

**⑤ CONNECTIONS**

- 0. 1/4" FNPT Back Connections (Standard)
- 2. 1/4" FNPT End Connections
- 6. 7/16" - 20 Str. Thd. O-Ring Port (Back Connections)
- 7. 1/2" FNPT Stainless Steel Adaptors
- 9. Special (Uncoded Options)

**⑥ OPTIONS (Up to four options)**

- O. None (Standard)
- A. Reversed High/Low Process Connections
- B. DIN2353 12-S (12mm) Steel Tube Fittings (2)
- C. Mounting Holes in Gauge Body for Field Mounting of Electrical Configurations Options A & B  
**(NOTE: Net Price Adder after any applicable discounts)**
- D. Mounting Holes in Gauge Body for Field Mounting of Electrical Configurations Options L & M  
**(NOTE: Net Price Adder after any applicable discounts)**
- F. Pipe Mounting Kit (Carbon Steel) (Not available w/C or D Electrical Switch Options)
- L. Liquid Fill (Not available w/follower pointer) (Not available with 3-1/2" dial)
- M. Maximum Indicator Follower Pointer
- T. Oxygen Cleaning
- U. S.S. Tag Mounted w/S.S. Wire
- V. S.S. Tag Mounted w/S.S. Screws
- W. Wall Mounting Kit
- X. Individual Gauge Packaging
- Z. Special (Uncoded Options)

**NOTE: NOT ALL OPTIONS AVAILABLE IN COMBINATION WITH OTHER OPTIONS.**

**⑦ ELECTRICAL CONFIGURATIONS**

**(NOTE: All options C<sup>o</sup> marked, except E, F, J & K)**

- O. None (Standard)
- A. One (1) Switch in STD. Enclosure with Grommet Wire Seal
- B. Two (2) Switches in STD. Enclosures with Grommet Wire Seal
- C. One (1) Switch in STD. Enclosure with 1/4" FNPT Conduit Connection NEMA 4X
- D. Two (2) Switches in STD. Enclosures with 1/4" FNPT Conduit Connection NEMA 4X
- E. One (1) Switch with 1/2" FNPT Connection, Rated Class I, Div. II, Groups A, B, C, D, Class II, Div. II, Groups F and G (Complete Assy, CSA Listed)
- F. Two (2) Switches with 1/2" FNPT Connection, Rated Class I, Div. II, Groups A, B, C, D, Class II, Div. II, Groups F and G (Complete Assy, CSA Listed)
- G. One (1) Switch & Gauge in NEMA 4X Plastic Enclosure (Not Available With End Connections)
- H. Two (2) Switches & Gauge in NEMA 4X Plastic Enclosure (Not Available With End Connections)
- J. One (1) Switch in Explosion Proof Enclosure and Glass Window Cover with C.S.A. Listing
- K. Two (2) Switches in Explosion Proof Enclosure and Glass Window in Cover with C.S.A. Listing
- L. One (1) Switch in STD. Enclosure with Plug-In Connector (DIN 43650/IP65-PG11)
- M. Two (2) Switches in STD. Enclosure with Plug-In Connector (DIN 43650/IP65-PG11)
- R. One (1) Switch, Flat Pack, Preset Only (Non-Adjustable) (10-100% of Range Only) (A option only)
- S. Two (2) Switches, Flat Pack, Preset Only (Non-Adjustable) (10-100% of Range Only) (A option only)
- Z. Special (Uncoded Options)

**⑧ ELECTRICAL SPECIFICATIONS (For Resistive Loads)**

- A. S.P.D.T., 3W, 0.25 Amp., 125 VAC/VDC (Standard) (Switch adjustable range of 10-90%)
- E. S.P.S.T., 60W, 3.0 Amp., 240 VAC/VDC (Normally Open) (Switch adjustable range of 25-95%)
- F. S.P.S.T., 60W, 3.0 Amp., 240 VAC/VDC (Normally Closed) (Except Options R & S)  
(Switch adjustable range of 25-95%)
- G. S.P.S.T., 60W, 3.0 Amp., 240 VAC/VDC One (1) Normally Open, One (1) Normally Closed (Except Options R & S)  
**(Available with Electrical Configurations B,D,H,K & M options only)**  
**(Switch adjustable range of 25-95%)**
- H. S.P.D.T., 60W, 1.0 Amp., 240 VAC/VDC (Switch adjustable range of 25-100%)
- Z. Special (Uncoded Options)

**NOTE: FACTORY PRESET SWITCHES AT NO CHARGE (SPECIFY SETTING)**

**NOTE: THE USE OF DIAPHRAGM SEALS IS NOT RECOMMENDED FOR MODEL 120 SERIES GAUGE. ATTEMPTS TO INSTALL SUCH SEALS ON THIS GAUGE WILL VOID THE WARRANTY.**

(Fig. 4)

⑧ (Up to three options)

Manufacturer reserves the right to change specifications without prior notice.

**PROOF PRESSURE: 12,000 PSI.**

**TEMPERATURE LIMITS: -40°F (-40°C) to +200°F (+93°C)** - These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation. Contact our customer service representative for details.

**STANDARDS:** All Model 120 Series differential pressure gauges either conform to and/or are designed to the requirements of the following standards:

- |                            |                             |
|----------------------------|-----------------------------|
| ASME B1.20.1               | NACE MR0175                 |
| ASME B40.1                 | NEMA Std. No. 250           |
| CSA-C22.2 No. 14.25 and 30 | SAE J514                    |
| EN-61010-1                 | UL Std. No. 50,508 and 1203 |



REPRESENTED BY:

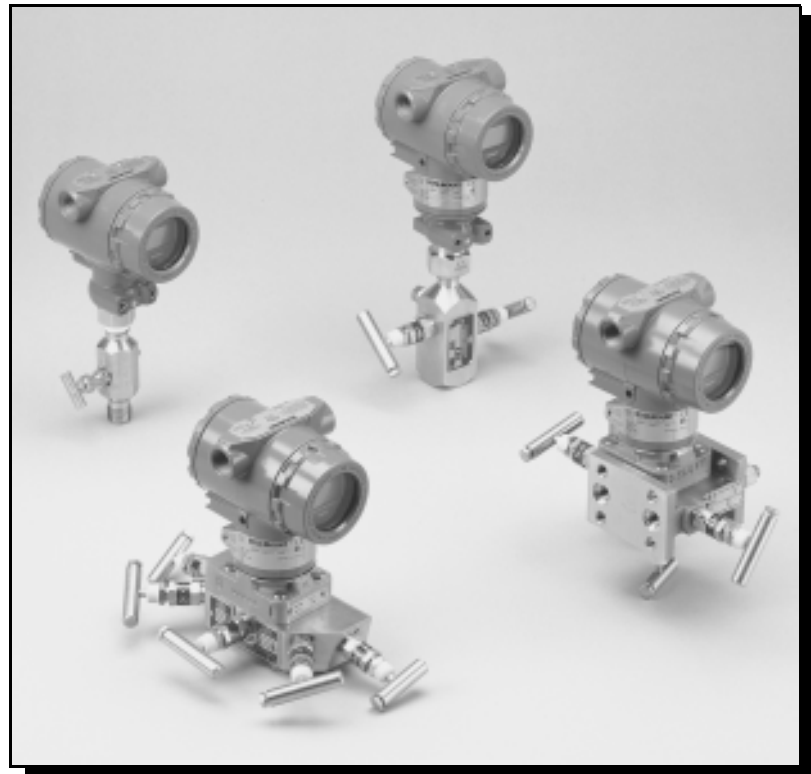
# Mid-West<sup>®</sup> Instrument

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 E-mail: sales@midwestinstrument.com  
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Printed in U.S.A.

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3		DIFFERENTIAL PRESSURE INSTRUMENTS			SHEET 1 OF 1 SPEC NO _____ FILE 14.11.P	
CUSTOMER : Fort Energy PLANT : 8MM Refridgeration Plant SERVICE : Differential Pressure Transmitter		NO 1 BY QH DATE 07/25/05 REVISION Issued for Purchase	JOB # 054468 DATE July 25, 2005 REQ. BY _____ CHK'D _____ APPR. _____			
1	TAG NO. DPT-670					
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL _____ BLIND _____ TRANS. <u>X</u> OTHER _____				
3	CASE	MFR STD <u>X</u> NOM SIZE _____ COLOR : MFR STD <u>X</u> OTHER _____				
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER <u>2" Pipe Mount</u>				
5	ENCLOSURE CLASS	GENERAL PURPOSE _____ WEATHER PROOF _____ EXPLOSION PROOF <u>X</u> CLASS <u>1 Div 2</u> FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____				
6	POWER SUPPLY	117 V 60Hz _____ OTHER AC _____ DC <u>X</u> VOLTS <u>24</u>				
7	CHART	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____				
8	CHART DRIVE	SPEED _____ POWER _____				
9	SCALES	TYPE _____ RANGE 1 _____ 2 _____ 3 _____ 4 _____				
X	10 TRANSMITTER OUTPUT	4 - 20 mA <u>X</u> 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____ FOR RECEIVER SEE SPEC. SHEET _____				
C	11 CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____				
R	12 ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES _____				
O	13 AUTO - MAN SWITCH	NONE _____ MFR STD _____ OTHER _____				
L	14 SET POINT ADJ.	MANUAL _____ EXTERNAL _____ REMOTE _____ OTHER _____				
L	15 MANUAL REG.	NONE _____ MFR STD _____ OTHER _____				
E	16 OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____				
U	17 SERVICE	FLOW _____ LEVEL _____ DIFF. PRESS. <u>X</u> OTHER _____				
N	18 ELEMENT TYPE	DIAPHRAGM <u>X</u> BELLOWS _____ MERCURY _____ OTHER _____				
I	19 MATERIAL	BODY <u>Aluminium</u> ELEMENT <u>316 SS</u>				
T	20 RATING	OVERRANGE <u>250 barg</u> BODY RATING _____ bar (g)				
	21 DIFF. RANGE	FIXED _____ ADJ. RANGE <u>-20.7 - 20.7 bar(g)</u> SET AT <u>0-1750 kPa(d)</u>				
	22 ELEVATION	SUPPRESSION _____				
	23 PROCESS DATA	FLUID <u>H.C. Gas</u> MAX TEMP. <u>93</u> ° C MAX. PRESS. <u>1724</u> bar (g)				
	24 PROCESS CONN.	21 mm NPT <u>X</u> OTHER _____				
25	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____				
26	FUNCTION	MEAS. VAR. _____ DEVIATION _____ CONTACTS TO _____ ON INC. MEAS.				
27	OPTIONS	PRESSURE ELEMENT _____ RANGE _____ MATL. _____ TEMP. ELEMENT _____ RANGE _____ TYPE _____ FILT REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS VALVE MANIFOLD <u>305RC32B11B4</u> COND. POTS _____ ADJ. DAMP _____ INTEGRAL SQ. RT. EXT. _____ INTEGRATOR _____ OTHER _____				
28	MFR. & MODEL NO.	<u>Rosemount</u>				
29	MODEL NO.	<u>3051CD4A22A1AS5C6</u>				
30	P. O. NUMBER	_____				
NOTES:						
AREA. UNIT # :						

# Model 3051 Smart Pressure Transmitter Family



**ROSEMOUNT®**

**FISHER-ROSEMOUNT™ Managing The Process Better.™**



# Model 3051 Smart Pressure Transmitter Family

Model 3051 Smart Software Revision 5.2.x

## NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

Within the United States, Rosemount Inc. has two toll-free assistance numbers:

### Customer Central

Technical support, quoting, and order-related questions.

1-800-999-9307 (7:00 am to 7:00 pm CST)

### North American Response Center

Equipment service needs.

1-800-654-7768 (24 hours—includes Canada)

Outside of the United States, contact your local Rosemount representative.

## ⚠ CAUTION

The products described in this document are NOT designed for nuclear-qualified applications. Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Rosemount Sales Representative.

*Rosemount Model 3051 Smart Pressure Transmitters may be protected by one or more of the following U.S. Patent Nos. 4,370,890; 4,466,290; 4,612,812; 4,791,352; 4,798,089; 4,818,994; 4,833,922; 4,866,435; 4,926,340; 4,988,990; and 5,028,746. Mexico Patentado No. 154,961. May depend on model. Other foreign patents issued and pending.*

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*Syltherm 800 and D.C. 200 are registered trademarks of Dow Corning Corporation.*

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*HART is a registered trademark of the HART Communication Foundation.*

*FOUNDATION fieldbus is a registered trademark of the Fieldbus Foundation.*

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Fisher-Rosemount satisfies all obligations coming from legislation to harmonize product requirements in the European Union.



# ROSEMOUNT®

**FISHER-ROSEMOUNT™ Managing The Process Better.™**



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# Introduction

## USING THIS MANUAL

The sections in this manual provide information on installing, operating, and maintaining devices from the Rosemount Model 3051 Smart Pressure Transmitter Family. The sections are organized as follows:

### **Section 2: Transmitter Functions**

Section 2 provides instruction on commissioning and operating Model 3051 Pressure Transmitters. Information on software functions, configuration parameters, and on-line variables is also included.

### **Section 3: Installation**

Section 3 contains mechanical and electrical installation instructions.

### **Section 4: Troubleshooting**

Section 4 provides troubleshooting techniques for the most common Model 3051 transmitter operating problems.

### **Section 5: Specifications and Reference Data**

Section 5 supplies reference and specification data for the Model 3051 Smart Pressure Transmitter Family.

### **Section 6: Options**

Section 6 describes the mounting and configuration options available for Model 3051 transmitters.

### **Appendix A: HART Communicator**

Appendix A gives an overview of the Model 275 HART Communicator, defines its command menu tree for the Model 3051 family, and provides a table of its fast key sequences. A table of diagnostic messages is also included.

### **Appendix B: Model 268 Communicator**

Appendix B gives an overview of the Model 268 Communicator, defines its command menu tree for the Model 3051 family, and provides a table of its fast key sequences. A table of diagnostic messages is also included.

### **Appendix C: Approval Drawings**

Appendix C contains intrinsic safety approval drawings.

### **Appendix D: European ATEX Directive Information**

Appendix D contains European ATEX Directive information.

## MODELS COVERED

The following Rosemount Model 3051 Pressure Transmitters are covered by this manual:

### **Model 3051CD Differential Pressure Transmitter**

The Model 3051CD measures pressures from 0.1 inH<sub>2</sub>O to 2000 psi (0,02 to 13 800 kPa) with superior performance including 0.075% accuracy and 100:1 rangeability.

### **Model 3051CG Gage Pressure Transmitter**

The Model 3051CG measures gage pressures from 2.5 inH<sub>2</sub>O to 2000 psig (0,62 to 13 800 kPa) using proven Rosemount capacitance cell technology.

### **Model 3051CA Absolute Pressure Transmitter**

The Model 3051CA measures absolute pressures from 0.167 to 4000 psia (8,6 mmHga to 27 580 kPa) using a Rosemount patented piezoresistive silicon sensor.

### **Model 3051L Liquid Level Transmitter**

The Model 3051L provides precise level and specific gravity measurements from 2.5 to 8310 inH<sub>2</sub>O (0,62 to 2 070 kPa) for a wide variety of tank configurations.

### **Model 3051H High Process Temperature Pressure Transmitter**

The Model 3051H provides high process temperature capability to 375 °F (191 °C) without the use of remote diaphragm seals or capillaries. Model 3051H transmitters are available for differential and gage configurations (3051HD and 3051HG).

### **Model 3051P Reference Class Pressure Transmitter**

The Model 3051P, at 0.05% accuracy, is the most accurate pressure transmitter available. The Model 3051P is ideal for fiscal and allocation metering.

### **Model 3051T Gage and Absolute Pressure Transmitter**

The Model 3051T measures absolute and gage pressures from 0.3 to 10000 psig/a (2,07 to 68 900 kPa). The Model 3051T uses a single isolator design and microprocessor-based electronics.

### **New Model 3051CD0 Draft Range Transmitter**

See page 1-4 for the details of the Model 3051CD0 transmitter.

---

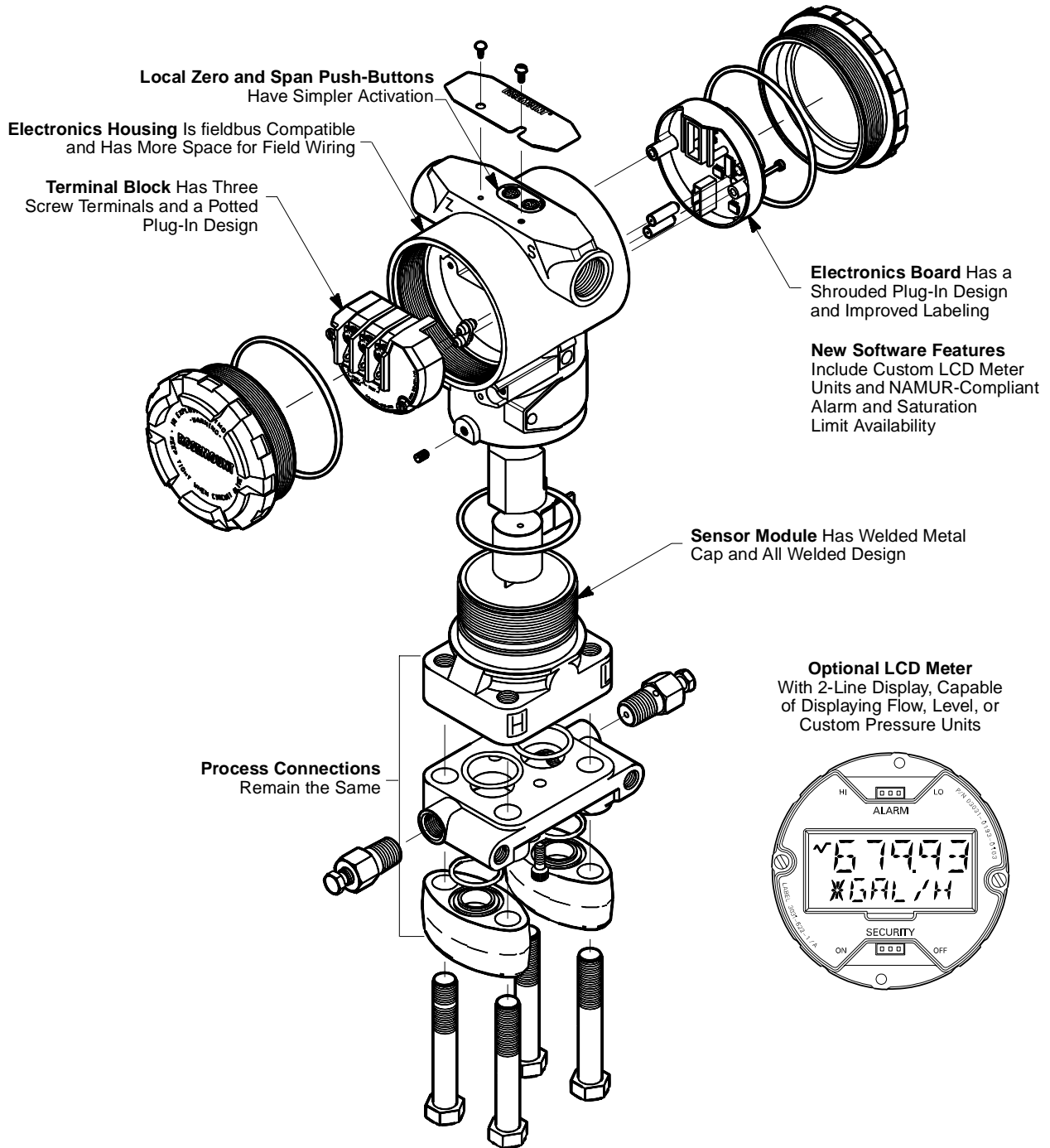
#### **NOTE**

For Model 3051 with FOUNDATION™ fieldbus, see Rosemount Product Manual 00809-0100-4774.

---

# NEW FEATURES OF THE MODEL 3051 PRESSURE TRANSMITTER

The latest line of Rosemount Model 3051 Pressure Transmitters feature physical and software enhancements for additional functionality and increased ease of use.



3051-3031A08E; 3051LCD

## **MODEL 3051CD0 DRAFT RANGE PRESSURE TRANSMITTER**

The Model 3051CD0 Draft Range Pressure Transmitter is a true draft range offering that features a pressure range from  $-3.0$  to  $3.0$  inH<sub>2</sub>O ( $-750$  to  $750$  Pa) with spans as small as  $0.1$  inH<sub>2</sub>O ( $25$  Pa). The transmitter has an accuracy of  $\pm 0.10\%$  of range and has a redesigned capacitance sensor optimized for draft measurements. Because the Model 3051CD0 Draft Range Transmitter is based on the standard Model 3051 Transmitter design, the requirement for spare parts is reduced.

The Model 3051CD0 Draft Range Transmitter is the perfect choice for applications including:

- Furnace and boiler draft
- HVAC duct flow and clogging filter detection
- Room and chamber pressurization
- Clean room pressurization control systems
- Flow measurements with low differential pressures

### **Special Draft Range Considerations**

#### **Installation**

It is best to mount the transmitter with the isolators parallel to the ground. Installing the transmitter in this way reduces oil head effect and provides for optimal temperature performance.

Be sure the transmitter is securely mounted. Tilting of the transmitter may cause a zero shift in the transmitter output.

#### **Reducing Process Noise**

It is often difficult to isolate the actual process variable from process noise in draft range applications. Pressure fluctuations and air currents can make accurate draft range measurements difficult to obtain.

There are two recommended methods of reducing process noise: output damping and, in gage applications, reference side filtering.

##### **Output Damping**

The output damping for the Model 3051CD0 is factory set to 3.2 seconds as a default. If the transmitter output is still noisy, increase the damping time. If faster response is needed, decrease the damping time. Damping adjustment information is available in Section 2: Transmitter Functions.

##### **Reference Side Filtering**

In gage applications it is important to minimize fluctuations in atmospheric pressure to which the low side isolator is exposed. One method of reducing fluctuations in atmospheric pressure is to attach a length of tubing to the reference side of the transmitter to act as a pressure buffer. Another method is to plumb the reference side to a chamber that has a small vent to atmosphere. If multiple draft transmitters are being used in an application, the reference side of each device can be plumbed to a chamber to achieve a common gage reference.


# Transmitter Functions

## OVERVIEW

This section contains information on commissioning and operating Model 3051 Smart Pressure Transmitters. Tasks that should be performed on the bench prior to installation are explained in this section.

For your convenience, HART communicator fast key sequences are listed for each software function. If you are unfamiliar with the communicator or how to follow fast key sequences, please refer to Appendices A and B for communicator operations.

## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol () . Refer to the following safety messages before performing an operation preceded by this symbol.

### Warnings ()

#### **WARNING**

##### **Explosions can result in death or serious injury.**

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

#### **WARNING**

##### **Electrical shock can result in death or serious injury.**

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.



**FAILURE MODE ALARM**

Model 3051 transmitters automatically and continuously perform self-diagnostic routines. If the self-diagnostic routines detect a failure, the transmitter drives its output outside of the normal saturation values. The transmitter will drive its output low or high based on the position of the failure mode alarm jumper. See Table 2-1, Table 2-2, and Table 2-3 for failure mode and saturation output levels. To select alarm position, see “Configuring Transmitter Alarm and Security Jumper Procedure” on page 2-5.

TABLE 2-1. Standard Alarm and Saturation Values.

Level	4–20 mA Saturation	4–20 mA Alarm
Low	3.9 mA	≤ 3.75 mA
High	20.8 mA	≥ 21.75 mA

TABLE 2-2. NAMUR-Compliant Alarm and Saturation Values.

Level	4–20 mA Saturation	4–20 mA Alarm
Low	3.8 mA	≤ 3.6 mA
High	20.5 mA	≥ 22.5 mA

TABLE 2-3. Low-Power Alarm and Saturation Values.

Level	1–5 V Saturation	1–5 V Alarm	0.8–3.2 V Saturation	0.8–3.2 V Alarm
Low	0.97 V	≤ 0.95 V	0.78 V	≤ 0.75 V
High	5.20 V	≥ 5.4 V	4.04 V	≥ 4.2 V

**NOTE**

You can alter the actual transmitter mA output values by performing an analog output trim.

**NOTE**

When a transmitter is in an alarm condition, the hand-held HART communicator indicates the analog output the transmitter would drive if the alarm condition did not exist. The transmitter will alarm high in the event of failure if the alarm jumper is removed.

**Alarm and Saturation Values for Transmitters Set to Burst Mode**

Transmitters set to burst mode handle saturation and alarm conditions differently.

**Alarm Conditions:**

- Analog output switches to alarm value.
- Primary variable (pressure) is burst with a status bit set.
- Percent of range follows primary variable (pressure).
- Temperature is burst with a status bit set.

**Saturation:**

- Analog output switches to saturation value.
- Primary variable (pressure) is burst normally.
- Temperature is burst normally.

**Alarm and Saturation Values for Transmitters Set to Multidrop Mode**

Transmitters set to multidrop mode handle saturation and alarm conditions differently.

**Alarm Conditions:**

- Primary variable (pressure) is sent with a status bit set.
- Percent of range follows primary variable (pressure).
- Temperature is sent with a status bit set.

**Saturation:**

- Primary variable (pressure) is sent normally.
- Temperature is sent normally.

**Alarm Level Verification**

Transmitters with shrouded design electronics boards (board version 5.3 or later) have increased functionality that allows verification testing of alarm current levels. If you repair or replace the transmitter electronics board, sensor module, or LCD meter, verify the transmitter alarm level before you return the transmitter to service. This feature is also useful in testing the reaction of your control system to a transmitter in an alarm state. To verify the transmitter alarm values, perform a loop test and set the transmitter output to the alarm value (see Tables 2-1 and 2-2 on page 2-2, and “Loop Test” on page 2-18).

## TRANSMITTER SECURITY

There are three security methods with the Model 3051 transmitter:

1. Security Jumper: prevents all writes to transmitter configuration.
2. Local Keys (Local Zero and Span) Software Lock Out: prevents changes to transmitter range points via local zero and span adjustment keys. With local keys security enabled, changes to configuration are possible via HART.
3. Physical Removal of Local Keys (Local Zero and Span) Magnetic Buttons: removes ability to use local keys to make transmitter range point adjustments. With local keys security enabled, changes to configuration are possible via HART.

---

### NOTE

If the security jumper is not installed, the transmitter will continue to operate in the security OFF configuration.

---

### Security Jumper (Write Protect)

You can prevent changes to the transmitter configuration data with the write protection jumper. Security is controlled by the security (write protect) jumper located on the electronics board or meter face. Position the jumper on the transmitter circuit board in the “ON” (WP on previous electronics board) position to prevent accidental or deliberate change of configuration data.

If the transmitter write protection jumper is in the “ON” position, the transmitter will not accept any “writes” to its memory. Configuration changes, such as digital trim and reranging, cannot take place when the transmitter security is on.

### Local Zero and Span (Local Keys) Software Lock Out

To enable this feature, see “Local Span and Zero Control (Local Keys)” on page 2-17.

### Physical Removal of Local Zero and Span (Local Keys)

To remove the magnetic buttons used to activate the local zero and span, use a small slotted head screwdriver and pry off the small, plastic cap located under the approval tag. Remove button assemblies and discard.

---

### NOTE

On previous versions of Model 3051, remove the magnetic screws.

---

## CONFIGURING TRANSMITTER ALARM AND SECURITY JUMPER PROCEDURE

To reposition the jumpers, follow the procedure described below.



1. If the transmitter is installed, secure the loop and remove power.
2. Remove the housing cover opposite the field terminal side. Do not remove the transmitter covers in explosive atmospheres when the circuit is alive.

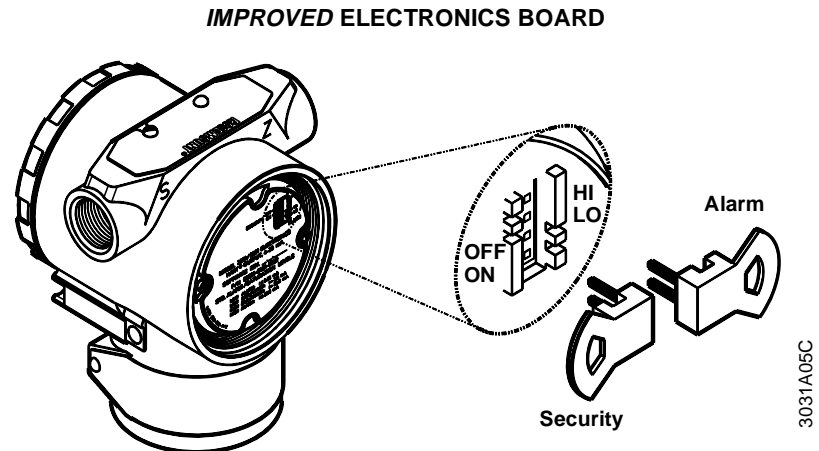
3. Reposition the jumpers as desired.

- Figure 2-1 shows the jumper positions for *Improved Electronics Boards*.
- Figure 2-2 shows *Previous Electronics Board* jumper positions.
- Figure 2-3 shows transmitters with an optional LCD meter.
- Figure 2-5 shows the jumper positions for low-power transmitters.



4. Reattach the transmitter cover. Transmitter covers must be fully engaged to meet explosionproof requirements.

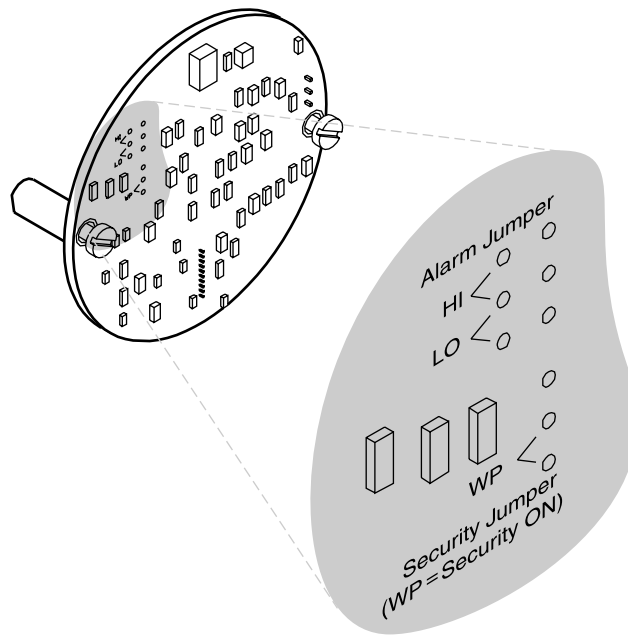
FIGURE 2-1. *Improved Electronics Board*.



### NOTE

Security jumper not installed = Not Write Protected.  
Alarm jumper not installed = High Alarm.

FIGURE 2-2. *Previous Electronics Board.*



On one version of the previous electronics board, the security jumper is located on the back side of the board. Contact Rosemount Customer Central at 1-800-999-9307 for more information.

3051-3051B

**NOTE**

Security jumper not installed = Not Write Protected.  
Alarm jumper not installed = High Alarm.

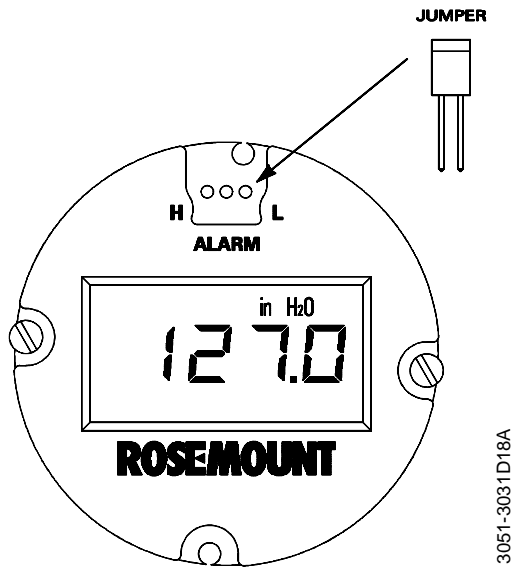
FIGURE 2-3. *Improved Model 3051 with Optional LCD Meter.*



**NOTE**

Security jumper not installed = Not Write Protected.  
Alarm jumper not installed = High Alarm.

FIGURE 2-4. Previous Model 3051 with Optional LCD Meter.



---

**NOTE**  
Alarm jumper not installed = High Alarm.

---

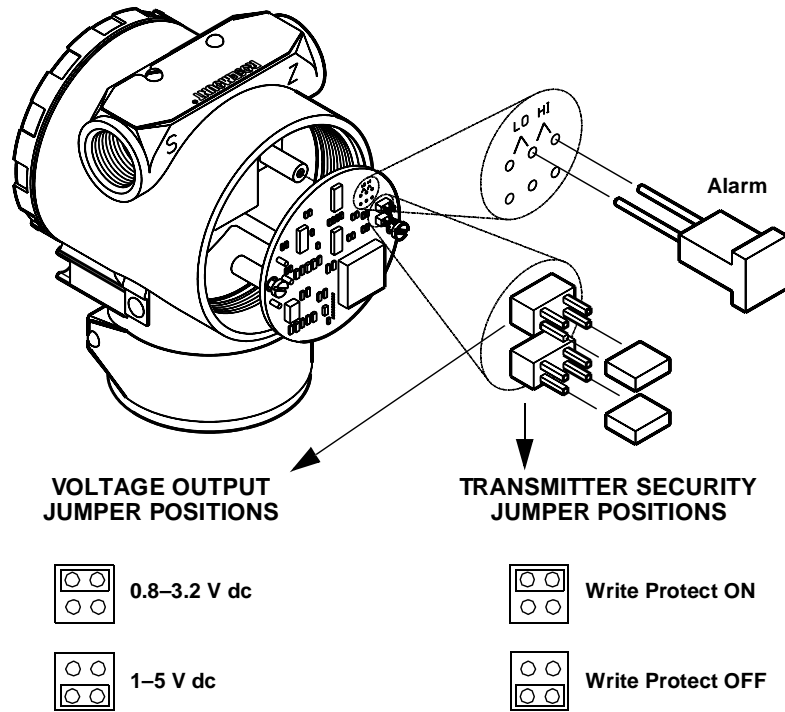
## SELECTING OUTPUT RANGE FOR LOW-POWER OUTPUT TRANSMITTERS

Low power transmitters output either 1–5 V dc or 0.8–3.2 V dc depending on the position of the voltage output jumper. To reposition the voltage output jumper, follow the procedure described on page 2-5.

### NOTE

Default low power output is 1–5 V dc. After changing output between 1–5 V and 0.8–3.2 V, perform a low power output trim.

FIGURE 2-5. Low Power Transmitter Electronics Boards.




3051-3031B05D

### NOTE

Security jumper not installed = Not Write Protected.  
 Alarm jumper not installed = High Alarm.  
 Voltage output jumper not installed = 1–5 V

## COMMISSIONING THE MODEL 3051 ON THE BENCH WITH A HART-BASED COMMUNICATOR

Commissioning consists of testing the transmitter and verifying transmitter configuration data. You may commission Model 3051 transmitters either before or after installation. Commissioning the transmitter on the bench before installation using a HART-based communicator ensures that all transmitter components are in good working order and acquaints you with the operation of the device.

 To commission on the bench, connect the transmitter and the communicator as shown in Figure 2-6 and 2-7. Make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices before connecting a communicator in an explosive atmosphere. Connect the communicator leads at any termination point in the signal loop. It is most convenient to connect them to the terminals labeled “COMM” on the terminal block. Connecting across the “TEST” terminals will prevent successful communication. To avoid exposing the transmitter electronics to the plant environment after installation, set all transmitter jumpers during the commissioning stage on the bench.

For 4–20 mA transmitters, you will need a power supply capable of providing 10.5 to 55 V dc at the transmitter, and a meter to measure output current. To enable communication, a resistance of at least 250 ohms must be present between the communicator loop connection and the power supply. Do not use inductive-based transient protectors with the Model 3051.

## Setting the Loop to Manual

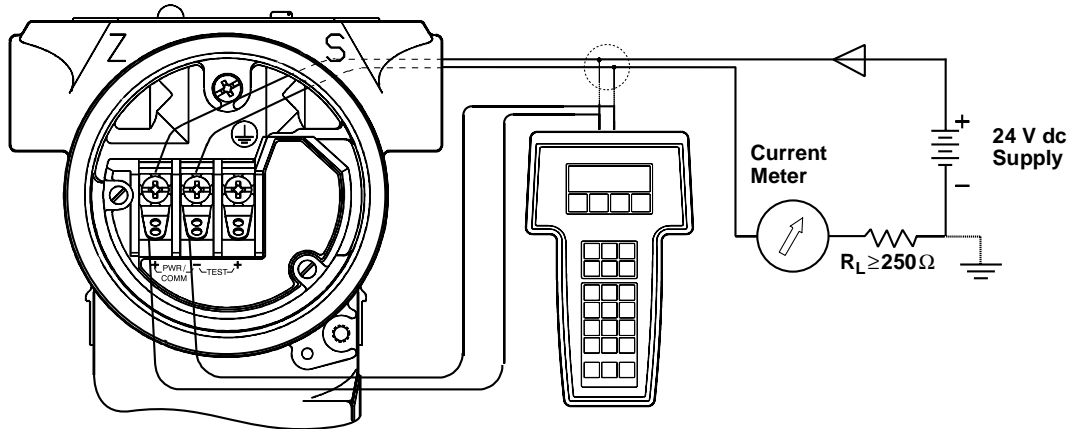
Whenever you are preparing to send or request data that would disrupt the loop or change the output of the transmitter, you must set your process application loop to manual. Both the HART Communicator Model 275 and the Rosemount Model 268 will prompt you to set the loop to manual when necessary. Keep in mind that acknowledging this prompt does not set the loop to manual. The prompt is only a reminder; you have to set the loop to manual yourself as a separate operation.



## Wiring Diagrams (Bench Hook-up)

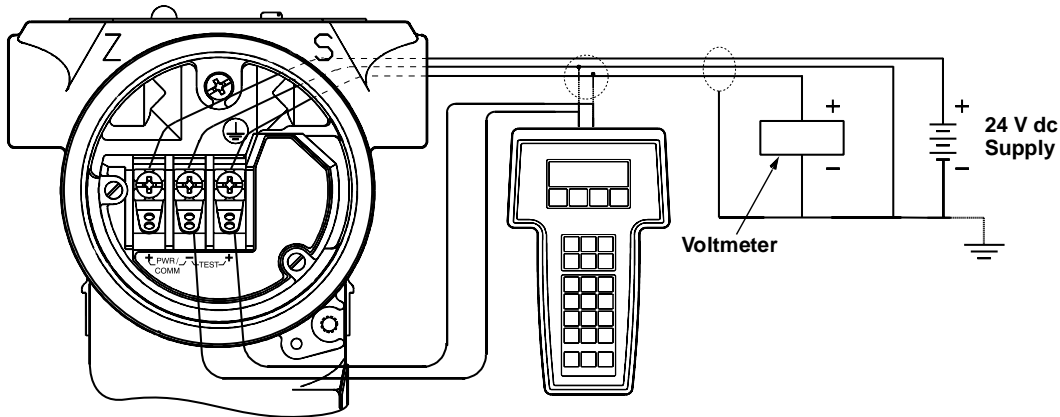
Connect the bench equipment as shown in Figure 2-6 and 2-7, and turn on the HART-based communicator by pressing the ON/OFF key. The communicator will search for a HART-compatible device and will indicate when the connection is made. If the communicator fails to connect, it will indicate that no device was found. If this occurs, refer to Section 4: Troubleshooting.

FIGURE 2-6. Bench Hook-up  
(4–20 mA Transmitters).



3051-3031G02B

FIGURE 2-7. Bench Hook-up  
(Low-Power Transmitters).

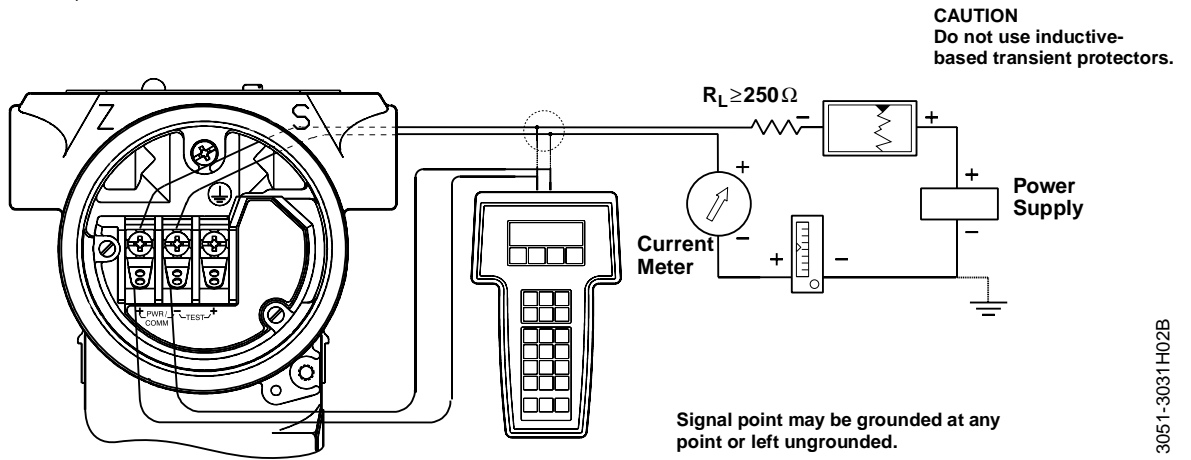


3051-3031I02B

**Wiring Diagrams  
(Field Hook-up)**

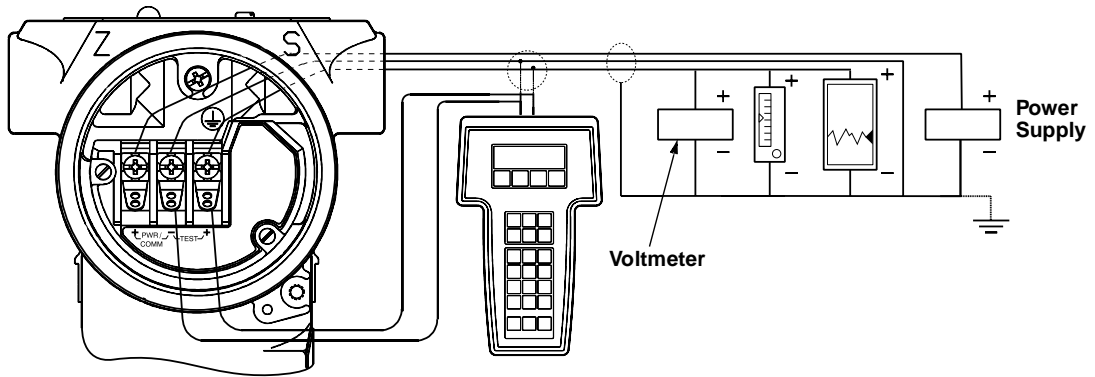
The following diagrams illustrate wiring loops for a field hook-up with a HART-based communicator.

FIGURE 2-8. Field Hook-up  
(4–20 mA Transmitters).



3051-3031H02B

FIGURE 2-9. Field Hook-up  
(Low-Power Transmitters).



3051-3031E02B

## REVIEW CONFIGURATION DATA

HART Comm	1, 5
Model 268	Review Key

### NOTE

Information and procedures in this section that make use of HART Communicator fast key sequences assume that the transmitter and communicator are connected, powered, and operating correctly. If you are not familiar with the HART Communicator or fast-key sequences, refer to Appendix A: HART Communicator.

---

Before you place the transmitter into operation, it is recommended that you review the transmitter configuration data that was set at the factory. You should review the following configuration data:

Transmitter Model	Type
Tag	Range
Date	Descriptor
Message	Minimum and Maximum Sensor Limits
Minimum Span	Units
4 and 20 mA points	Output (linear or sq. root)
Damping	Alarm Setting (high, low)
Security Setting (on, off)	Local Zero/Span Keys (enabled, disabled)
Integral Meter	Sensor Fill
Isolator Material	Flange (type, material)
O-Ring Material	Drain/Vent
Remote Seal (type, fill fluid, isolator material, number)	Transmitter S/N
Address	Sensor S/N

## CHECK OUTPUT

Before performing other transmitter on-line operations, review the digital output parameters to ensure that the transmitter is operating properly and is configured to the appropriate process variables.

### Process Variables

HART Comm.	2
Model 268	PV

The process variables for the Model 3051 provide the transmitter output, and are continuously updated. The process variable menu displays the following process variables:

- Pressure
- Percent of Range
- Analog Output

The pressure reading in both Engineering Units and Percent of Range will continue to track with pressures outside of the defined range from the lower to the upper range limit of the sensor module. (Previous versions of the software will track with pressure up to 105% of span and remain there as pressure increases.)

**NOTE**

Regardless of the range points, the Model 3051 will measure and report all readings within the digital limits of the sensor. For example, if the 4 and 20 mA points are set to 0 and 10 inH<sub>2</sub>O, and the transmitter detects a pressure of 25 inH<sub>2</sub>O, it digitally outputs the 25 inH<sub>2</sub>O reading and a 250% of span reading. However, there may be up to ±5.0% error associated with output outside of the range points.

**Sensor Temperature**

HART Comm.	1, 1, 4
Model 268	PV, F3

The Model 3051 contains a temperature sensor just above its pressure sensor in the sensor module. When reading this temperature, keep in mind that this is not a process temperature reading.

**BASIC SETUP**

**Set Process Variable Units**

HART Comm.	1, 3
Model 268	F3, F2

The *PV Unit* command sets the process variable units to allow you to monitor your process using the appropriate units of measure. Select from the following engineering units:

- inH<sub>2</sub>O
- inHg
- ftH<sub>2</sub>O
- mmH<sub>2</sub>O
- mmHg
- psi
- torr
- inH<sub>2</sub>O at 4 °C<sup>(1)</sup>
- bar
- mbar
- g/cm<sup>2</sup>
- kg/cm<sup>2</sup>
- Pa
- kPa
- atm
- mmH<sub>2</sub>O at 4 °C<sup>(1)</sup>

(1) Not available with low power or previous Model 3051 transmitters.

**Set Output**

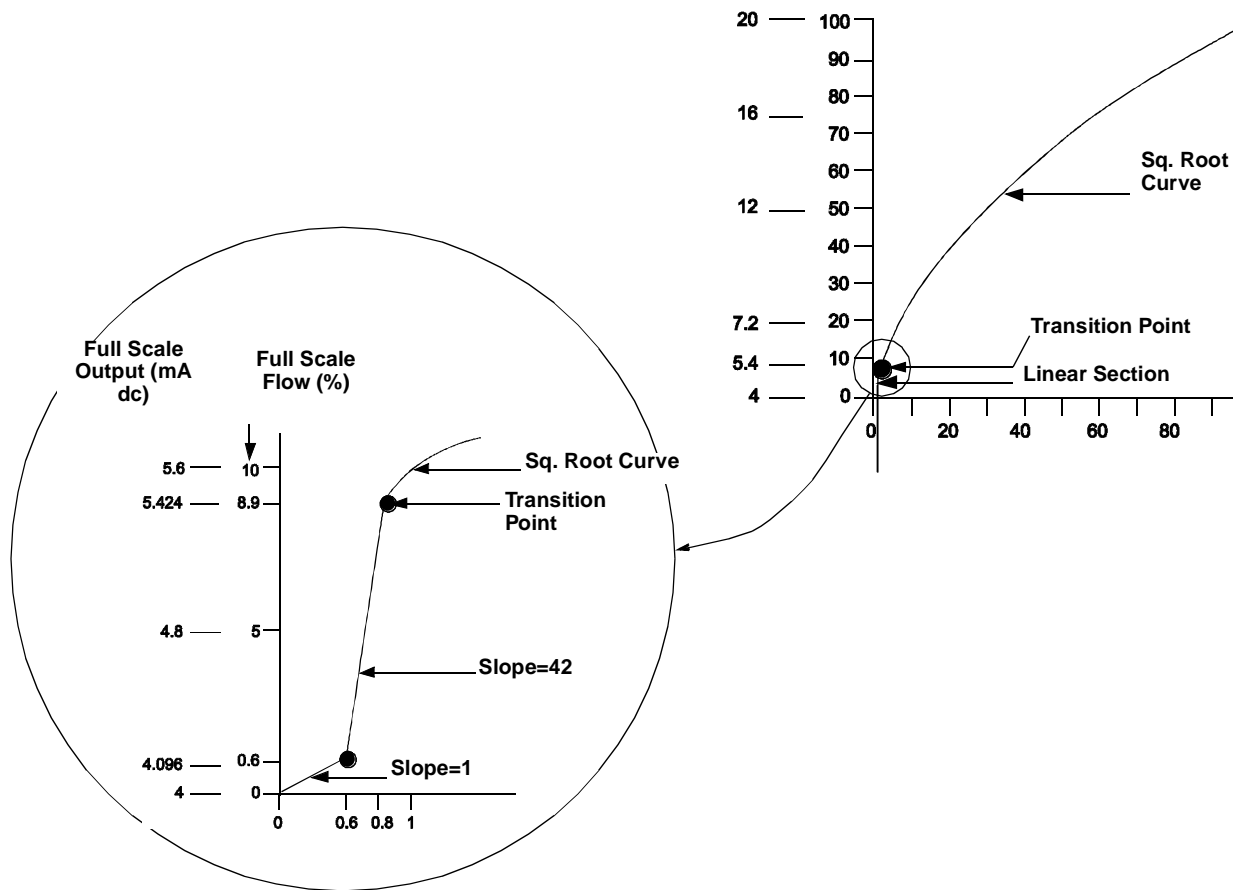
HART Comm.	1, 3, 5
Model 268	F3, F2, F1, F1

Activate the transmitter square root output option to make the analog output proportional to flow. As the input approaches zero, the Model 3051 automatically switches to a linear output in order to ensure a more smooth, stable output near zero. See Figure 2-10.

The transition from linear to square root is not adjustable. It occurs at 0.8% of ranged pressure input or 9% of full-scale flow output in transmitters with Revision 5.2 or higher software. In earlier software, the transition point occurred at 4% of ranged pressure input, or 20% of full scale flow output.

From 0 percent to 0.6 percent of the ranged pressure input, the slope of the curve is unity ( $y = x$ ). This allows accurate calibration near zero. Greater slopes would cause large changes in output for small changes at input. From 0.6 percent to 0.8 percent, the slope of the curve equals 42 ( $y = 42x$ ) to achieve continuous transition from linear to square root at the transition point.

FIGURE 2-10. Square Root Output Transition Point.



## Rerange

The *Range Values* command sets the 4 and 20 mA points (lower and upper range values). Setting the range values to the limits of expected readings maximizes transmitter performance. In practice, you may reset the transmitter range values as often as necessary to reflect changing process conditions.

### NOTE

Regardless of the range points, the Model 3051 will measure and report all readings within the digital limits of the sensor. For example, if the 4 and 20 mA points are set to 0 and 10 inH<sub>2</sub>O, and the transmitter detects a pressure of 25 inH<sub>2</sub>O, it digitally outputs the 25 inH<sub>2</sub>O reading and a 250% percent of span reading. However, there may be up to ±5.0% error associated with output outside of the range points.

You may use one of three methods to rerange the transmitter. Each method is unique; examine all three closely before deciding which method to use.

**Rerange with a Communicator Only**

HART Comm.	1, 2, 3, 1, 1
Model 268	F3, F2, F1, F3, F1

Reranging using only the communicator is the easiest and most popular way to rerange the transmitter. This method changes the values of the analog 4 and 20 mA points independently without a pressure input.

**NOTE**

Changing the lower or upper range point results in similar changes to the span.

To rerange using only the communicator, enter the fast-key sequence above, select *1 Keypad input*, and follow the on-line instructions. Or enter the values directly from the **HOME** screen.

**NOTE**

If the transmitter security jumper is in the **ON** position, you will not be able to make adjustments to the zero and span. Refer to Figure 2-1 on page 2-5 for the appropriate placement of the transmitter security jumper.

**Rerange with a Pressure Input Source and a Communicator**

HART Comm.	1, 2, 3, 1, 2
Model 268	F3, F2, F1, F3, F2

Reranging using the communicator and a pressure source or process pressure is a way of reranging the transmitter when specific 4 and 20 mA points are not known. This method changes the values of the analog 4 and 20 mA points.

**NOTE**

When you set the 4 mA point the span is maintained; when you set the 20 mA point the span changes. If you set the lower range point to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.

To rerange using the communicator and a pressure source or process pressure, enter the fast-key sequence above, select *2 Apply values*, and follow the on-line instructions.

**NOTE**

If the transmitter security jumper is in the **ON** position, you will not be able to make adjustments to the zero and span. Refer to Figure 2-1 on page 2-5 for the appropriate placement of the transmitter security jumper.

**Rerange with a Pressure Input Source and the Local Zero and Span Buttons**

Reranging using the local zero and span adjustments (see Figure 2-11 on page 2-16) and a pressure source is a way of reranging the transmitter when specific 4 and 20 mA points are not known and a communicator is not available.

**NOTE**

When you set the 4 mA point the span is maintained; when you set the 20 mA point the span changes. If you set the lower range point to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.

To rerange the transmitter using the span and zero buttons, perform the following procedure:

1. Loosen the screw holding the certifications label on top of the transmitter housing, and rotate the label to expose the zero and span buttons (see Figure 2-11 on page 2-16).
2. Using a pressure source with an accuracy three to ten times the desired calibrated accuracy, apply a pressure equivalent to the lower range value to the high side of the transmitter.
3. To set the 4 mA point, press and hold the zero button for at least two seconds, then verify that the output is 4 mA. If a meter is installed, it will display ZERO PASS.

---

**NOTE**

The zero and span adjustments on previous versions of the transmitter are screws instead of buttons. To activate the zero and span adjustments loosen the screws until they pop up.

---

4. Apply a pressure equivalent to the upper range value to the high side of the transmitter.
5. To set the 20 mA point, press and hold the span button for at least two seconds, then verify that the output is 20 mA. If a meter is installed, it will display SPAN PASS.

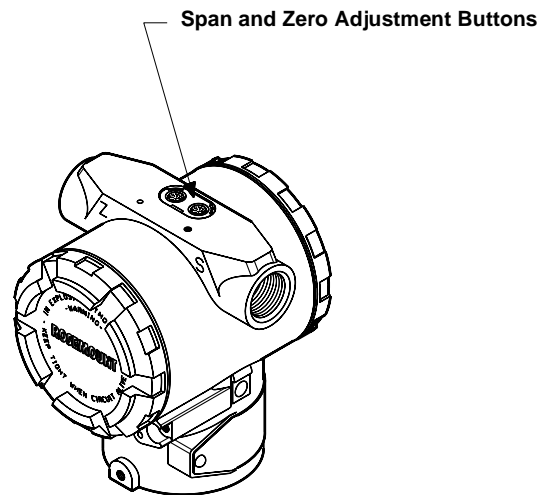
---

**NOTE**

If the transmitter security jumper is in the **ON** position, or if the local zero and span adjustments are disabled through the software, you will not be able to make adjustments to the zero and span using the local buttons. Refer to Figure 2-1 on page 2-5 for the proper placement of the transmitter security jumper. Or refer to “Local Span and Zero Control (Local Keys)” on page 2-17 for instructions on how to enable the span and zero buttons.

---

FIGURE 2-11. Local Zero and Span Adjustments.



3051-3031D02A

After you rerange the transmitter using the span and zero adjustments, it is possible to disable the adjustments to prevent further reranging. Refer to “Local Span and Zero Control (Local Keys)” below for more information.

## Damping

HART Comm.	1, 3, 6
Model 268	F3, F2, (F1 × 3)

The PV damp command changes the response time of the transmitter to smooth variations in output readings caused by rapid changes in input. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the of loop dynamics of your system. The default damping value is 0.4 seconds,<sup>(1)</sup> and can be reset to any of ten pre-configured damping values between 0 and 25.6 seconds.

## LCD Meter Options

HART Comm.	1, 4, 3, 4
Model 268	not available

The Meter Options command allows you to customize the LCD meter for use in your application. You can configure the meter to display the following information:

- Engineering Units
- Percent of Range
- User-Configurable LCD Scale
- Alternating between any two of the above

### NOTE

The user-configurable LCD scale is a feature specific to the new 4–20 mA output transmitters. If you have a previous Model 3051 transmitter, upgrade the transmitter electronics board and LCD display to attain this new functionality.

The user-configurable scale is a new feature that enables you to configure the LCD meter to a custom scale using a Model 275 HART communicator. With this feature you can define the decimal point position, the upper range value, the lower range value, the engineering units, and the transfer function. Refer to “Custom Meter Configuration” on page 6-3 for complete configuration information.

## DETAILED SETUP

### Local Span and Zero Control (Local Keys)

HART Comm.	1, 4, 4, 1, 7
Model 268	F4, F4, F2, F1

The *Local keys* command allows software control over the use of the local span and zero adjustments. To enable or disable the span and zero adjustment buttons on your transmitter, perform the fast key sequence at left.

### NOTE

Disabling the local keys does not disable all transmitter configuration changes. With the local keys disabled, you can still make changes to the transmitter configuration—including range values—using a HART communicator.

### Sensor Temperature Output Unit Selection

HART Comm.	1, 4, 1, 2, 2
Model 268	F4, F4, F2, F1

The *Sensor Temperature Output Unit Selection* command selects between Celsius and Fahrenheit units for output of the sensor temperature. The sensor temperature output is accessible via HART only. (The Sensor Temperature Output Units command is not available on previous design transmitters.)

(1) Model 3051CD0 default damping is 3.2 seconds. Model 3051CD1, with calibrations below 2.5 inH<sub>2</sub>O (0.62 kPa), have damping set at 3.2 seconds.



## DIAGNOSTICS AND SERVICE

The diagnostics and service functions listed here are primarily for use after you install the transmitter in the field. The transmitter test feature is designed to verify that the transmitter is operating properly, and can be performed either on the bench or in the field. The loop test feature is designed to verify proper loop wiring and transmitter output, and should only be performed after you install the transmitter.

### Transmitter Test

HART Comm.	1, 2, 1, 1
Model 268	F2, F2

The transmitter test command initiates a more extensive diagnostics routine than that performed continuously by the transmitter. The transmitter test routine can quickly identify potential electronics problems. If the transmitter test detects a problem, messages to indicate the source of the problem are displayed on the communicator screen.

### Loop Test

HART Comm.	1, 2, 2
Model 268	F2, F3

The *Loop Test* command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect a reference meter to the transmitter. To do so, either connect the meter to the test terminals on the transmitter terminal block, or shunt the power to the transmitter through the meter at some point in the loop.
2. From the **HOME** screen, select *1 Device Setup, 2 Diagnostics and Service, 2 Loop Test*, to prepare to perform a loop test.
3. Select **OK** after you set the control loop to manual (see “Setting the Loop to Manual” on page 2-9). The communicator displays the loop test menu.
4. Select a discreet milliamp level for the transmitter to output. At the **CHOOSE ANALOG OUTPUT** prompt, select *1 4mA, 2 20mA*, or select *3 other* to manually input a value. **IF** you are performing a loop test to verify the output of a transmitter, **THEN** enter a value between 4 and 20 mA. **IF** you are performing a loop test to verify the transmitter alarm levels, **THEN** enter the milliamp value representing an alarm state (see Tables 2-1, 2-3, and 2-2 on page 2-2).
5. Check the electrical current meter installed in the test loop to verify that it reads the value you commanded the transmitter to output. **IF** the readings match, **THEN** the transmitter and the loop are configured and functioning properly. **IF** the readings do not match, **THEN** you may have the current meter attached to the wrong loop, there may be a fault in the wiring, the transmitter may require an output trim, or the electrical current meter may be malfunctioning.

After completing the test procedure, the display returns to the loop test screen and allows you to choose another output value or to exit loop testing.

---

## CALIBRATION

Calibrating a smart transmitter is different from calibrating an analog transmitter. The one-step calibration process of an analog transmitter is done in three steps with a smart transmitter:

- **Rerange**—sets the 4 and 20 mA points at the desired pressures;
- **Sensor Trim**—Adjusts the position of the factory characterization curve to optimize the transmitter performance over a specified pressure range or to adjust for mounting effects
- **Analog Output Trim**—Adjusts the analog output to match the plant standard or the control loop.

Smart transmitters operate differently than analog transmitters. A smart transmitter uses a microprocessor that contains information about the sensor's specific characteristics in response to pressure and temperature inputs. A smart transmitter compensates for these sensor variations. The process of generating the sensor performance profile is called factory characterization. Factory characterization also provides the ability to readjust the 4 and 20 mA points without applying pressure to the transmitter.

The trim and rerange functions also differ. Reranging sets the transmitter analog output to the selected upper and lower range points and can be done with or without an applied pressure. Reranging does not change the factory characterization curve stored in the microprocessor. Sensor trimming requires an accurate pressure input and adds additional compensation that adjusts the position of the factory characterization curve to optimize transmitter performance over a specific pressure range.

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### NOTE

Sensor trimming adjusts the position of the factory characterization curve. It is possible to degrade the performance of the transmitter if the sensor trim is done improperly or with inaccurate equipment. Contact your local Rosemount representative or call Rosemount Customer Central at 800-999-9307 if you have questions.

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TABLE 2-4. Recommended Calibration Tasks.

Transmitter	Bench Calibration Tasks	Field Calibration Tasks
3051CD 3051CG 3051L 3051HD 3051HG	<ol style="list-style-type: none"> <li>1. Set output configuration parameters:                             <ol style="list-style-type: none"> <li>a. Set the range points.</li> <li>b. Set the output units.</li> <li>c. Set the output type.</li> <li>d. Set the damping value.</li> </ol> </li> <li>2. <i>Optional:</i> Perform a full sensor trim. (Accurate multimeter required.)</li> <li>3. <i>Optional:</i> Perform an analog output trim. (Accurate multimeter required.)</li> </ol>	<ol style="list-style-type: none"> <li>1. Reconfigure parameters if necessary.</li> <li>2. Zero trim the transmitter to compensate for mounting effects or static pressure effects.</li> </ol>
3051CA 3051TA 3051TG	<ol style="list-style-type: none"> <li>1. Set output configuration parameters:                             <ol style="list-style-type: none"> <li>a. Set the range points.</li> <li>b. Set the output units.</li> <li>c. Set the output type.</li> <li>d. Set the damping value.</li> </ol> </li> <li>2. <i>Optional:</i> Perform a full sensor trim if equipment available (accurate absolute pressure source required), otherwise perform the low trim value section of the full sensor trim procedure.</li> <li>3. <i>Optional:</i> Perform an analog output trim (multimeter required).</li> </ol>	<ol style="list-style-type: none"> <li>1. Reconfigure parameters if necessary.</li> <li>2. Perform low trim value section of the full sensor trim procedure to correct for mounting position effects.</li> </ol>

**Notes:**

- A HART communicator is required for all sensor and output trim procedures.
- Model 3051C Range 4 and Range 5 transmitters require a special calibration procedure when used in differential pressure applications under high static line pressure (see “Compensating Model 3051 Range 4 and 5 Differential Transmitters for Line Pressure” on page 2-28).
- Model 3051TG Range 5 transmitters use an absolute sensor that requires an accurate absolute pressure source to perform the optional full sensor trim.

**Calibration Overview**

Complete calibration of the Model 3051 Pressure Transmitter involves the following tasks:

**Configure the Analog Output Parameters**

- Set Process Variable Units (page 2-13)
- Set Output Type (page 2-13)
- Rerange (page 2-14)
- Set Damping (page 2-17)

**Calibrate the Sensor**

- Full Trim (page 2-25)
- Zero Trim (page 2-25)

**Calibrate the 4–20 mA Output**

- 4–20 mA Output Trim (page 2-27) or
- 4–20 mA Output Trim Using Other Scale (page 2-27) or
- Low-Power 1–5 V dc or Low-Power 0.8–3.2 V dc (page 2-27)

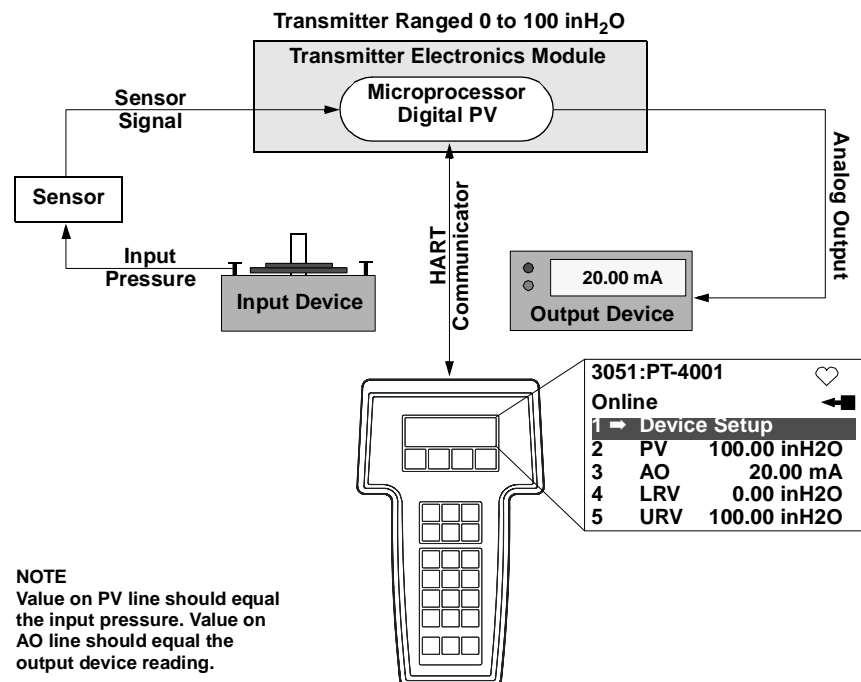
Figure 2-12 on page 2-21 illustrates the Model 3051 transmitter data flow. This data flow can be summarized in four major steps:

1. A change in pressure is measured by a change in the sensor output (Sensor Signal).
1. The sensor signal is converted to a digital format that can be understood by the microprocessor (Analog-to-Digital Signal Conversion).
2. Corrections are performed in the microprocessor to obtain a digital representation of the process input (Digital PV).
3. The Digital PV is converted to an analog value (Digital-to-Analog Signal Conversion).

Figure 2-12 also identifies the approximate transmitter location for each calibration task. Note that the data flows from left to right, and a parameter change affects all values to the right of the changed parameter.

Not all calibration procedures should be performed for each Model 3051 transmitter. In addition, some procedures are appropriate for bench calibration but should not be performed during field calibration. Table 2-4 identifies the recommended calibration procedures for each type of Model 3051 transmitter for both bench and field calibration.

FIGURE 2-12. Transmitter Data Flow with Calibration Options.



### Deciding Which Trim Procedure to Use

To decide which trim procedure to use, you must first determine whether the analog-to-digital section or the digital-to-analog section of the transmitter electronics is in need of calibration. To do so, refer to Figure 2-12 and perform the following procedure:

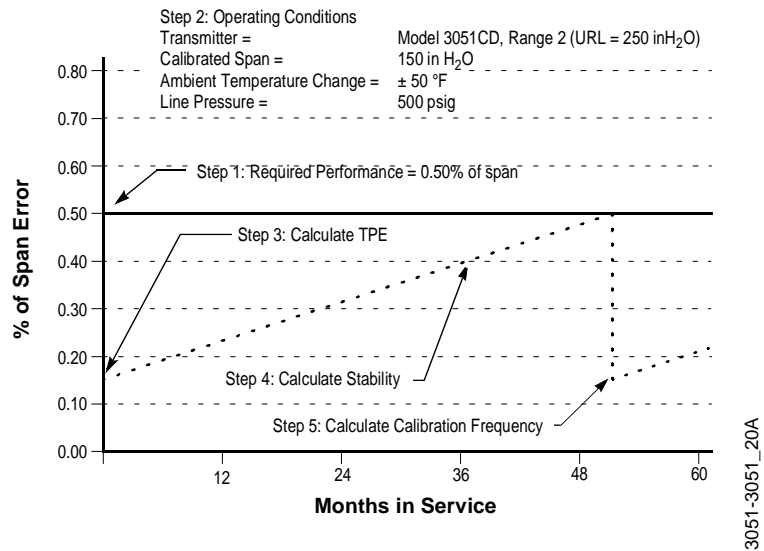
1. Connect a pressure source, a HART communicator, and a digital readout device to the transmitter.
2. Establish communication between the transmitter and the communicator.
3. Apply pressure equal to the upper range point pressure (100 inH<sub>2</sub>O, for example).
4. Compare the applied pressure to the Process Variable (PV) line on the Communicator On-line Menu. **IF** the PV reading on the communicator does not match the applied pressure, and you are confident that your test equipment is accurate, **THEN** perform a sensor trim.
5. Compare the Analog Output (AO) line on the communicator on-line menu to the digital readout device. **IF** the AO reading on the communicator does not match the digital readout device, and you are confident that your test equipment is accurate, **THEN** perform an output trim.

### Determining Calibration Frequency

Calibration frequency can vary greatly depending on the application, performance requirements, and process conditions. Use the following procedure to determine the calibration frequency that meets the needs of your application.

1. Determine the performance required for your application.
2. Determine the operating conditions.
3. Calculate the Total Probable Error (TPE).
4. Calculate the stability per month.
5. Calculate the calibration frequency.

FIGURE 2-13. Calculating Calibration Frequency.



**Sample Calculation**

Step 1: Determine the performance required for your application.

Required Performance: 0.30% of span

Step 2: Determine the operating conditions.

Transmitter: Model 3051CD, Range 2 (URL=250 inH<sub>2</sub>O)  
 Calibrated Span: 150 inH<sub>2</sub>O  
 Ambient Temperature Change: ± 50 °F  
 Line Pressure: 500 psig

Step 3: Calculate total probable error (TPE).

$$TPE = \sqrt{(ReferenceAccuracy)^2 + (TemperatureEffect)^2 + (StaticPressureEffect)^2} = 0.150\% \text{ of span}$$

Where:

Reference Accuracy = ± 0.075% of span

Ambient Temperature Effect =

$$\pm \left( \frac{0.0125 \times URL}{Span} + 0.0625 \right) \text{ per } 50 \text{ }^\circ\text{F} = \pm 0.0833\% \text{ of span}$$

Span Static Pressure Effect<sup>(1)</sup> =

0.1% reading per 1000 psi = ±0.05 of span at maximum span

(1) Zero static pressure effect removed by zero trimming at line pressure.

Step 4: Calculate the stability per month.

$$Stability = \pm \left[ \frac{0.0125 \times URL}{Span} \right] \% \text{ of span for 5 years} = \pm 0.05\% \text{ of span per month}$$

Step 5: Calculate calibration frequency.

$$Cal. \text{ Freq.} = \frac{(Req. \text{ Performance} - TPE)}{Stability \text{ per Month}} = \frac{(0.3\% - 0.123\%)}{0.0035\%} = 51 \text{ months}$$

## Sensor Trim

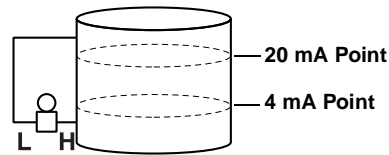
You can trim the sensor using either the full trim or the zero trim function. The trim functions vary in complexity, and their use is application-dependent. Both trim functions alter the transmitter's interpretation of the input signal.

A **zero trim** is a single-point adjustment. It is useful for compensating for mounting position effects and is most effective when performed with the transmitter installed in its final mounting position. Since this correction maintains the slope of the characterization curve, it should not be used in place of a full trim over the full sensor range.

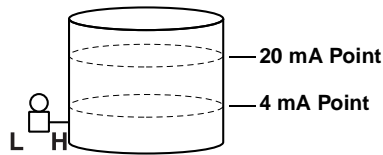
When performing a zero trim, ensure that the equalizing valve is open and all wet legs are filled to the correct levels.

### NOTE

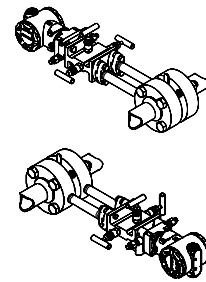
**Do not perform a zero trim on Model 3051 Absolute pressure transmitters.** A zero trim is zero based, and absolute pressure transmitters reference absolute zero. To correct mounting position effects on a Model 3051 Absolute Pressure Transmitter, perform a low trim within the full sensor trim function. The low trim function provides a "zero" correction similar to the zero trim function but it does not require the input to be zero based.



**NONZERO-BASED  
LEVEL APPLICATION**



**ZERO-BASED LEVEL  
APPLICATION**



**ZERO-BASED FLOW  
APPLICATION**

3051-3031B03A, B03B, 3051\_18A, 19A

A **full trim** is a two-point sensor calibration where two end-point pressures are applied, and all output is linearized between them. You should always adjust the low trim value first to establish the correct offset. Adjustment of the high trim value provides a slope correction to the characterization curve based on the low trim value. The factory-established characterization curve is not changed by this procedure. The trim values allow you to optimize performance over your specified measuring range at the calibration temperature.

**Zero Trim**

<b>HART Comm.</b>	1, 2, 3, 3, 1
<b>Model 268</b>	F3, F2, F1, F3, F2

To calibrate the sensor with a HART Communicator using the zero trim function, perform the following procedure.

1. Vent the transmitter and attach a communicator to the measurement loop.
2. From the communicator main menu select *1 Device setup, 2 Diagnostics and service, 3 Calibration, 3 Sensor trim, 1 Zero trim* to prepare to adjust the zero trim.

**NOTE**

The transmitter must be within 3% of true zero (zero based) in order to calibrate it using the zero trim function.

3. Follow the commands provided by the communicator to complete the adjustment of the zero trim.

**Full Trim**

<b>HART Comm.</b>	1, 2, 3, 3
<b>Model 268</b>	F4, F4, F3, F2, F1

To calibrate the sensor with a HART communicator using the full trim function, perform the following procedure:

1. Assemble and power the entire calibration system including a transmitter, HART communicator, power supply, pressure input source, and readout device (see Figure 2-14).

**NOTE**

Use a pressure input source that is at least three times more accurate than the transmitter, and allow the input pressure to stabilize for 10 seconds before entering any values.

2. From the communicator **MAIN** menu select *1 Device setup, 2 Diagnostics and service, 3 Calibration, 3 Sensor trim, 2 Lower sensor trim* to prepare to adjust the lower trim point.

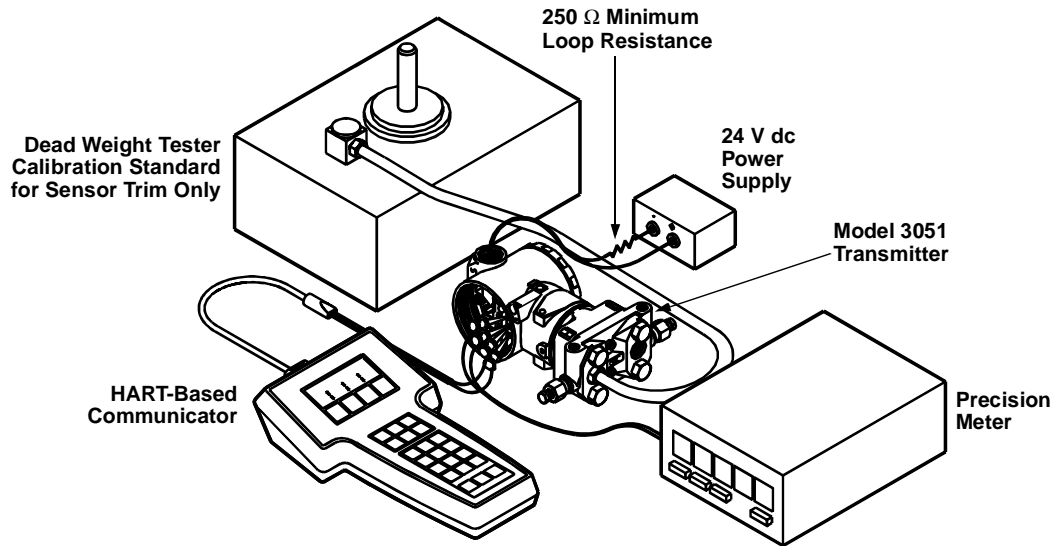
**NOTE**

Select pressure input values so that the low and high values are equal to or outside the 4 and 20 mA points. Do not attempt to obtain reverse output by reversing the high and low points. The transmitter allows approximately a 5% URL deviation from the characterized curve established at the factory.

3. Follow the commands provided by the communicator to complete the adjustment of the lower value.
4. Repeat the procedure for the upper value, replacing *2 Lower sensor trim* with *3 Upper sensor trim* in Step 2.



FIGURE 2-14. Digital Trim Connection Drawing (4–20 mA Transmitters).



3051-3031A01A

## Recall Factory Trim

The *Recall Factory Trim* commands allow the restoration of the as-shipped factory settings of the sensor trim and analog output trim.

### NOTE

The Recall Factory Trim commands are not available on previous design transmitters.

### Recall Factory Trim— Sensor Trim

HART Comm.	1, 2, 3, 4, 1
Model 268	Not available

Resets the transmitter sensor trim to the as-shipped factory settings. The *Recall Factory Trim—Sensor Trim* command can be useful for recovering from an inadvertent zero trim of an absolute pressure unit.

### Recall Factory Trim— Analog Output

HART Comm.	1, 2, 3, 4, 2
Model 268	Not available

Resets the transmitter analog output trim to the as-shipped factory settings. The *Recall Factory Trim—Analog Output* command can be useful for recovering from an inadvertent zero trim on an absolute pressure transmitter.

## Analog Output Trim

The *Analog Output Trim* commands allow you to adjust the transmitter's current output at the 4 and 20 mA points to match the plant standards. This command adjusts the digital to analog signal conversion (see Figure 2-12 on page 2-21).

### Digital-to-Analog Trim

HART Comm.	1, 2, 3, 2, 1
Model 268	F4, F4, F3, F1, F1

To perform a digital-to-analog trim with a HART communicator, perform the following procedure.

1. From the **HOME** screen, select *1 Device setup, 2 Diag/Service, 3 Calibration, 4 D/A trim*. Select **OK** after you set the control loop to manual (see "Setting the Loop to Manual" on page 2-9).
2. Connect an accurate reference ammeter to the transmitter at the **CONNECT REFERENCE METER** prompt. To do so, connect the positive lead to the positive terminal and the negative lead to the test terminal in the transmitter terminal compartment, or shunt the transmitter power through the reference meter at some point.
3. Select **OK** after connecting the reference meter.
4. Select **OK** at the **SETTING FLD DEV OUTPUT TO 4 MA** prompt. The transmitter outputs 4,00 mA.
5. Record the actual value from the reference meter, and enter it at the **ENTER METER VALUE** prompt. The communicator prompts you to verify whether or not the output value equals the value on the reference meter.
6. Select *1 Yes* if the reference meter value equals the transmitter output value, or *2 No* if it does not.  
IF you select *1 Yes*, THEN proceed to Step 7.  
IF you select *2 No*, THEN repeat Step 5.
7. Select **OK** at the **SETTING FLD DEV OUTPUT TO 20 MA** prompt, and repeat Steps 5 and 6 until the reference meter value equals the transmitter output value.
8. Select **OK** after you return the control loop to automatic control.

### Digital-to-Analog Trim Using Other Scale

HART Comm.	1, 2, 3, 2, 2
Model 268	F4, F4, F3, F1, F2

The *Scaled D/A Trim* command matches the 4 and 20 mA points to a user-selectable reference scale other than 4 and 20 mA (1 to 5 volts if measuring across a 250 ohm load, or 0 to 100 percent if measuring from a DCS, for example). To perform a scaled D/A trim, connect an accurate reference meter to the transmitter and trim the output signal to scale as outlined in the Output Trim procedure.

### NOTE

Use a precision resistor for optimum accuracy. If you add a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with the additional loop resistance.

### Analog Output Trim (Low Power)

HART Comm.	1, 2, 3, 2, 1
Model 268	F4, F4, F3, F1, F1

The Model 3051 Low-Power Transmitter has two jumper-selectable output ranges: 1–5 V dc and 0.8–3.2 V dc. Positioning this jumper for the desired output range selects the proper coefficients for temperature corrections. The jumper position also sets the output values (1–5 or 0.8–3.2) which are communicated through HART protocol and accessed by a hand held communicator.

## Compensating Model 3051 Range 4 and 5 Differential Transmitters for Line Pressure

However, switching this jumper does not by itself select the new outputs; you must perform the “Digital-to-Analog Trim” procedure above to match the transmitter’s output voltages to the new jumper selection.

Model 3051 Range 4 and Range 5 pressure transmitters require a special calibration procedure when used in differential pressure applications. The purpose of this procedure is to optimize transmitter performance by reducing the effect of static line pressure in these applications. Model 3051 differential pressure transmitters (Ranges 1, 2, and 3) do not require this procedure because the optimization occurs in the sensor.

Applying high static pressure to Model 3051 Range 4 and Range 5 pressure transmitters causes a systematic shift in the output. This shift is linear with static pressure; correct it by performing the Full Trim procedure on page 2-18.

The following specifications show the static pressure effect for Model 3051 Range 4 and Range 5 transmitters used in differential pressure applications:

### Zero Effect:

±0.1% of the upper range limit per 1000 psi (6,9 MPa) for line pressures from 0 to 2000 psi (0 to 13,8 MPa)

±0.2% of the upper range limit per 1000 psi (6,9 MPa) for line pressures above 2000 psi (13,8 MPa)

### Span Effect:

Correctable to ±0.2% of reading per 1000 psi for line pressures from 0 to 3626 psi.

The systematic span shift caused by the application of static line pressure is –1.00% of reading per 1000 psi for 3051C Range 4 transmitters, and –1.25% of reading per 1000 psi for Range 5 transmitters.

Use the following example to compute corrected input values.

### Example

A transmitter with model number 3051CD4 will be used in a differential pressure application where the static line pressure is 1200 psi. The transmitter is ranged so that the output is 4 mA at 500 inH<sub>2</sub>O and 20 mA at 1500 inH<sub>2</sub>O.

To correct for systematic error caused by high static line pressure, first use the following formulas to determine corrected values for the low trim and high trim.

$$LT = LRV + S (LRV) P$$

Where:	LT =	Corrected Low Trim Value
	LRV =	Lower Range Value
	S =	–(Span shift per specification)
	P =	Static Line Pressure

**HT = URV + S (URV) P**

Where: HT = Corrected High Trim Value  
 URV = Upper Range Value  
 S = -(Span shift per specification)  
 P = Static Line Pressure

In this example:

URV = 1500 inH<sub>2</sub>O  
 LRV = 500 inH<sub>2</sub>O  
 P = 1200 psi  
 S = ± 0.01/1000

To calculate the low trim (LT) value:

LT = 500 + (0.01/1000)(500)(1200)  
 LT = 506 inH<sub>2</sub>O

To calculate the high trim (HT) value:

HT = 1500 + (0.01/1000)(1500)(1200)  
 HT = 1518 inH<sub>2</sub>O

To complete a Model 3051 full trim and enter the corrected values for low trim (LT) and high trim (HT), refer to “Full Trim” on page 2-25.

Enter the corrected input values for low trim and high trim through the communicator keypad after you apply the nominal value of pressure as the transmitter input.

**NOTE**

After calibrating Model 3051 Range 4 and Range 5 transmitters for high differential pressure applications, rerange the 4 and 20 mA points using the communicator to maintain the systematic static line pressure correction. You may re-zero the 4 mA point at line pressure after installation using the local zero button without affecting the completed calibration.

**ADVANCED FUNCTIONS**

**Saving, Recalling, and Cloning Configuration Data**

HART Comm.	left arrow, 1, 2
Model 268	F4, F3, F1

Use the cloning feature of the Model 275 HART Communicator if you need to configure several Model 3051 transmitters similarly. The cloning process involves configuring a transmitter, saving the configuration data, then sending a copy of the data to a separate transmitter. There are a number of possible procedures to use when saving, recalling, and cloning configuration data. For complete instructions refer to the HART Communicator manual, publication no. 00809-0100-4275. One common method is as follows:

1. Completely configure the first transmitter.
2. Save the configuration data:
  - a. Select **F2 SAVE** from the communicator **HOME/ONLINE** screen.
  - b. Ensure that the location to which the data will be saved is set to **MODULE**. If it is not, select *1 Location* to set the save location to **MODULE**.
  - c. Select *2 Name* to name the configuration data. The default is the transmitter tag number.
  - d. Ensure that the data type is set to **STANDARD**. IF the data type is **NOT STANDARD**, THEN select *3 Data Type* to set the data type to **STANDARD**.
  - e. Select **F2 SAVE**.
3. Connect and power the receiving transmitter and communicator.
4. Select the back arrow from the **HOME/ONLINE** screen. The HART Communicator menu appears.
5. Select *1 Offline, 2 Saved Configuration, 1 Module Contents* to reach the **MODULE CONTENTS** menu.
6. Use the **DOWN ARROW** to scroll through the list of configurations in the memory module, and use the **RIGHT ARROW** to select the configuration you wish to retrieve.
7. Select *1 Edit*.
8. Select *1 Mark All*.
9. Select **F2 SAVE**.
10. Use the **DOWN ARROW** to scroll through the list of configurations in the memory module, and use the **RIGHT ARROW** to select the configuration again.
11. Select *3 Send* to download the configuration to the transmitter.

When finished, the communicator informs you of the status. To configure another transmitter, repeat Steps 3 through 10.

---

**NOTE**

The transmitter receiving the cloned data must have the same software version (or later) as the original transmitter.

---

**Burst Mode**

<b>HART Comm.</b>	1, 4, 3, 3, 3
<b>Model 268</b>	F4, F4, F4, F1

When configured for burst mode, the Model 3051 provides faster digital communication from the transmitter to the control system by eliminating the time required for the control system to request information from the transmitter. Burst mode is compatible with use of the analog signal. Because the HART protocol features simultaneous digital and analog data transmission, the analog value can drive other equipment in the loop while the control system is receiving the digital information. Burst mode applies only to the transmission of dynamic data (pressure and temperature in engineering units, pressure in percent of range, and/or analog output), and does not affect the way other transmitter data is accessed.

Access to information other than dynamic transmitter data is obtained through the normal poll/response method of HART communication. A HART-based communicator or the control system may request any of the information that is normally available while the transmitter is in burst mode. Between each message sent by the transmitter, a short pause allows the HART-based communicator or a control system to initiate a request. The transmitter will receive the request, process the response message, and then continue “bursting” the data approximately three times per second.

## Multidrop Communication

Multidropping transmitters refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated. Many of the Rosemount SMART FAMILY<sup>®</sup> transmitters can be multidropped. With the HART smart communications protocol, up to 15 transmitters can be connected on a single twisted pair of wires or over leased phone lines. This feature can greatly reduce wiring costs.

The application of a multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Communication with the transmitters can be accomplished with commercially available Bell 202 modems and a host implementing the HART protocol. Each transmitter is identified by a unique address (1–15) and responds to the commands defined in the HART protocol. HART-based communicators can test, configure, and format a multidropped transmitter the same way as a transmitter in a standard point-to-point installation.

Figure 2-15 shows a typical multidrop network. This figure is not intended as an installation diagram. Contact Rosemount product support with specific requirements for multidrop applications.

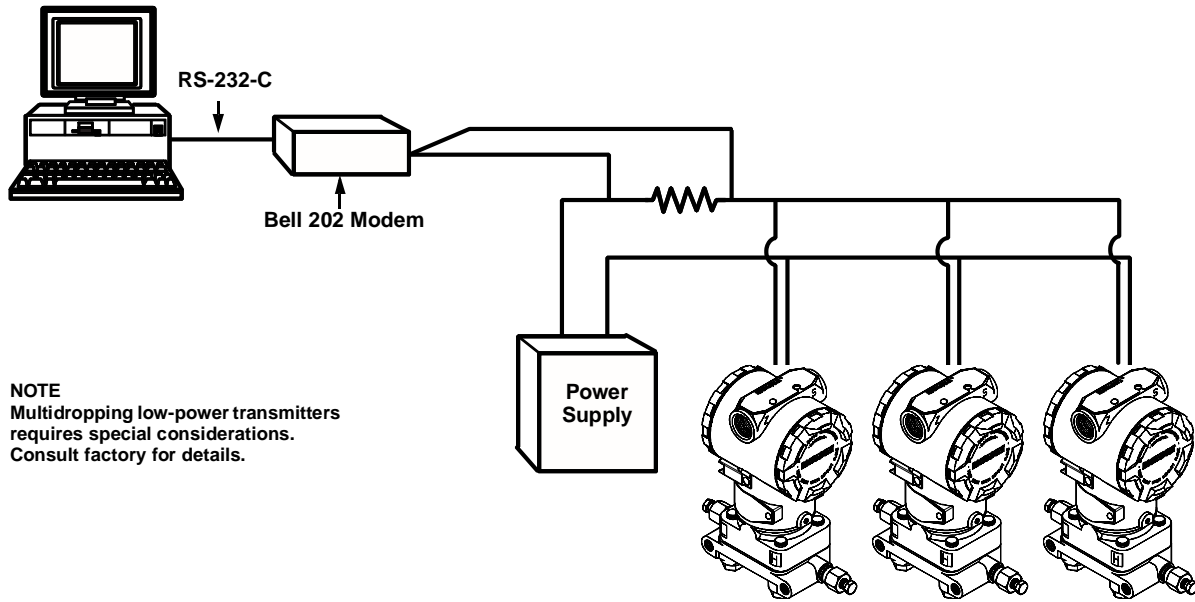
---

### NOTE

A transmitter in multidrop mode has the analog output fixed at 4 mA. If a meter is installed to a transmitter in multidrop mode, it will alternate the display between “current fixed” and the specified meter output(s).

---

FIGURE 2-15. Typical Multidrop Network.



**NOTE**  
Multidropping low-power transmitters requires special considerations. Consult factory for details.

3051-0087A, 3031A07B

**NOTE**

The Model 3051 is set to address 0 at the factory, allowing it to operate in the standard point-to-point manner with a 4–20 mA output signal. To activate multidrop communication, the transmitter address must be changed to a number from 1 to 15. This change deactivates the 4–20 mA analog output, sending it to 4 mA. It also disables the failure mode alarm signal, which is controlled by the upscale/downscale jumper position. Failure signals in multidropped transmitters are communicated through HART messages.

**Changing a Transmitter Address**

HART Comm.	1, 4, 3, 3, 1
Model 268	F1, F4, F4, F2, F3

To change the address of a multidropped transmitter, follow these fast key sequences. To activate multidrop communication, the transmitter address must be changed to a number from 1 to 15, and each transmitter in a multidropped loop must have a unique address.

**Communicating with a Multidropped Transmitter**

HART Comm.	1, 4, 3, 3, 2
Model 268	F1, F4, F4, F2, F2

To communicate with a multidropped transmitter for the purpose of testing, configuring, or formatting, follow the fast key sequence at left.

**Polling a Multidropped Transmitter**

HART Comm.	Left arrow, 4, 1
Model 268	F1, F4, F4, F2, F3

Polling a multidropped loop determines the model, address, and number of transmitters on the given loop.

**NOTE**

The HART Communicator Model 275 requires you to use the **UTILITY** menu to perform and autopoll. This menu is available from the **MAIN** menu of the HART Communicator. Press the **LEFT ARROW** to move from the **ONLINE MENU** to the **MAIN** menu. Press **4** from the **MAIN** menu to access the **UTILITY** menu.

# Installation

## OVERVIEW

The information in this section covers installation considerations. Dimensional drawings for each Model 3051 variation and mounting configuration are included in this section.

## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operation. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

### Warnings (⚠)

#### ⚠ WARNING

##### **Explosions can result in death or serious injury.**

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.

#### ⚠ WARNING

##### **Electrical shock can result in death or serious injury.**

- Avoid contact with the leads and terminals.

#### ⚠ WARNING

##### **Process leaks could result in death or serious injury.**

- Install and tighten all four flange bolts before applying pressure.
- Do not attempt to loosen or remove flange bolts while the transmitter is in service.

#### ⚠ WARNING

##### **Replacement equipment or spare parts not approved by Rosemount Inc. for use as spare parts could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.**

- Use only bolts supplied with the Model 3051 or sold by Rosemount Inc. as spare parts for the Model 3051.

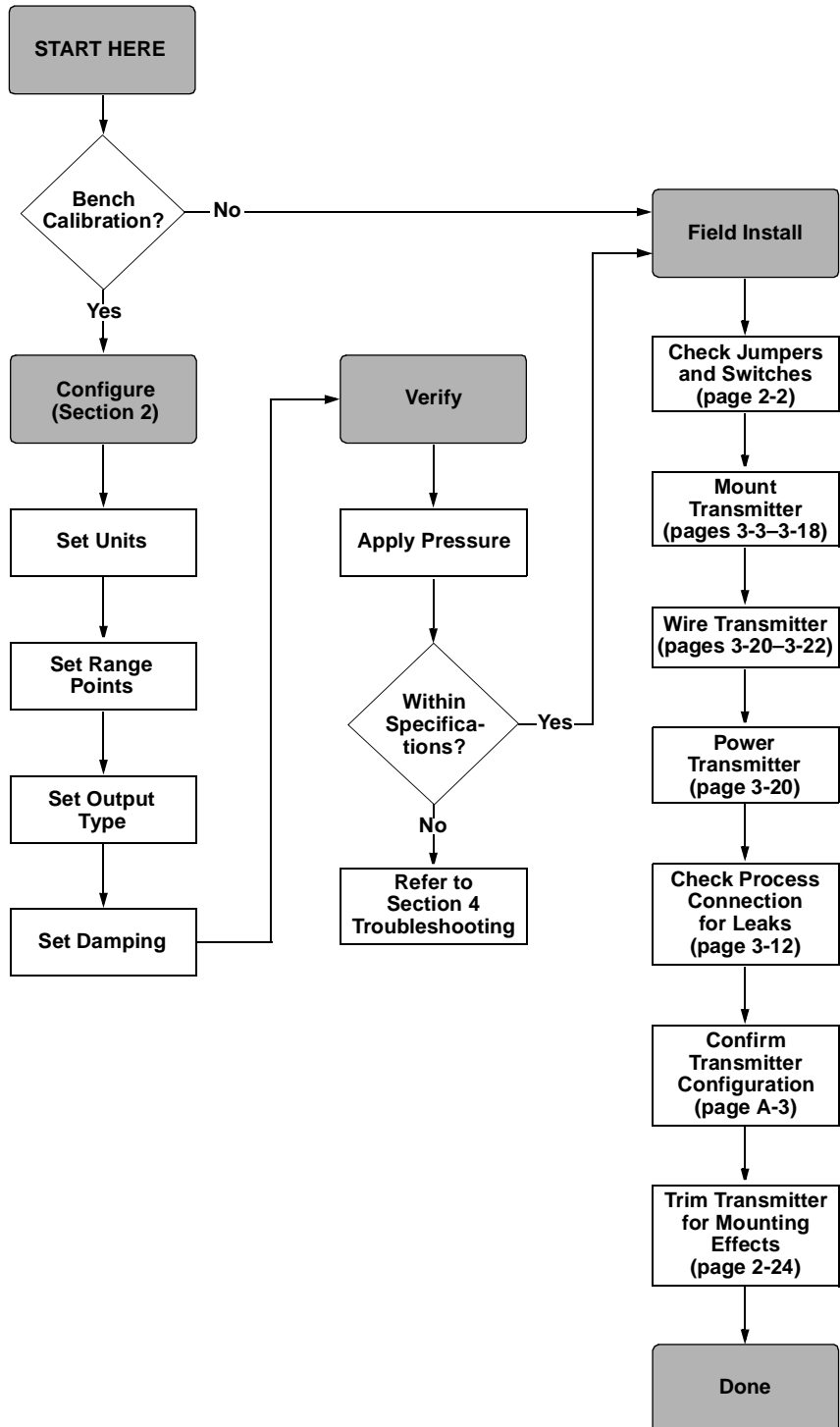


**⚠ WARNING**

**Improper assembly of manifolds to traditional housing can damage sensor module.**

- For safe assembly of manifold to traditional flange, bolts must break back plane of flange web (i.e., bolt hold) but must not contact module housing.

FIGURE 3-1. Installation Flowchart.



---

**GENERAL  
CONSIDERATIONS**

Measurement accuracy depends upon proper installation of the transmitter and impulse piping. Mount the transmitter close to the process and use a minimum of piping to achieve best accuracy. Keep in mind the need for easy access, personnel safety, practical field calibration, and a suitable transmitter environment. Install the transmitter to minimize vibration, shock, and temperature fluctuation.

---

**IMPORTANT**

Install the enclosed pipe plug in unused conduit openings with a minimum of five threads engaged to comply with explosionproof requirements. The transmitter is shipped with the plug installed on transmitters ordered with CSA explosionproof approval.

---

**MECHANICAL  
CONSIDERATIONS**

Figures 3-2 through 3-7 on pages 3-4 through 3-8 show dimensional drawings of Model 3051 transmitters. Figure 3-9 on page 3-11 shows installation examples. Figures 3-12 through 3-14 on pages 3-16 through 3-17 show dimensional drawings of mounting brackets.

---

**NOTE**

For Model 3051CD0 and 3051CD1, mount the transmitter solidly to prevent tilting. A tilt in the physical transmitter may cause a zero shift in the transmitter output.

---

---

**NOTE**

For steam service, do not blow down impulse piping through the transmitter. Flush the lines with the blocking valves closed and refill the lines with water before resuming measurement.

---

---

**NOTE**

When the transmitter is mounted on its side, position the Coplanar flange to ensure proper venting or draining. Mount the flange as shown in Figure 3-10 on page 3-14, keeping drain/vent connections on the bottom for gas service and on the top for liquid service.

---

---

**NOTE**

The Model 3051 transmitter incorporates two independent seals between the process connection and the conduit connection.

---

# Rosemount Model 3051 Smart Pressure Transmitters

FIGURE 3-2. Model 3051CD  
Dimensional Drawings.

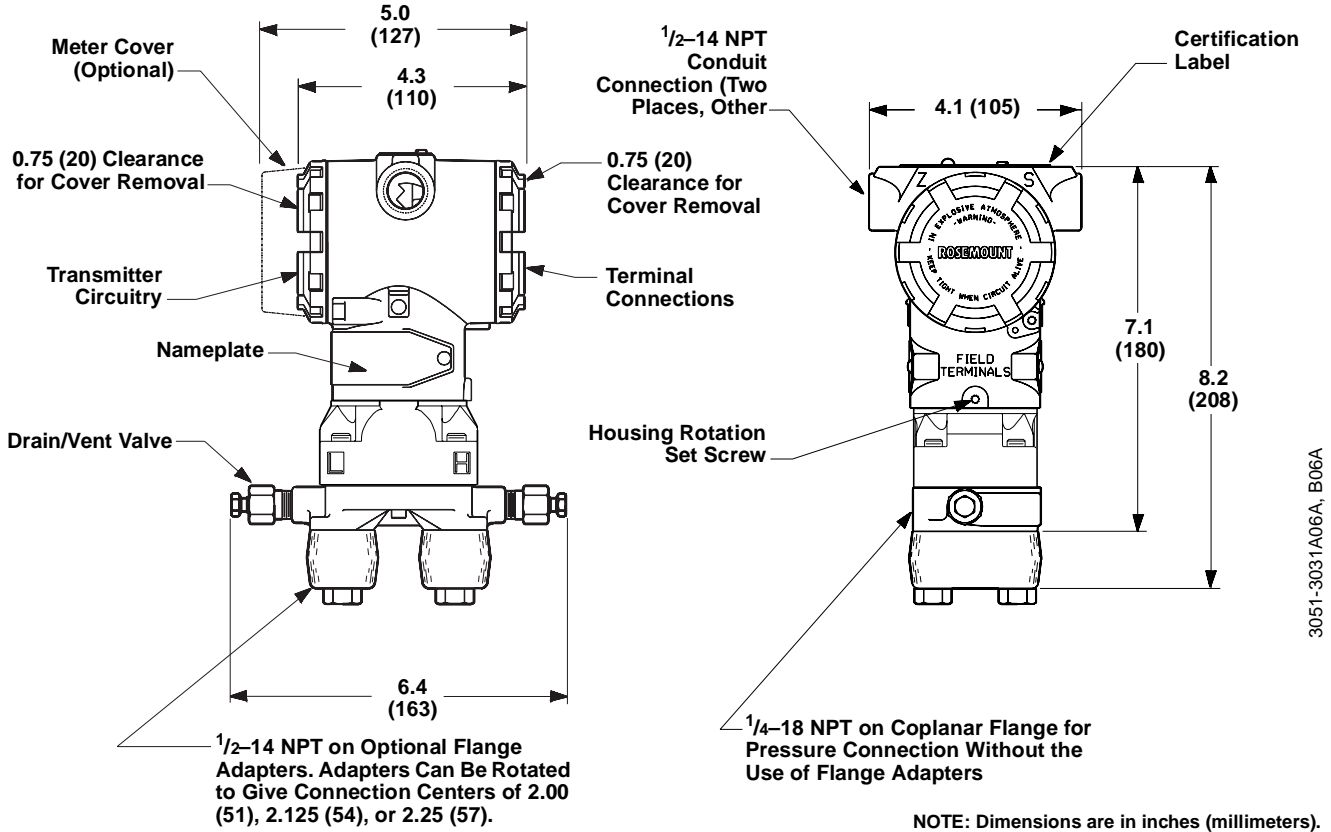


FIGURE 3-3. Model 3051CG and  
3051CA Dimensional Drawings.

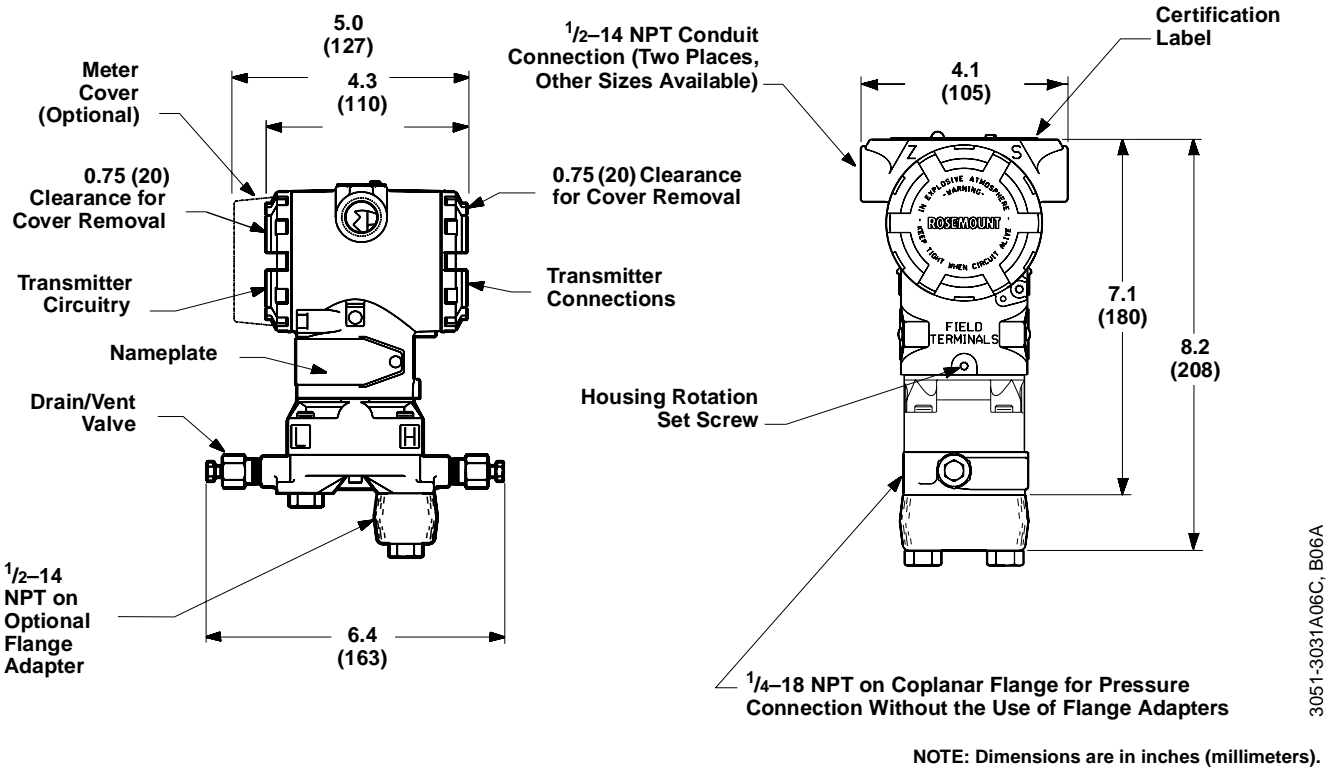


FIGURE 3-4. Model 3051C (Traditional Flange) Dimensional Drawings.

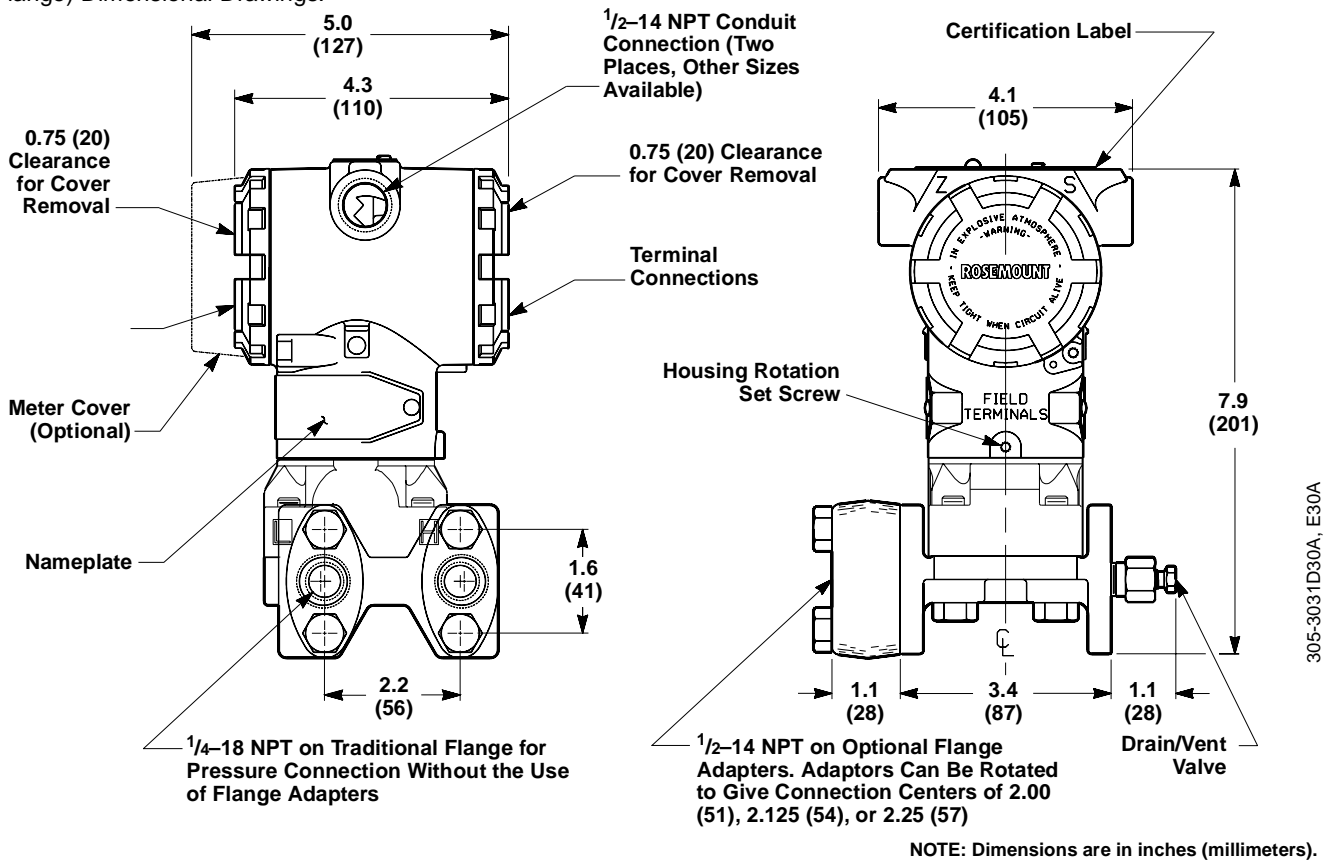
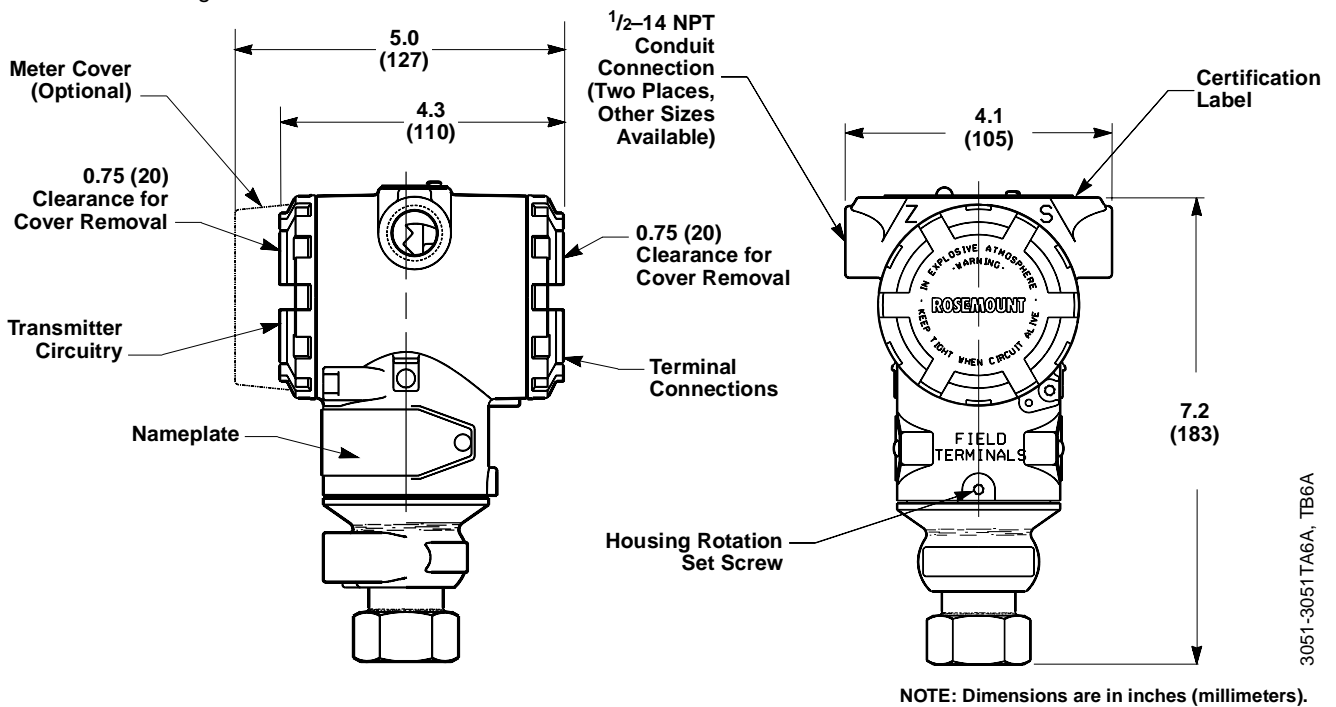
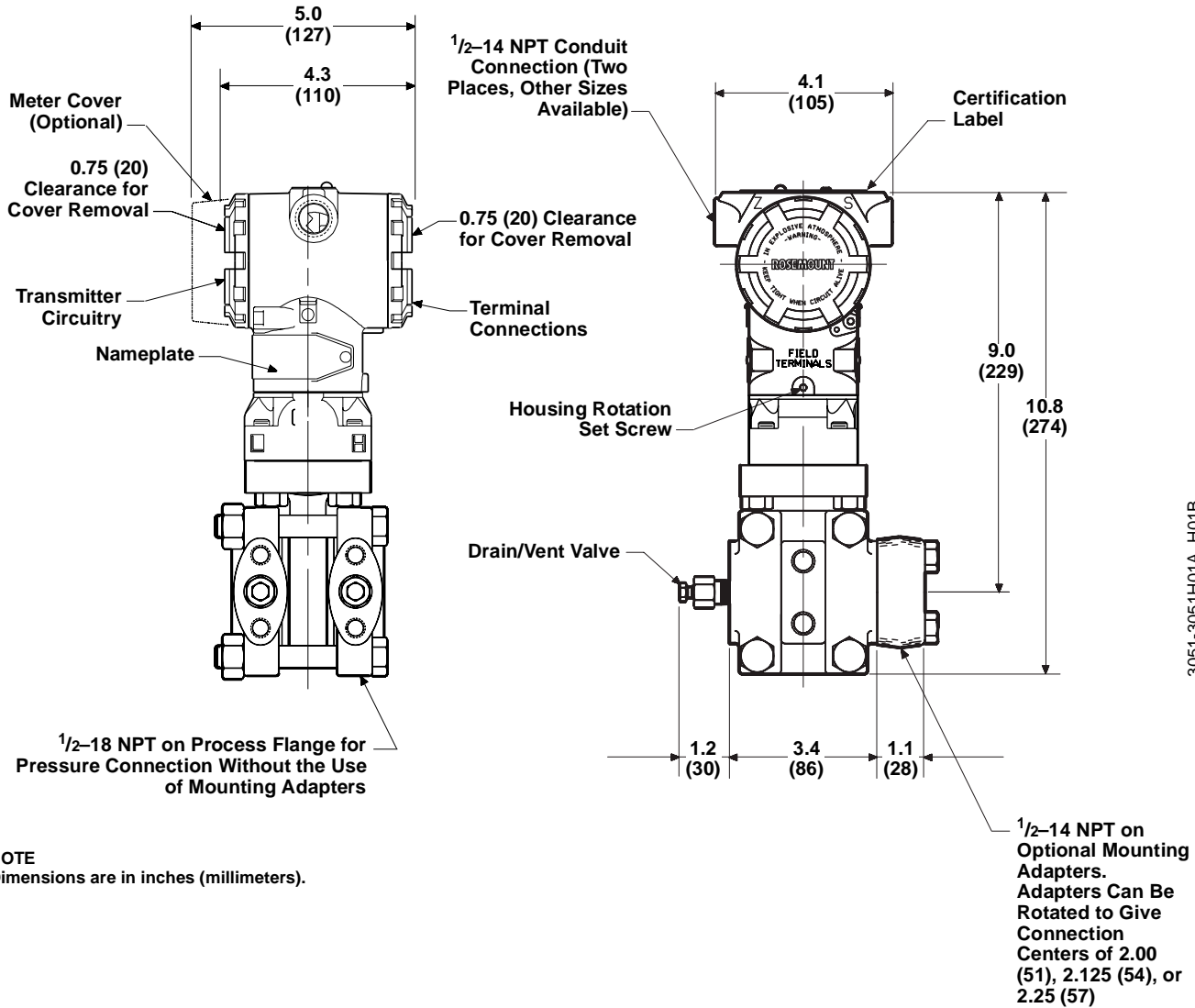


FIGURE 3-5. Model 3051T Dimensional Drawings.



# Rosemount Model 3051 Smart Pressure Transmitters

FIGURE 3-6. Model 3051H  
Dimensional Drawings.



NOTE  
Dimensions are in inches (millimeters).

TABLE 3-1. Model 3051L Dimensional Specifications—*Except Where Noted, Dimensions Are in Inches (Millimeters).*

Class	Pipe Size	Flange Thickness	Bolt Diameter	Outside Diameter	No. of Bolts	Bolt Hole Diameter	Exten. Diam. (1)	O.D. Gask. Surf.	Lower Housing	
									Xmtr Side	Proc. Side
		A	B	C			D	E	F	G
ASME B 16.5 (ANSI) 150	2 (51)	1.12 (28)	4.75 (121)	6.0 (152)	4	0.75 (19)	NA	3.75 (95)	2.9 (74)	2.16 (55)
	3 (76)	1.31 (33)	6.0 (152)	7.5 (190)	4	0.75 (19)	2.58 (65)	5.0 (127)	3.11 (79)	3.11 (79)
	4 (102)	1.31 (33)	7.5 (190)	9.0 (228)	8	0.75 (19)	3.5 (89)	6.81 (173)	4.06 (103)	4.06 (103)
ASME B 16.5 (ANSI) 300	2 (51)	1.25 (32)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.75 (95)	2.9 (74)	2.16 (55)
	3 (76)	1.50 (38)	6.62 (168)	8.25 (209)	8	0.88 (22)	2.58 (65)	5.0 (127)	3.11 (79)	3.11 (79)
	4 (102)	1.62 (41)	7.88 (200)	10.0 (254)	8	0.88 (22)	3.5 (89)	6.81 (173)	4.06 (103)	4.06 (103)
ASME B 16.5 (ANSI) 600	2 (51)	1.12 (28)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.75 (95)	2.9 (74)	2.16 (55)
	3 (76)	1.37 (35)	6.62 (168)	6.62 (168)	8	0.88 (22)	2.58 (65)	5.0 (127)	3.11 (79)	3.11 (79)
DIN PN 10–40	DN 50	26 mm	125 mm	165 mm	4	18 mm	NA	95 mm	74 mm	55 mm
DIN PN 25/40	DN 80	30 mm	160 mm	200 mm	8	18 mm	65 mm	127 mm	79 mm	79 mm
	DN 100	30 mm	190 mm	235 mm	8	22 mm	89 mm	173 mm	103 mm	103 mm
DIN PN 10/16	DN 100	26 mm	180 mm	220 mm	8	18 mm	89 mm	173 mm	103 mm	103 mm

(1) Tolerances are 0.040 (1,02), -0.020 (0,51).

#### NOTE

Use this table in conjunction with Figure 3-7.

FIGURE 3-7. Model 3051L  
Dimensional Drawings.

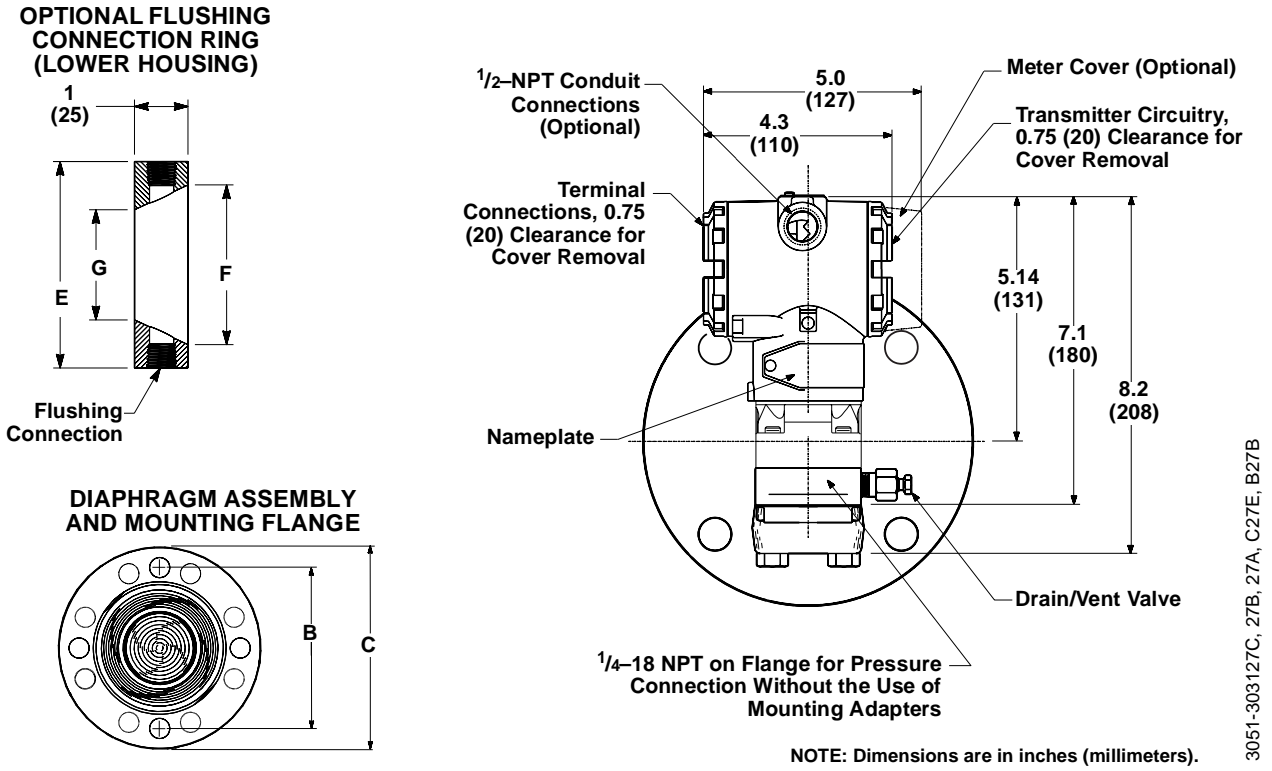
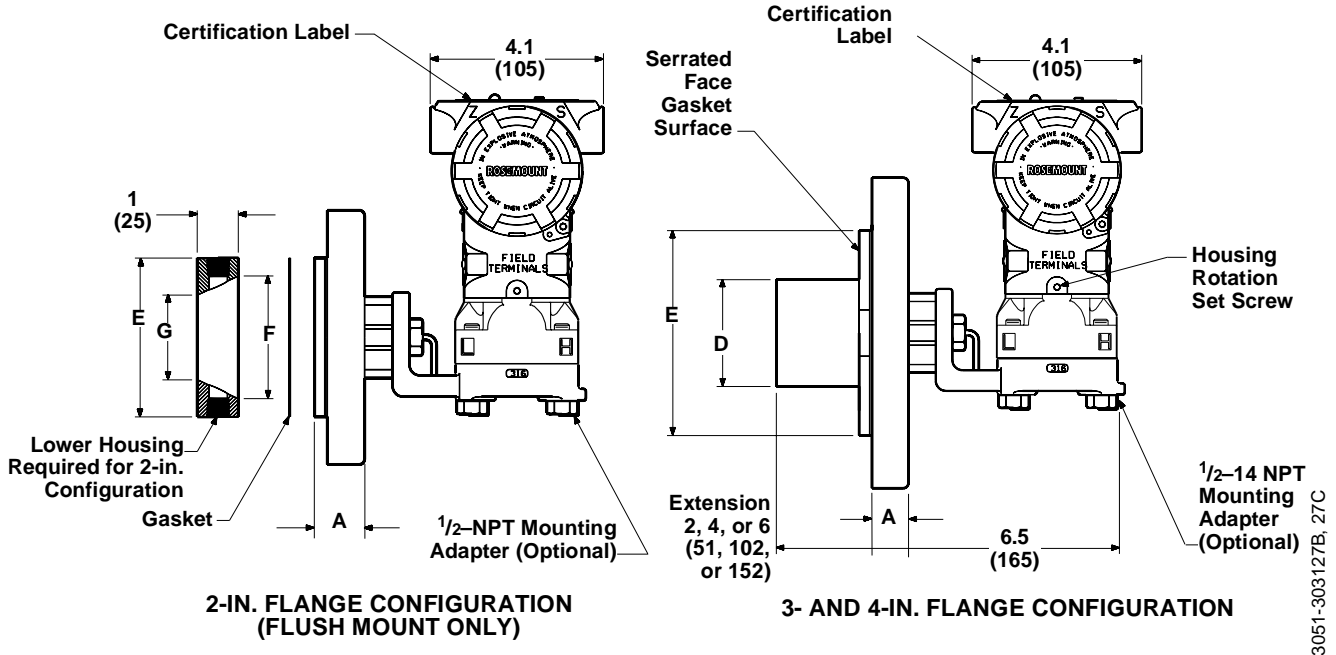
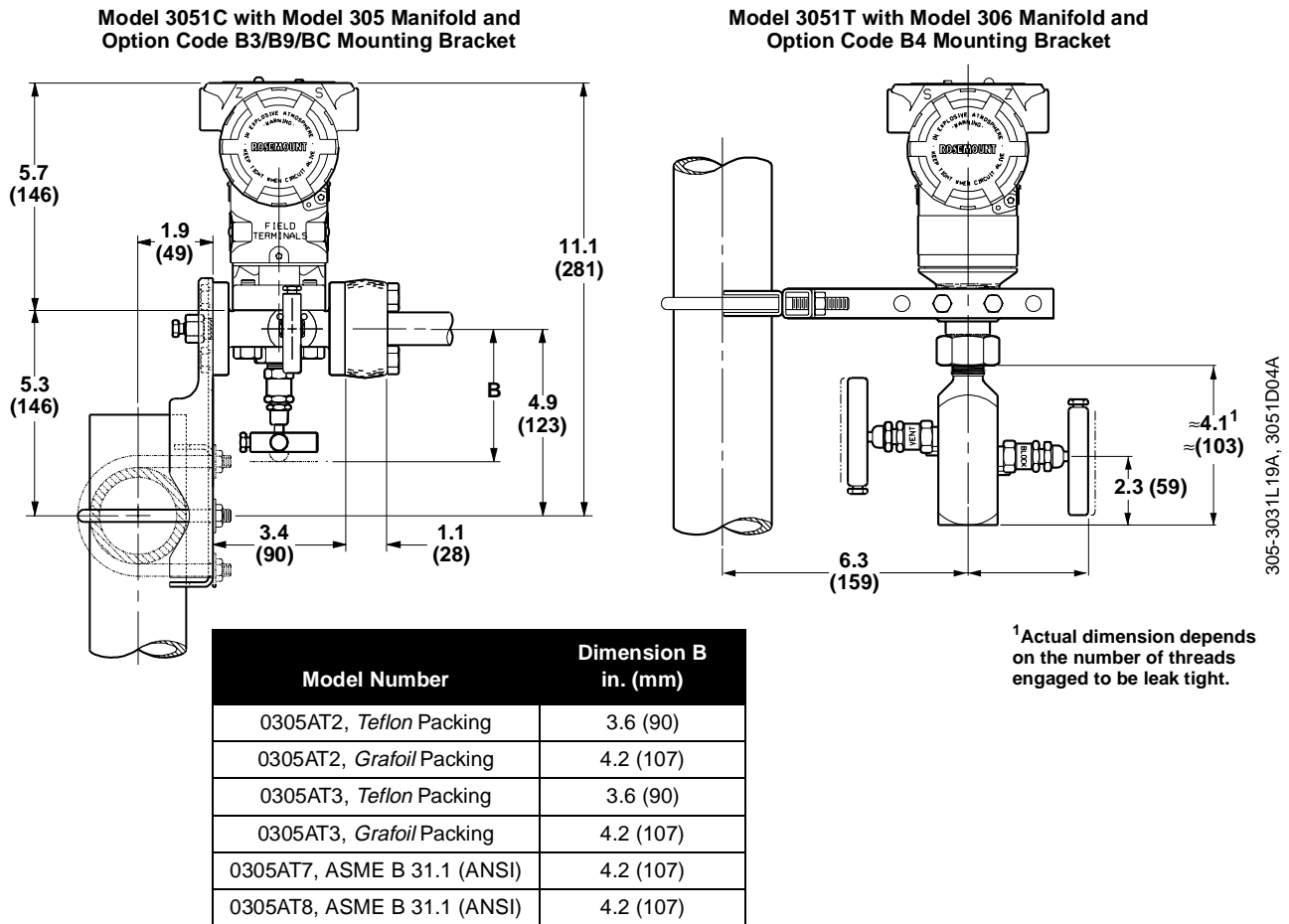


FIGURE 3-8. Typical Mounting Configurations for Model 3051 Transmitters with Model 305 and 305 Manifolds.



NOTE: Dimensions are in inches (millimeters).

## Mounting

The Model 3051C Pressure Transmitter weighs 5.7 lbs (2,6 kg) without additional options. Optional mounting brackets available with the Model 3051 allow mounting to a panel, wall, or 2-inch pipe. The B4 Bracket Option for use with the Coplanar flange and the Model 3051T is 316 SST with 316 SST bolts. Figures 3-10 and 3-11 on pages 3-14 and 3-15 show bracket dimensions and mounting configurations for the B4 Option.

Bracket options B1, B2, B3, B7, B8, and B9 are sturdy polyurethane painted carbon steel brackets designed for use in pipe or panel mounting the traditional flange (H2, H3, H4, or H7 option). The B1–B3 brackets have carbon steel bolts, while the B7–B9 brackets have stainless steel bolts. Bracket options BA and BC are stainless steel with stainless steel bolts. Dimensionally, these brackets are identical to the B1–B3 brackets used with the Rosemount Model 1151 Pressure Transmitter except for the length of the bolts used to mount the transmitter to the bracket. Bracket options B5/B6 are used for Model 3051H transmitters. These bracket styles facilitate multiple mounting configurations (see Figures 3-12 and 3-13 on page 3-16). When installing the transmitter to one of the mounting brackets, torque the bolts to 125 inch-pounds.



**NOTE**

The transmitter is calibrated in an upright position at the factory. If you mount the transmitter in any other position, the zero point will shift by an amount equivalent to the liquid head caused by the varied mounting position. To reset the zero point, refer to “Sensor Trim” on page 2-24.

---

**Mounting Requirements**

Refer to Figure 3-9 for examples of the following mounting configurations:

**Liquid Flow Measurement**

- Place taps to the side of the line to prevent sediment deposits on the transmitter’s process isolators.
- Mount the transmitter beside or below the taps so gases can vent into the process line.
- Mount drain/vent valve upward to allow gases to vent.

**Gas Flow Measurement**

- Place taps in the top or side of the line.
- Mount the transmitter beside or above the taps so liquid will drain into the process line.

**Steam Flow Measurement**

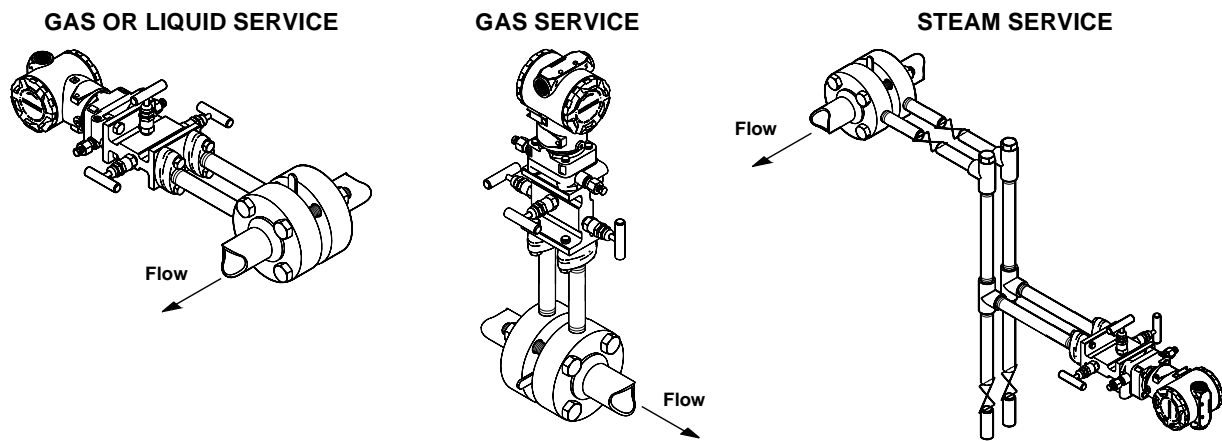
- Place taps to the side of the line.
- Mount the transmitter below the taps to ensure that the impulse piping will stay filled with condensate.
- Fill impulse lines with water to prevent the steam from contacting the transmitter directly and to ensure accurate measurement start-up.

**NOTE**

In steam or other elevated temperature services, it is important that temperatures at the coplanar process flanges not exceed 250 °F (121 °C) for transmitters with silicone fill or 185 °F (85 °C) for inert fill. In vacuum service, these temperature limits are reduced to 220 °F (104 °C) for silicone fill and 160 °F (71 °C) for inert fill. Models 3051L, 3051H, and the traditional flange allow higher temperatures.

---

FIGURE 3-9. Installation Examples.



3051-3031A03A, B03A, C03A

### Impulse Piping

The piping between the process and the transmitter must accurately transfer the pressure to obtain accurate measurements. There are five possible sources of error: pressure transfer, leaks, friction loss (particularly if purging is used), trapped gas in a liquid line, liquid in a gas line, and density variations between the legs.

The best location for the transmitter in relation to the process pipe depends on the process itself. Use the following guidelines to determine transmitter location and placement of impulse piping:

- Keep impulse piping as short as possible.
- For liquid service, slope the impulse piping at least 1 inch per foot (8 cm per m) upward from the transmitter toward the process connection.
- For gas service, slope the impulse piping at least 1 inch per foot (8 cm per m) downward from the transmitter toward the process connection.
- Avoid high points in liquid lines and low points in gas lines.
- Make sure both impulse legs are the same temperature.
- Use impulse piping large enough to avoid friction effects and blockage.
- Vent all gas from liquid piping legs.
- When using a sealing fluid, fill both piping legs to the same level.
- When purging, make the purge connection close to the process taps and purge through equal lengths of the same size pipe. Avoid purging through the transmitter.
- Keep corrosive or hot (above 250 °F [121 °C]) process material out of direct contact with the sensor module and flanges.
- Prevent sediment deposits in the impulse piping.
- Keep the liquid head balanced on both legs of the impulse piping.
- Avoid conditions that might allow process fluid to freeze within the process flange.

## Process Connections

Model 3051 process connections on the transmitter flange are 1/4–18 NPT. Flange adapter unions with 1/2–14 NPT connections are supplied as standard. The threads are Class 2; use your plant-approved lubricant or sealant when making the process connections. The process connections on the transmitter flange are on 2 1/8-inch (54 mm) centers to allow direct mounting to a three-valve or five-valve manifold. Rotate one or both of the flange adapters to attain connection centers of 2 inches (51 mm), 2 1/8 inches (54 mm), or 2 1/4 inches (57 mm). See page 3-12 for information on the Model 3051T process connection.

**⚠** Install and tighten all four flange bolts before applying pressure, or process leakage will result. When properly installed, the flange bolts will protrude through the top of the module housing. Do not attempt to loosen or remove the flange bolts while the transmitter is in service.

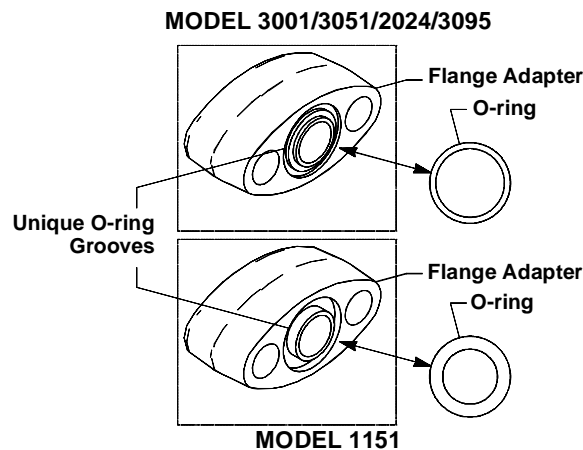
To install adapters to a Coplanar flange, perform the following procedure:

1. Remove the flange bolts.
2. Leaving the flange in place, move the adapters into position with the O-ring installed.
3. Clamp the adapters and the Coplanar flange to the transmitter module using the larger of the bolts supplied.
4. Tighten the bolts. Refer to “Mounting Bolts” on page 3-18 for torque specifications.

### **⚠ WARNING**

Failure to install proper flange adapter O-rings can cause process leaks, which can result in death or serious injury.

Each style of Rosemount flange adapters requires a unique O-ring, as shown below. Flange adapters are distinguished by their unique grooves.



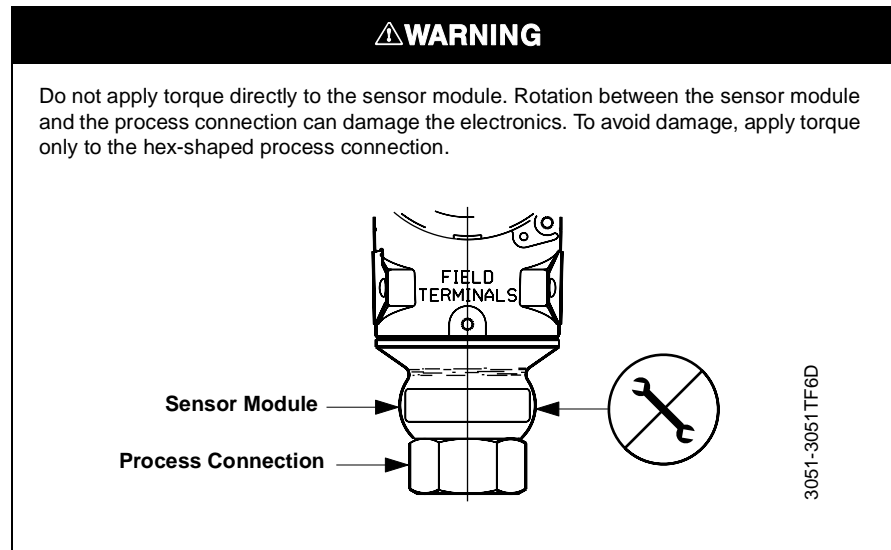
3051-0569A01A

Use only the O-ring designed to seal with an adapter. Refer to the Spare Parts list in Section 5: Specifications and Reference Data for the correct part numbers of the flange adapters and O-rings designed for Model 3051 transmitters.

**⚠** See “Safety Messages” on page 3-1 for complete warning information.

When compressed, Teflon® O-rings tend to cold flow, which aids in their sealing capabilities. Whenever you remove flanges or adapters, visually inspect the Teflon O-rings. Replace them if there are any signs of damage, such as nicks or cuts. If they are undamaged, you may reuse them. If you replace the O-rings, retorque the flange bolts after installation to compensate for cold flow. Refer to the process sensor body reassembly procedure in Section 4: Troubleshooting.

### Model 3051T Process Connection



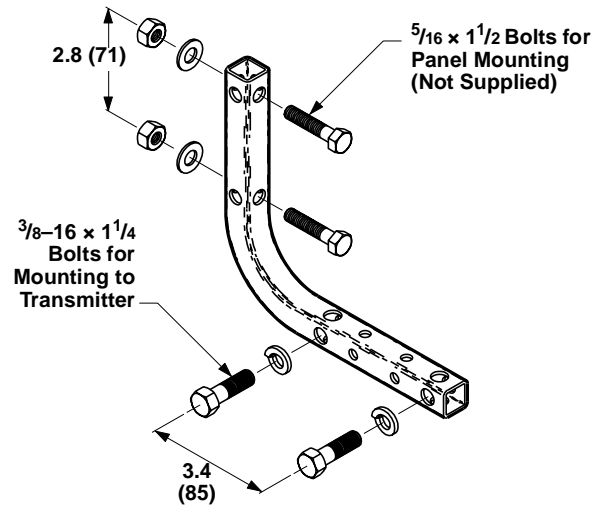
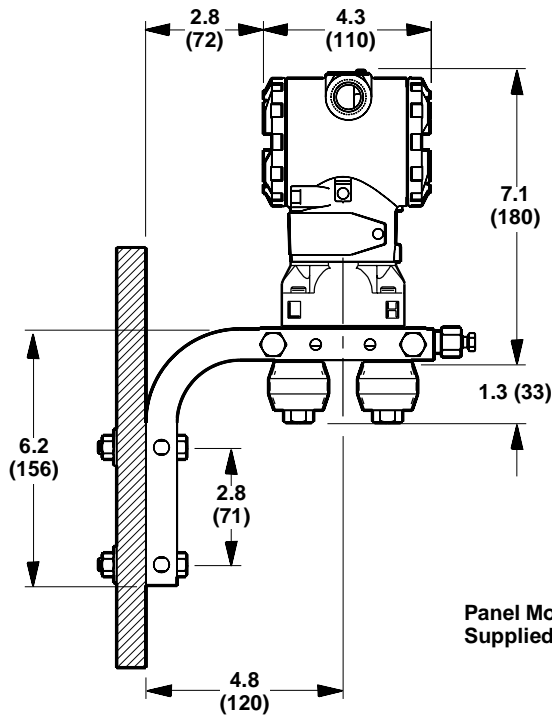
### Housing Rotation

The electronics housing can be rotated up to 180 degrees (left or right) to improve field access or to better view the optional LCD meter. To rotate the housing, perform the following procedure:

1. Loosen the housing rotation set screw using a  $\frac{9}{64}$ -in. hex wrench.
2. Turn the housing up to 180 degrees to the left or right of its original (as shipped) position. **Do not rotate the housing more than 180 degrees without first performing a disassembly procedure (see “Disassembly Procedures” on page 4-3). Over-rotation will sever the electrical connection between the sensor module and the electronics module.**
3. Retighten the housing rotation set screw.

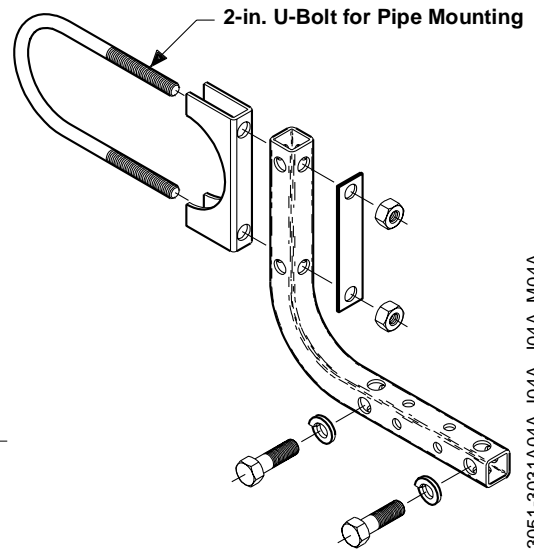
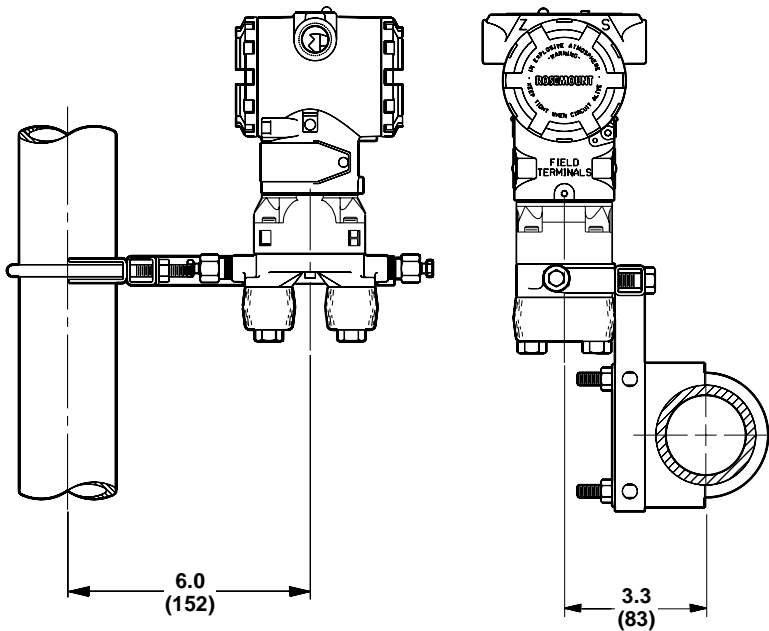
FIGURE 3-10. Coplanar Flange Mounting Configurations with Optional Bracket (B4) for 2-in. Pipe or Panel Mounting.

PANEL MOUNTING



Panel Mounting Configuration 3/8-16 x 1 1/4 Bolts (2) Supplied for Attaching Bracket to Transmitter

PIPE MOUNTING

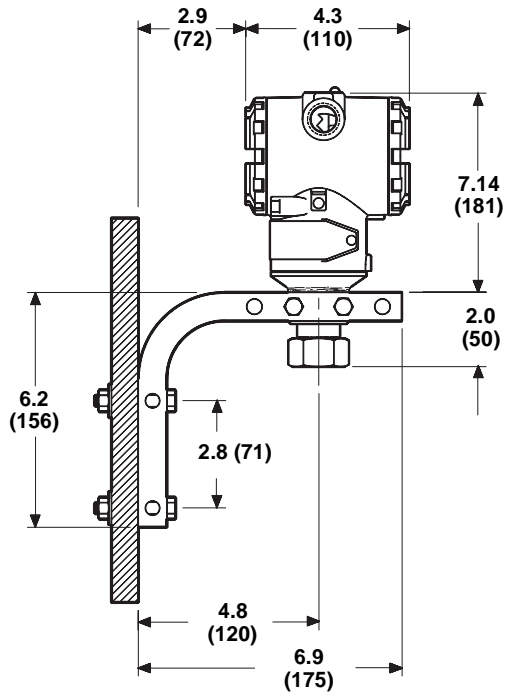


3051-3031A04A, I04A, J04A, M04A

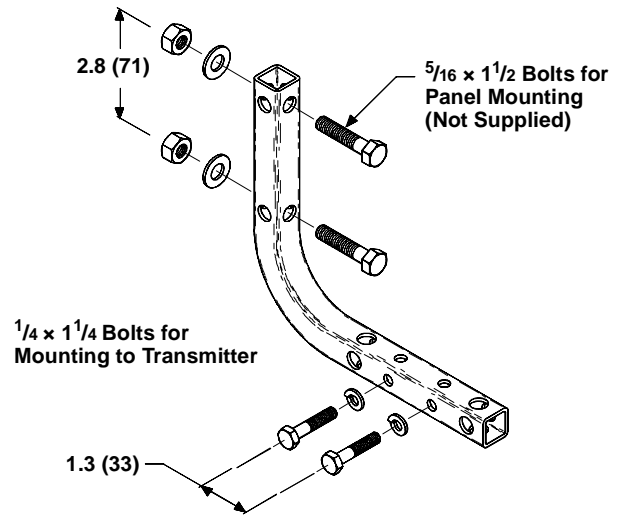
NOTE  
Dimensions are in inches (millimeters).

FIGURE 3-11. Model 3051T Mounting Configurations with Optional Bracket (B4) for 2-in. Pipe or Panel Mounting.

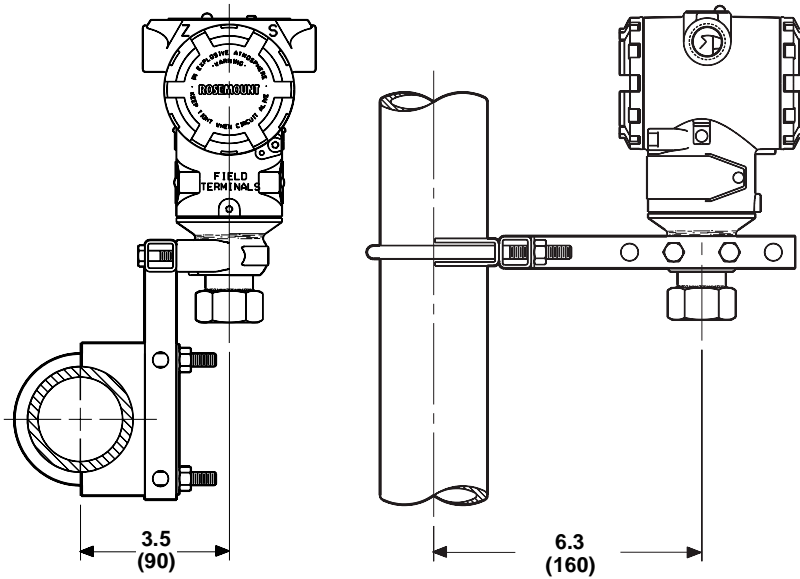
**PANEL MOUNTING**



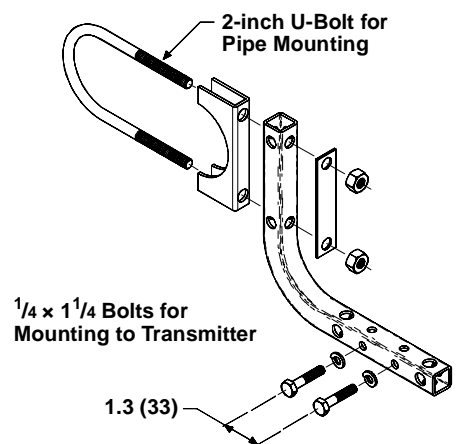
**PANEL MOUNTING BRACKET**



**PIPE MOUNTING**



**PIPE MOUNTING BRACKET**

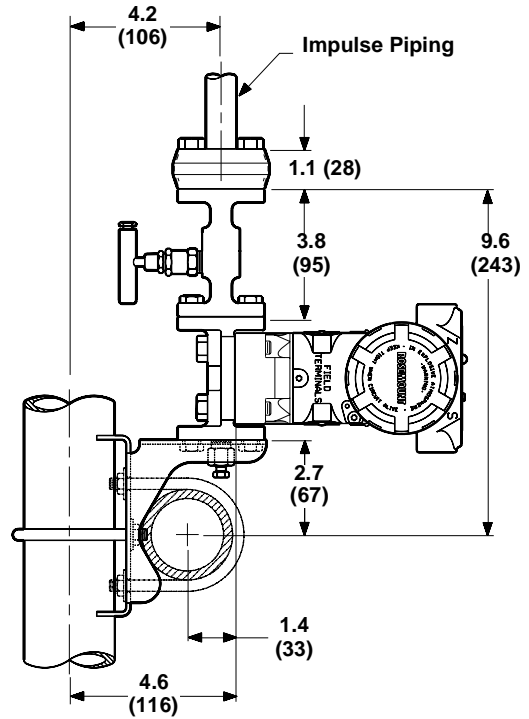
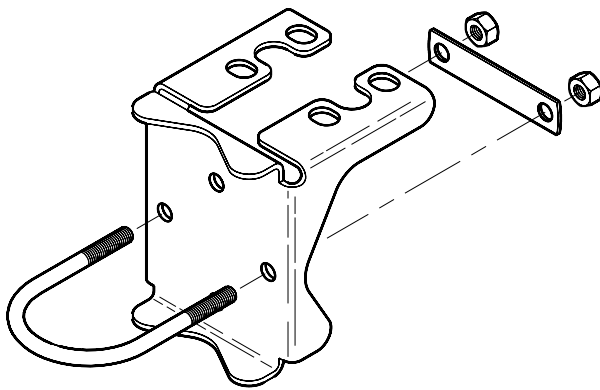


**NOTE**  
Dimensions are in inches (millimeters).

3051-3051TA4A, TB4A, TC4A, TD4A, TE4A

FIGURE 3-12. Optional Mounting Bracket for Traditional Flange Options B1/B7/BA.

OPTION B1/B7/BA: TRADITIONAL FLANGE 2-IN. PIPE MOUNTING BRACKET

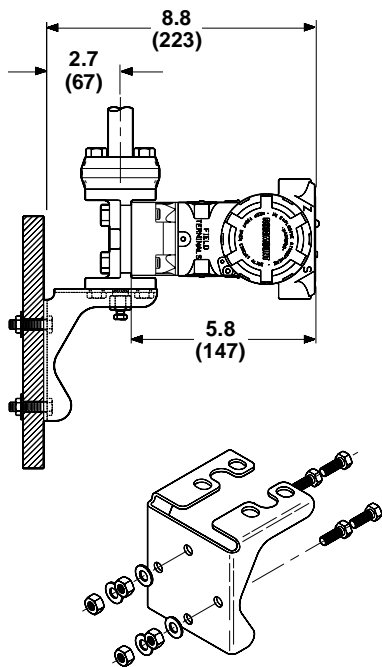


NOTE  
Dimensions are in inches (millimeters).

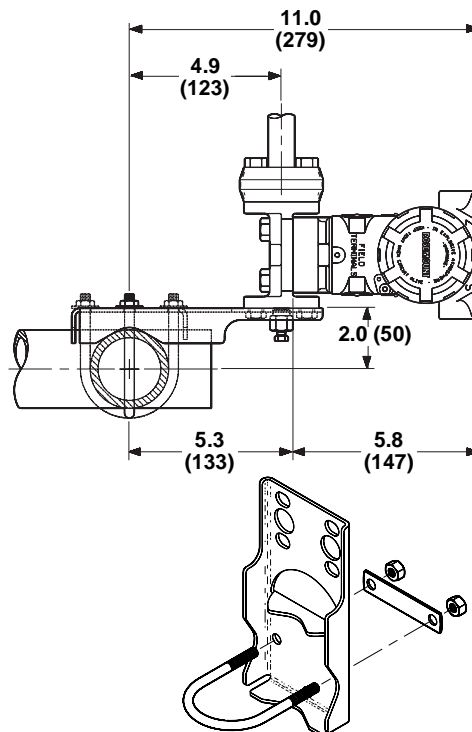
3051-3031C19A, I19A

FIGURE 3-13. Optional Mounting Brackets for Traditional Flange Options B2/B8, B3/B9/BC.

OPTION B2/B8: TRADITIONAL FLANGE PANEL MOUNTING BRACKET



OPTION B3/B9/BC: TRADITIONAL FLANGE

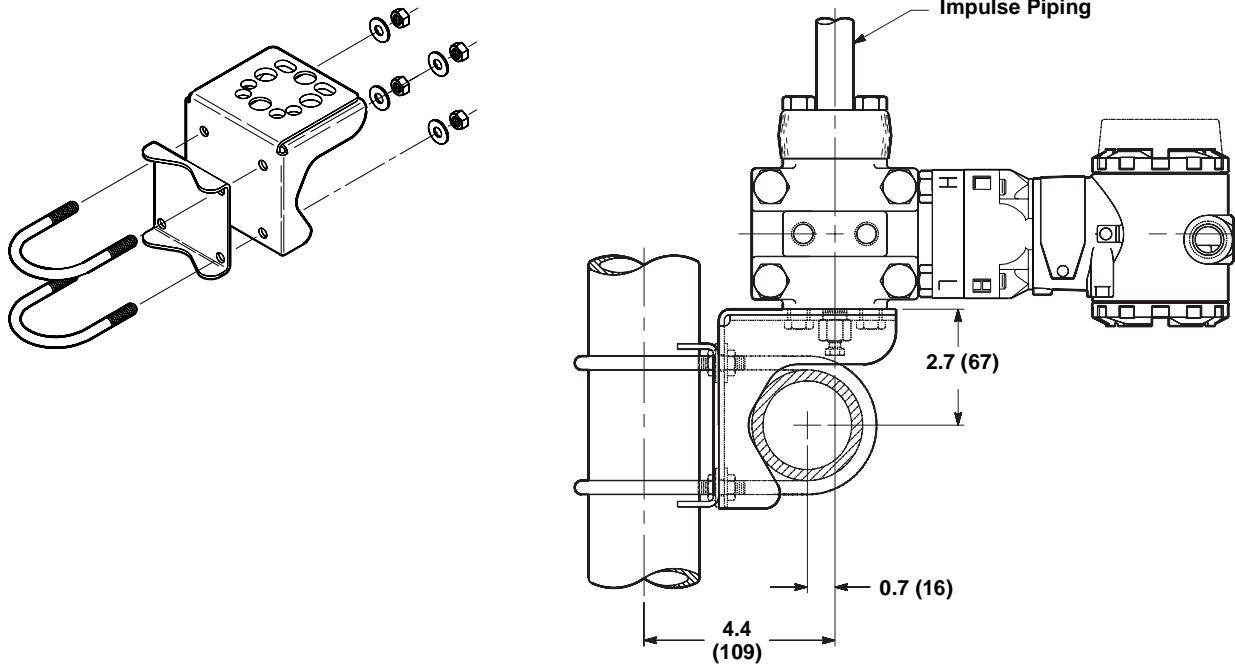


NOTE  
Dimensions are in inches (millimeters).

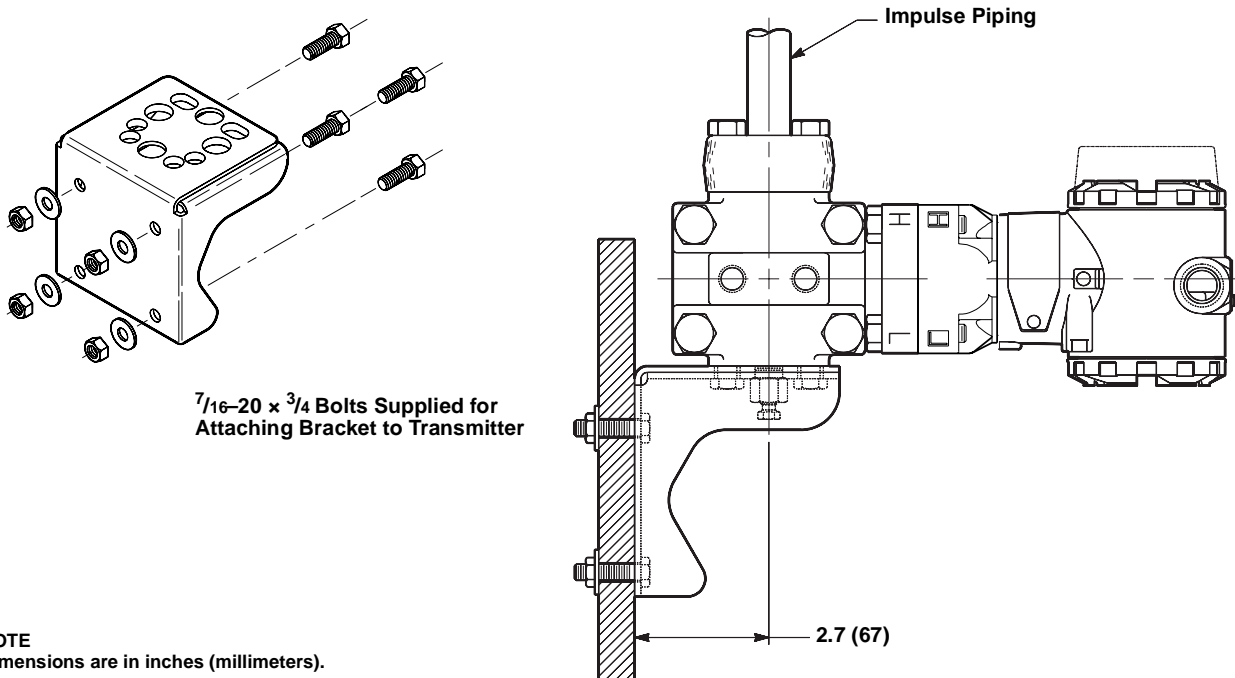
3051-3031E19B, H19A, J19D, J19E

FIGURE 3-14. Optional Mounting Bracket for 3051H Option Codes B5/B6.

2-IN. PIPE MOUNTING CONFIGURATION



PANEL MOUNTING CONFIGURATION



NOTE  
Dimensions are in inches (millimeters).

3051-3031F19B, G19A; 3051HA3A, HA3B



## Mounting Bolts

The following guidelines have been established to ensure a tight flange, adapter, or manifold seal. The Model 3051 is shipped with the Coplanar flange installed with four 1.75-inch flange bolts. The following bolts also are supplied to facilitate other mounting configurations:

### Differential Pressure

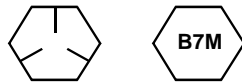
- Four 2.88-inch flange/adapter bolts for mounting the flange adapters to the Coplanar flange.
- Four 2.25-inch manifold/flange bolts for mounting the Coplanar flange on a three-valve manifold. In this configuration, the 1.75-inch bolts may be used to mount the flange adapters to the process connection side of the manifold.

### Gage/Absolute Pressure

- Two 2.88-inch flange/adapter bolts for mounting the flange adapters to the Coplanar flange.

Figures 3-15 and 3-16 on pages 3-19 and 3-20 show mounting bolts and bolting configurations. See page 6-11 for bolting requirements for alternate mounting configurations. Stainless steel bolts supplied by Rosemount Inc. are coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. No additional lubricant should be applied when installing either type of bolt. Bolts supplied by Rosemount Inc. are identified by their head markings:

#### Carbon Steel (CS) Head Markings




#### Stainless Steel (SST) Head Markings



\* The last digit in the F593\_ head marking may be any letter between A and M.

## Bolt Installation

 Only use bolts supplied with the Model 3051 or sold by Rosemount Inc. as spare parts for the Model 3051 transmitter. Use the following bolt installation procedure:

1. Finger-tighten the bolts.
2. Torque the bolts to the initial torque value using a crossing pattern (see Table 3-2 for torque values).
3. Torque the bolts to the final torque value using the same crossing pattern.

TABLE 3-2. Bolt Installation Torque Values.

Bolt Material	Initial Torque Value	Final Torque Value
CS-ASTM-A445 Standard	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
316 SST—Option L4	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)
ASTM-A-193-B7M—Option L5	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
<i>Monel</i> —Option L6	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)


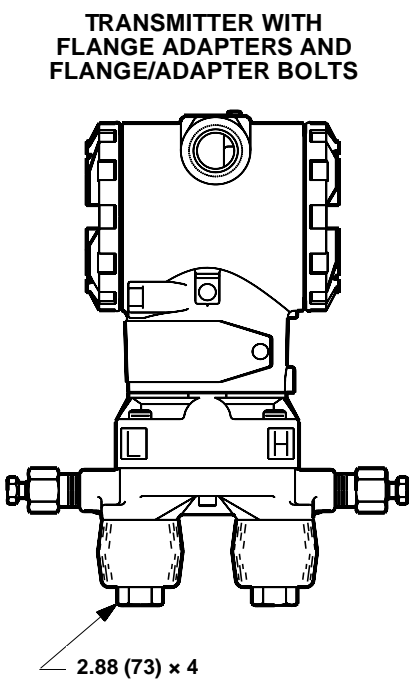
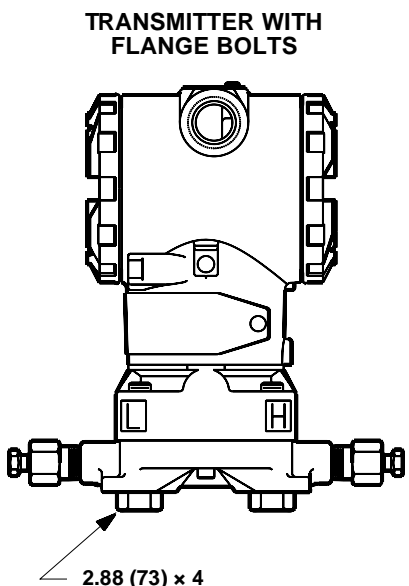
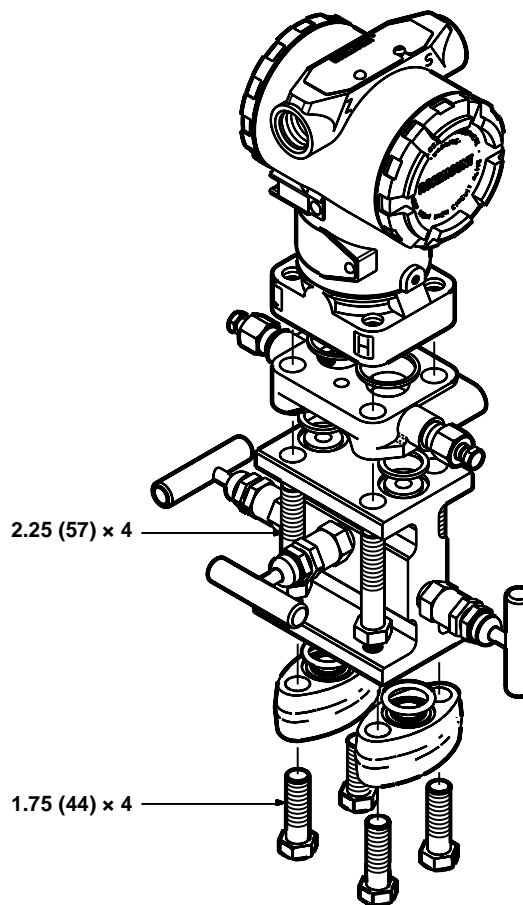
 See “Safety Messages” on page 3-1 for complete warning information.

FIGURE 3-15. Mounting Bolts and Bolt Configurations for Coplanar Flange.



**TRANSMITTER WITH 3-VALVE MANIFOLD  
MANIFOLD/FLANGE BOLTS  
FLANGE ADAPTERS  
AND FLANGE/ADAPTER BOLTS**  
(Differential Configuration Shown)



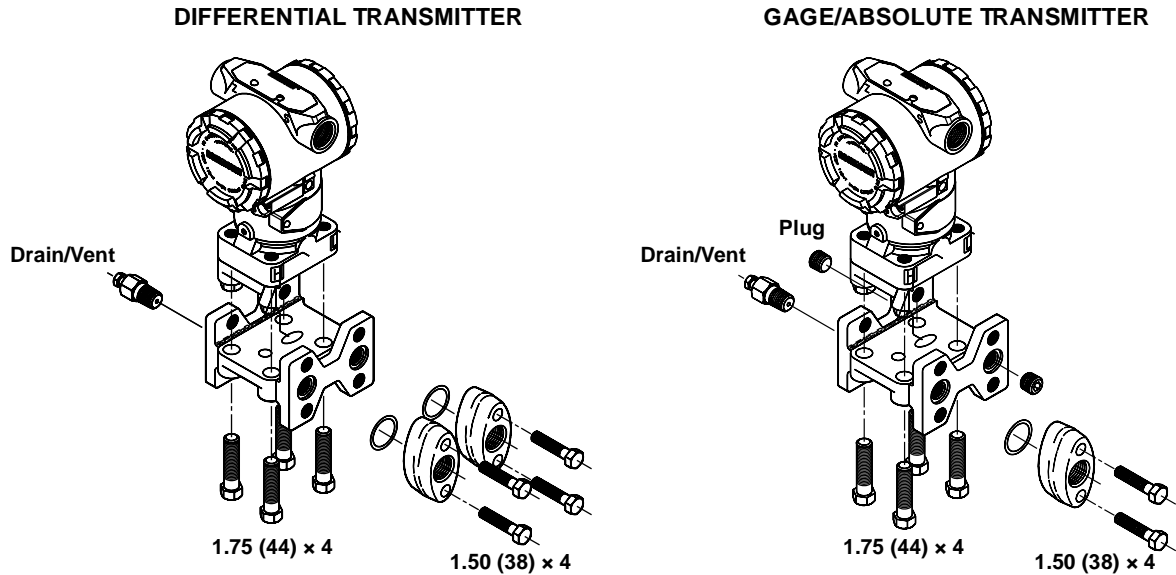
Description	Qty	Size in. (mm)
<b>Differential Pressure</b>		
Flange Bolts	4	1.75 (44)
Flange/Adapter Bolts	4	2.88 (73)
Manifold/Flange Bolts	4	2.25 (57)
<b>Gage/Absolute Pressure <sup>(1)</sup></b>		
Flange Bolts	4	1.74 (44)
Flange/Adapter Bolts	2	2.88 (73)

**NOTE**  
Dimensions are in inches (millimeters).

<sup>(1)</sup> Model 3051 T transmitters are direct mount and do not require bolts for process connection.

3051-3031E06FD E06F; 305-3031A29P

FIGURE 3-16. Traditional Flange Bolt Configurations.



3051-3031B07G, B07I

**NOTE**  
Dimensions are in inches (millimeters).

## ELECTRICAL CONSIDERATIONS

The transmitter terminal block is in the compartment of the electronics housing labeled “FIELD TERMINALS.” The other compartment contains the transmitter electronics module. Connections for the HART-based communicator are attached beneath the terminal screws on the terminal block. You can connect the Rosemount Model 272 Field Calibrator at the signal terminals to provide power to the transmitter temporarily for calibration or diagnostic purposes. Or you can attach it to the test connections on the terminal block of the transmitter for indication purposes. Figure 3-17 shows power supply load limitations for the transmitter.

### Power Supply

#### 4–20 mA Transmitters

The dc power supply should provide power with less than 2 percent ripple. The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, and related pieces. Note that the resistance of intrinsic safety barriers, if used, must be included.

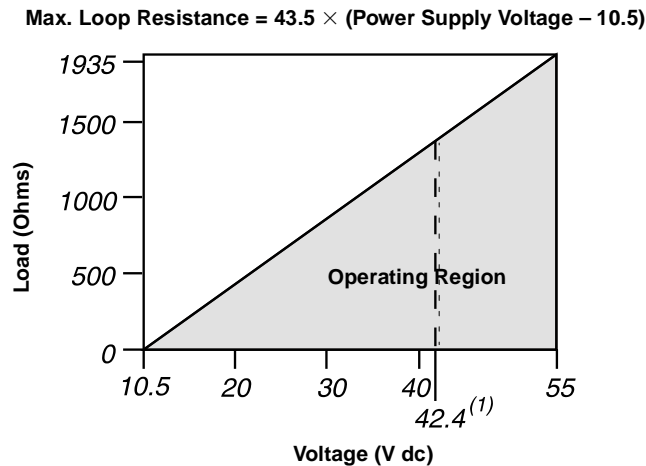
#### NOTE

A minimum loop resistance of 250 ohms is required to communicate with a HART-based communicator. With 250 ohms of loop resistance, the transmitter will require a minimum of 16 volts to output 20 mA. If a single power supply is used to power more than one Model 3051 transmitter, the power supply used, and circuitry common to the transmitters, should not have more than 20 ohms of impedance at 1200 Hz.

#### Low Power Transmitters

Low-power transmitters require a 6–12 V dc external power supply.

FIGURE 3-17. Power Supply Load Limitations, 4–20 mA Transmitters.





3051-0103A

Communication requires a minimum loop resistance of 250 ohms.

*(1) For CSA approval, power supply must not exceed 42.4 V.*

## Wiring


To make connections, perform the following procedure:

-  1. Remove the housing cover on the side marked “FIELD TERMINALS.” Do not remove the cover in explosive atmospheres when the circuit is alive. All power to the transmitter is supplied over the signal wiring.
-  2. Connect the lead that originates at the positive side of the power supply to the terminal marked “+” and the lead that originates from the negative side of the power supply to the terminal marked “-”. Avoid contact with the leads and terminals. Do not connect the powered signal wiring to the test terminals. Power could damage the test diode in the test connection.
3. Plug and seal unused conduit connections on the transmitter housing to avoid moisture accumulation in the terminal side of the housing. If you do not seal the unused connections, mount the transmitter with the electrical housing positioned downward for drainage. Install wiring with a drip loop. Arrange the drip loop so the bottom is lower than the conduit connections and the transmitter housing.

### NOTE

Signal wiring needs to be shielded, but use twisted pairs for best results. In order to ensure proper communication, use 24 AWG or larger wire, and do not exceed 5000 feet (1 500 meters).

Inductive-based transient protectors, including the Rosemount Model 470, can adversely affect the output of Model 3051 4–20 mA transmitters. Do not use the Model 470 for transient protection with the Model 3051. If your application requires transient protection, install the Transient Protection Terminal Block (see “Transient Protection Terminal Block (T1)” on page 6-12).

 See “Safety Messages” on page 3-1 for complete warning information.

**Signal Wiring Grounding**

Do not run signal wiring in conduit or open trays with power wiring, or near heavy electrical equipment. You may ground the signal wiring at any one point on the signal loop, or leave it ungrounded. The negative terminal of the power supply is a recommended grounding point.

**HAZARDOUS LOCATIONS**

The Model 3051 has an explosion-proof housing and circuitry suitable for intrinsically safe and non-incendive operation. Individual transmitters are clearly marked with a tag indicating the certifications they carry. See Section 5 Specifications and Reference Data for specific approval categories, and see Appendix C Approval Drawings for installation drawings.

---


**IMPORTANT NOTE**

Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

---

**Grounding the Transmitter Case**

The transmitter case should always be grounded in accordance with national and local electrical codes. The most effective transmitter case grounding method is direct connection to earth ground with minimal impedance. Methods for grounding the transmitter case include:

- **Internal Ground Connection:** The Internal Ground Connection screw is inside the FIELD TERMINALS side of the electronics housing. This screw is identified by a ground symbol () and is standard on all Model 3051 transmitters.
- **External Ground Assembly:** This assembly is included with the optional transient protection terminal block (Option Code T1), and it is included with CESI/CENELEC Flameproof Certification (Option Code E8), BASEEFA/CENELEC Intrinsic Safety Certification (Option Code I1), and BASEEFA Type N Certification (Option Code N1). The External Ground Assembly can also be ordered with the transmitter (Option Code V5), or as a spare part (03031-0398-0001).

---

**NOTE**

Grounding the transmitter case using the threaded conduit connection may not provide a sufficient ground. The transient protection terminal block (Option Code T1) does not provide transient protection unless the transmitter case is properly grounded. Use the above guidelines to ground the transmitter case. Do not run the transient protection ground wire with signal wiring as the ground wire may carry excessive current if a lightning strike occurs.

---

---

## ENVIRONMENTAL CONSIDERATIONS

The following guidelines can help optimize transmitter performance. Mount the transmitter to minimize ambient temperature changes, vibration, mechanical shock, and to avoid external contact with corrosive materials. Section 5: Specifications and Reference Data lists the transmitter temperature operating limits.

### Access Requirements

When choosing an installation location and position, take into account the need for access to the transmitter.

### Process Flange Orientation

Mount the process flanges with sufficient clearance for process connections. For safety reasons, place the drain/vent valves so the process fluid is directed away from technicians when the vents are used. In addition, consider the possible need for a testing or calibration input.

### Housing Rotation

See “Housing Rotation” on page 3-13.

### Terminal Side of Electronics Housing

Mount the transmitter so that the terminal side is accessible. A 0.75-inch (19 mm) clearance is required for cover removal. Use a conduit plug on the unused side of the conduit opening.

### Circuit Side of Electronics Housing

Provide 0.75 inches (19 mm) clearance if possible for cover removal. Three inches of clearance is required for cover removal if a meter is installed.

### Exterior of Electronics Housing

The integral span and zero adjustments are located under the certifications plate on the top of the transmitter. Allow a minimum of 1.0 inch of clearance above the transmitter if you intend to use the integral zero and span adjustments.

### Cover Installation

Always install the electronics housing covers metal-to-metal to ensure a proper seal.



# Troubleshooting

## OVERVIEW

Table 4-1 provides summarized troubleshooting suggestions for the most common operating problems.

If you suspect a malfunction despite the absence of any diagnostic messages on the communicator display, follow the procedures described here to verify that transmitter hardware and process connections are in good working order. Always deal with the most likely and easiest-to-check conditions first.

## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

### Warnings (⚠)

#### ⚠ WARNING

##### **Explosions can result in death or serious injury.**

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure that the instruments in the loop are installed according to intrinsically safe or nonincendive field wiring practices.

#### ⚠ CAUTION

##### **Static electricity can damage sensitive components.**

- Observe safe handling precautions for static-sensitive components.



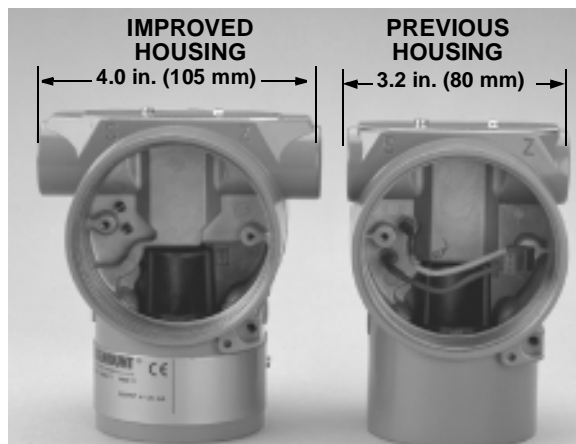
TABLE 4-1. Model 3051 Troubleshooting Chart.

Symptom	Corrective Actions
Milliamp Reading Is Zero	<ul style="list-style-type: none"> <li>• Check if power polarity is reversed.</li> <li>• Verify voltage across terminals (should be 10 to 55 V dc).</li> <li>• Check for bad diode in terminal block.</li> <li>• Replace transmitter terminal block.</li> </ul>
Transmitter Not Communicating with HART Communicator	<ul style="list-style-type: none"> <li>• Check power supply voltage at transmitter (minimum 10.5 V).</li> <li>• Verify calibration settings (4 and 20 mA points)</li> <li>• Check load resistance (250 Ω minimum).</li> <li>• Check if unit is addressed properly.</li> <li>• Replace electronics board.</li> </ul>
Milliamp Reading Is Low or High	<ul style="list-style-type: none"> <li>• Check pressure variable reading for saturation.</li> <li>• Check if output in alarm condition.</li> <li>• Verify 4 and 20 mA range points.</li> <li>• Perform 4–20 mA output trim.</li> <li>• Replace electronics board.</li> </ul>
No Response to Changes in Applied Pressure	<ul style="list-style-type: none"> <li>• Check test equipment.</li> <li>• Check impulse piping for blockage.</li> <li>• Check disabled span adjustment.</li> <li>• Check if output in alarm condition.</li> <li>• Replace sensor module.</li> </ul>
Pressure Variable Reading Is Low or High	<ul style="list-style-type: none"> <li>• Check impulse piping for blockage.</li> <li>• Check test equipment.</li> <li>• Perform full sensor trim.</li> <li>• Replace sensor module.</li> </ul>
Pressure Variable Reading Is Erratic	<ul style="list-style-type: none"> <li>• Check impulse piping for blockage.</li> <li>• Check damping.</li> <li>• Check for EMF interference.</li> <li>• Replace sensor module.</li> </ul>

**BEFORE DISASSEMBLING THE TRANSMITTER**

Maintenance procedures differ for improved and previous style transmitter housings. Verify the specific physical characteristics of your transmitter before you begin any maintenance procedures. The width of the conduit entries is the most noticeable physical difference between the improved and the previous style housing (see Figure 4-1).

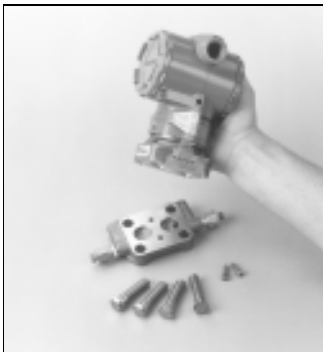
FIGURE 4-1. Improved and Previous Styles of the Model 3051 Transmitter Housing.



3051\_063AB

## DISASSEMBLY PROCEDURES

### Remove the Transmitter from Service



**⚠** Do not remove the instrument cover in explosive atmospheres when the circuit is alive.

---

#### NOTE

Once you have determined a transmitter to be inoperable, remove it from service.

---

Be aware of the following:

- Isolate and vent the process from the transmitter before removing the transmitter from service.
- Remove all electrical leads and conduit.
- Detach the process flange by removing the four flange bolts and the two alignment screws that secure it.
- Do not scratch, puncture, or depress the isolating diaphragms.
- Clean isolating diaphragms with a soft rag and a mild cleaning solution, and rinse with clear water.
- Whenever you remove the process flange or flange adapters, visually inspect the Teflon O-rings. Replace the O-rings if they show any signs of damage, such as nicks or cuts. If they are undamaged, you may reuse them.

The Model 3051C transmitter is attached to the process connection by four bolts and two cap screws. Remove the four bolts and separate the transmitter from the process connection manifold or flange. You can leave the process connection in place and ready for re-installation.

The Model 3051T is attached to the process by a single hex nut process connection. Loosen the hex nut to separate the transmitter from the process.

### Remove the Terminal Block

Electrical connections are located on the terminal block in the compartment labelled “FIELD TERMINALS.”

Loosen the two small screws located at the 9 o'clock and 4 o'clock positions, and pull the entire terminal block out to remove it.

---

#### NOTE

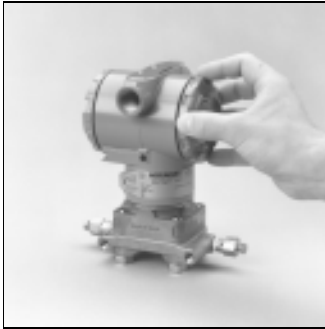
If removing the terminal block from the housing of a previous version of the transmitter, you will have to manually disconnect the power leads from the rear of the terminal block before completely separating it from the housing.

---

## Remove the Electronics Board

The transmitter electronics board is located in the compartment opposite the terminal side. To remove the electronics board perform the following procedure:

1. Remove the housing cover opposite the field terminal side.



2. Loosen the two captive screws that anchor the board to the housing. The electronics board is electrostatically sensitive; observe handling precautions for static-sensitive components.

---

### NOTE

If you are disassembling a transmitter with a LCD meter, loosen the two captive screws that are visible on the right and left side of the meter display. The two screws anchor the LCD meter to the electronics board and the electronics board to the housing.

---

3. Slowly pull the electronics board out of the housing. With the two captive screws free of the transmitter housing, only the sensor module ribbon cable holds the board to the housing.

---

### NOTE

Previous versions of the electronics board utilize a snap-in power plug and receptacle. Carefully unsnap the power plug from the receptacle to free the board from the power cord.

---



4. Disconnect the sensor module ribbon cable to release the electronics board from the transmitter.



See "Safety Messages" on page 4-1 for complete warning information.

## Remove the Sensor Module from the Electronics Housing

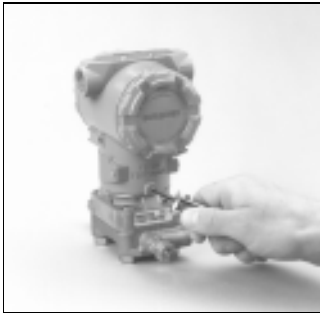


3051-057AB

1. Carefully tuck the cable connector completely inside of the internal shroud.

### NOTE

Do not remove the housing until after you tuck the cable connector completely inside of the internal shroud. The shroud protects the cable from damage that can occur when you rotate the housing.

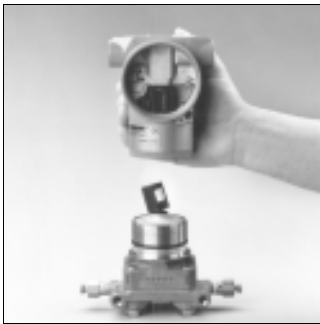


3051-059AB

2. Loosen the housing rotation set screw with a  $\frac{9}{64}$ -inch hex wrench, and back off one full turn.

### IMPORTANT

To prevent damage to the sensor module ribbon cable, disconnect it from the electronics board before you remove the sensor module from the electrical housing.



3051-060AB

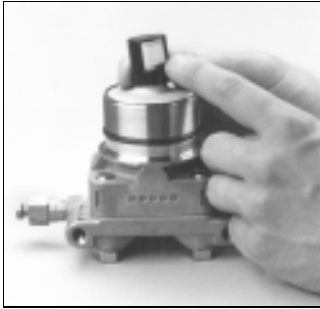
3. Unscrew the housing from the module, making sure the shroud and sensor cable do not catch on the housing.

### IMPORTANT

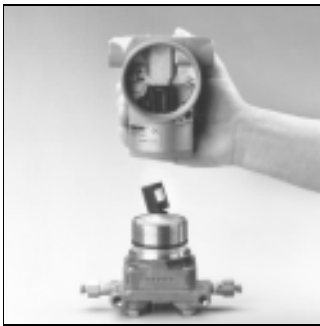
Make sure the sensor ribbon cable and internal shroud remain completely free of the housing as you rotate it. Damage can occur to the cable if the internal shroud and sensor cable become hung up and rotate with the housing.

## REASSEMBLY PROCEDURES

### Attach the Sensor Module to the Electronics Housing



3051-062AB



3051-060AB

1. Inspect all cover and housing (non-process wetted) O-rings and replace if necessary. Lightly grease with silicone lubricant to ensure a good seal.
2. Carefully tuck the cable connector completely inside the internal shroud. To do so, turn the shroud and cable counterclockwise one rotation to tighten the cable.

3. Lower the electronics housing onto the module. Guide the internal shroud and cable through the housing and into the external shroud.

4. Turn the housing clockwise to fasten it to the module.

---

#### IMPORTANT

To prevent damage to the cable connector, watch the cable and shroud as you attach the housing to the module. Make sure the cable connector does not slip out of the internal shroud and begin to rotate with the housing. Reinsert the cable connector into the shroud if it escapes before the housing is fully fastened.

---



5. Thread the housing completely onto the sensor module. The housing must be no more than one full turn from flush with the sensor module to comply with explosionproof requirements.

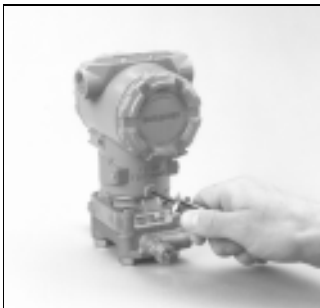
6. Tighten the housing rotation set screw using a  $\frac{9}{64}$ -inch hex wrench.

---

#### NOTE

Electronics board revision 5.3.163 or later (all shrouded designs) are able to verify alarm current levels. After replacing the transmitter electronics board, sensor module, or LCD meter, an alarm level test is recommended before returning the transmitter to service (see "Alarm Level Verification" on page 2-3).

---



3051-059AB



See "Safety Messages" on page 4-1 for complete warning information.

---

## Attach the Electronics Board



3051-056AB

1. Remove the cable connector from its position inside of the internal shroud and attach it to the electronics board.

2. Insert the electronics board into the housing, making sure that the posts from the electronics housing properly engage the receptacles on the electronics board.

---

### NOTE

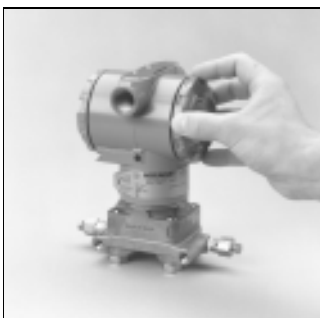
If you are reassembling a previous version of the electronics board (or placing a new version of the electronics board in a previous version of the housing), attach the snap-in power connection to the receptacle on the board with the black and red wires routed toward the center of the board and below the white reed switch holder.

---



3051-054AB

3. Tighten the captive mounting screws.



3051-053AB



4. Replace the electronics housing cover. The transmitter covers must be engaged metal-to-metal to ensure a proper seal and to meet explosionproof requirements.

---

### NOTE

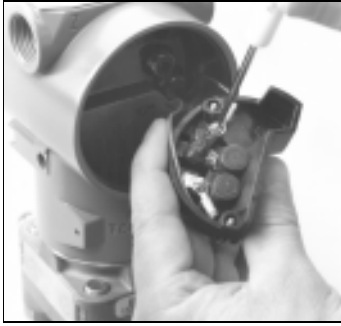
Electronics board revision 5.3.163 or later (all shrouded designs) are able to verify alarm current levels. After replacing the transmitter electronics board, sensor module, or LCD meter, an alarm level test is recommended before returning the transmitter to service (see "Alarm Level Verification" on page 2-3).

---



See "Safety Messages" on page 4-1 for complete warning information.

## Install the Terminal Block



3051-068AB

## Reassemble the Process Sensor Body

Gently slide the terminal block into place, making sure the posts from the electronics housing properly engage the receptacles on the terminal block. Tighten the captive screws and replace the electronics housing cover. The transmitter covers must be fully engaged to meet explosionproof requirements.

---

### NOTE

If you are reassembling a previous version of the terminal block, attach the black and red wires to the back side of the block before you insert it into the electronics housing.

---

1. Visually inspect the Teflon sensor module O-rings. If the O-rings are undamaged, you may reuse them. If the O-rings show signs of damage, such as nicks or cuts, or if there is any doubt about their ability to seal properly, replace them with new O-rings.

---

### NOTE

If you are replacing the O-rings, be careful not to scratch the O-ring grooves or the surface of the isolating diaphragm when removing the damaged O-rings.

---

2. Install the process flange on the sensor module. To hold the process flange in place, install the two hex head alignment screws. These screws are not pressure retaining and need only be finger tight. Do not overtighten; this will affect the module/flange alignment.
3. Install the appropriate flange bolts.
  - a. **IF** the installation requires a 1/4-18 NPT mounting, **THEN** use four 1.75-inch flange bolts. Go to **step f**.
  - b. **IF** the installation requires a 1/2-14 NPT mounting, **THEN** use four 2.88-inch process flange/adaptor bolts. **EXCEPTION:** For gage pressure configurations, use two 2.88-inch bolts and two 1.75-inch bolts. Go to **step d**.
  - c. **IF** the installation uses a three-valve manifold (differential pressure applications only), **THEN** use four 2.25-inch manifold flange bolts. Go to **step e**.
  - d. Hold the flange adapters and adapter O-rings in place while finger-tightening the bolts. Go to **step g**.
  - e. Align the process flange with the three-valve manifold.
  - f. Finger tighten the bolts.
  - g. Tighten the bolts to the initial torque value using a crossed pattern. See Table 4-2 for appropriate torque values.
  - h. Tighten the bolts to the final torque value using a crossed pattern. See Table 4-2 for appropriate torque values. When fully tightened, the bolts should extend through the top of the module housing.
  - i. If the installation uses a three-valve manifold, then install flange adapters on the process end of the manifold using the 1.75-inch flange bolts supplied with the transmitter.

TABLE 4-2. Bolt Installation Torque Values.

Bolt Material	Initial Torque Value	Final Torque Value
CS-ASTM-A445 Standard	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
316 SST—Option L4	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)
ASTM-A-193-B7M—Option L5	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
<i>Monel</i> —Option L6	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)

4. **IF** you replaced the Teflon sensor module O-rings, **THEN** re-torque the flange bolts after installation to compensate for cold flow.
5. Install the drain/vent valve.
  - a. Apply sealing tape to the threads on the seat. Starting at the base of the valve with the threaded end pointing toward the installer, apply two clockwise turns of the sealing tape.
  - b. Take care to place the opening on the valve so that process fluid will drain toward the ground and away from personnel when the valve is opened.
  - c. Tighten the drain/vent valve to 250 in.-lb (28.25 N-m).

**NOTE**

After replacing O-rings on Range 1 transmitters and re-installing the process flange, expose the transmitter to a temperature of 185 °F (85 °C) for two hours. Then re-tighten the flange bolts in a cross pattern, and again expose the transmitter to a temperature of 185 °F (85 °C) for two hours before calibration.

**Returning Rosemount Products and Materials**

To expedite the return process outside of the United States, contact the nearest Rosemount representative.

Within the United States, call the Rosemount National Response Center using the 1-800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the process material to which the product was last exposed.

<b>⚠ CAUTION</b>
<p>Individuals who handle products exposed to a hazardous substance can avoid injury if they are informed of and understand the hazard. If the product being returned was exposed to a hazardous substance as defined by OSHA, a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.</p>

Rosemount National Response Center representatives will explain the additional information and procedures necessary to return goods exposed to hazardous substances.





## Specifications and Reference Data

### PERFORMANCE SPECIFICATIONS

*Total Performance is based on combined errors of reference accuracy, ambient temperature effect, and static pressure effect.*

*For detailed performance specifications, see page 5-2.*

#### Model 3051C (Ranges 2–5), Model 3051T

##### Reference Accuracy

±0.075% of span.

##### Total Performance

±0.15% of span for ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure (CD only), from 1:1 to 5:1 rangedown.

##### Stability

±0.125% of URL for 5 years for ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.

##### Dynamic Performance

###### Total Response Time ( $T_d + T_c$ )

100 ms

#### Model 3051CD, Low/Draft Range (Ranges 0–1)

##### Reference Accuracy

±0.10% of span.

##### Stability

±0.20% of URL for 1 year.

#### Model 3051P—Reference Class

##### Reference Accuracy

±0.05% of span.

##### Total Performance

±0.10% of span for ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure, from 1:1 to 5:1 rangedown.

##### Stability

±0.125% of URL for 5 years for ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.

##### Dynamic Performance

###### Total Response Time ( $T_d + T_c$ )

100 ms

**Model 3051L—Liquid Level**

**Reference Accuracy**

±0.075% of span.

**Model 3051H—High Process Temperature**

**Reference Accuracy**

±0.075% of span.

**Stability**

±0.1% of URL for 12 months for Ranges 2 and 3.

±0.2% of URL for 12 months for Ranges 4 and 5.

**DETAILED  
PERFORMANCE  
SPECIFICATIONS**

*Zero-based spans, reference conditions, silicone oil fill, 316 SST isolating diaphragms, 4–20 mA analog output, and digital trim values equal to the span set points.*

**Reference Accuracy**

Stated reference accuracy includes hysteresis, terminal-based linearity, setability, and repeatability.

**3051CD Ranges 2–5 and 3051CG**

±0.075% of span.

For spans less than 10:1, accuracy =

$$\pm \left[ 0.025 + 0.005 \left( \frac{URL}{Span} \right) \right] \% \text{ of Span}$$

**3051CD Range 1**

±0.10% of span.

For spans less than 15:1, accuracy =

$$\pm \left[ 0.025 + 0.005 \left( \frac{URL}{Span} \right) \right] \% \text{ of Span}$$

**3051CD Range 0**

±0.10% of span.

For spans less than 2:1, accuracy =

±0.05% of URL.

**3051T/CA Ranges 1–5**

±0.075% of span.

For spans less than 10:1, accuracy =

$$\pm \left[ 0.0075 \left( \frac{URL}{Span} \right) \right] \% \text{ of Span}$$

**3051CA Range 0**

±0.075% of span.

For spans less than 5:1, accuracy =

$$\pm \left[ 0.025 + 0.01 \left( \frac{URL}{Span} \right) \right] \% \text{ of Span}$$

**3051H/3051L**

±0.075% of span. For spans less than 10:1, accuracy =

$$\pm \left[ 0.025 + 0.005 \left( \frac{URL}{Span} \right) \right] \% \text{ of Span}$$

**3051P**

±0.05% of span.

**Ambient Temperature Effect per 50 °F (28 °C)**

**3051CD/CG**

±(0.0125% URL + 0.0625% span) from 1:1 to 5:1

±(0.025% URL + 0.125% span) from 5:1 to 100:1

Range 0: ±(0.25% URL + 0.05% span)

Range 1: ±(0.1% URL + 0.25% span)

**3051P**

±(0.006% URL + 0.03% span)

**3051H**

±(0.025% URL + 0.125% span + 0.35 inH<sub>2</sub>O)

For spans below 30:1 rangedown:

±(0.035% URL + 0.125% span + 0.35 inH<sub>2</sub>O)

**3051L**

See the Rosemount Instrument Toolkit™ or SOAP 2000 software.

**3051T and 3051CA**

±(0.025% URL + 0.125% span) from 1:1 to 30:1

±(0.035% URL + 0.125% span) from 30:1 to 100:1

Range 0: ±(0.1% URL + 0.25% span)

Range 5: ±(0.1% URL + 0.15% span)

Model 3051T Range 1:

±(0.025% URL + 0.125% span) from 1:1 to 10:1

±(0.05% URL + 0.125% span) from 10:1 to 100:1

**Static Pressure Effect per 1000 psi (6,9 MPa)**

**Zero Error (can be calibrated out at line pressure)**

Zero line pressure effect per 1000 psi (6,9 MPa).

Model	Range	Zero Effect with Static Pressure	
		≤ 2000 psi (13,7 MPa)	Pressure > 2000 psi (13,7 MPa)
3051CD	0 <sup>(1)</sup>	±0.125% URL	N/A
	1	±0.25% URL	N/A
	2,3	±0.05% URL	[0.20 + 0.20 (Pressure – 2)]%
	4,5	±0.10% URL	[0.10 + 0.10 (Pressure – 2)]%
3051PD	2,3	±0.04% URL	N/A
3051HD	2–5	±0.10% URL	[0.20 + 0.20 (Pressure – 2)]%

(1) Specification expressed in Percent/100 psi (0,69 MPa) up to 750 psi (5,17 MPa).

**Span Error**

Span line pressure effect per 1000 psi (6,9 MPa).

Model	Range	Span Effect
3051CD	0 <sup>(1)</sup>	±0.15% of reading
	1	±0.40% of reading
	2,3	±0.10% of reading
	4,5 <sup>(2)</sup>	±0.20% of reading
3051PD	2,3	±0.10% of reading
3051HD	2,3	±0.10% of reading
	4,5 <sup>(2)</sup>	±0.20% of reading

(1) Specification expressed in Percent/100 psi (0,69 MPa) up to 750 psi (5,17 MPa).

(2) Accuracy listed is after correction of systematic span effect. Refer to page 2-28 for line pressure compensation procedure.

**Dynamic Performance**

Dead Time and Update Rate applies to all models and ranges, analog output only.

**Dead Time (T<sub>d</sub>):**45 milliseconds (nominal)

**Update Rate:**22 times per second

**Total Response Time (T<sub>d</sub> + T<sub>c</sub>):**

**3051C/P**

100 milliseconds for ranges 2–5

255 milliseconds for range 1

700 milliseconds for range 0

**3051T**

100 milliseconds for ranges 1–5

**3051H/3051L**

Consult factory

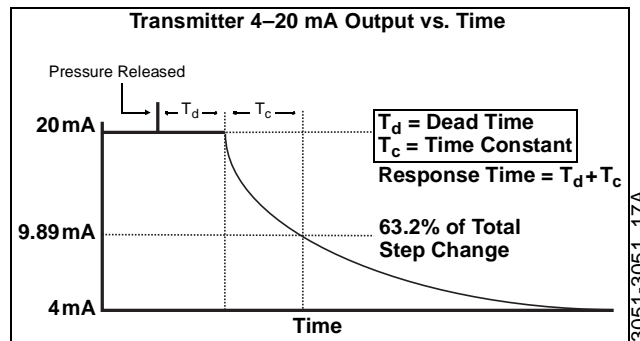


Figure 5-1. Typical Smart Transmitter Response Time

**Mounting Position Effects**

**3051C/P**

Zero shifts up to ±1.25 inH<sub>2</sub>O (0,31 kPa), which can be calibrated out. No span effect.

**3051H**

Zero shifts up to ±5 inH<sub>2</sub>O (127 mmH<sub>2</sub>O), which can be calibrated out. No span effect.

**3051L**

With liquid level diaphragm in vertical plane, zero shift of up to 1 inH<sub>2</sub>O (25,4 mmH<sub>2</sub>O).

With diaphragm in horizontal plane, zero shift of up to 5 inH<sub>2</sub>O (127 mmH<sub>2</sub>O) plus extension length on extended units. All zero shifts can be calibrated out. No span effect.

**3051T/CA**

Zero shifts up to 2.5 inH<sub>2</sub>O (63,5 mmH<sub>2</sub>O), which can be calibrated out. No span effect.

**Vibration Effect**

**All Models**

Measurement effect due to vibrations is negligible except at resonance frequencies. When at resonance frequencies, vibration effect is less than ±0.1% of URL per g when tested between 15 and 2000 Hz in any axis relative to pipe-mounted process conditions.

**Power Supply Effect**

**All Models**

Less than ±0.005% of calibrated span per volt.

**RFI Effects**

**All Models**

±0.1% of span from 20 to 1000 MHz and for field strength up to 30 V/m.

**Transient Protection  
(Option Code T1)**

**All Models**

**Meets IEEE Standard 587, Category B**

1 kV crest (10 × 1000 microseconds)

3 kV crest (8 × 20 microseconds)

6 kV crest (1,2 × 50 microseconds)

**Meets IEEE Standard 472,  
Surge Withstand Capability**

SWC 2,5 kV crest, 1 MHz wave form

**General Specifications:**

<b>Response Time:</b>	< 1 nanosecond
<b>Peak Surge Current:</b>	5000 amps to housing
<b>Peak Transient Voltage:</b>	100 V dc
<b>Loop Impedance:</b>	< 25 ohms
<b>Applicable Standards:</b>	IEC 801-4, IEC 801-5

**NOTE:**

Calibrations at 68 °F (20 °C) per ASME Z210.1 (ANSI).

**FUNCTIONAL SPECIFICATIONS**

**Range and Sensor Limits**

TABLE 5-1. Model 3051CD, 3051CG, 3051P, 3051L, and 3051H Range and Sensor Limits

Range	Minimum Span		Range and Sensor Limits								
	Model 3051 CD, CG, L, H	Model 3051P	Upper (URL)	Lower (LRL)							
				3051C Differential	3051C/P Gage	3051P Differential	3051L Differential	3051L Gage	3051H Differential	3051H Gage	
0	0.1 inH <sub>2</sub> O (25 Pa)	NA	3.0 inH <sub>2</sub> O (750 Pa)	-3.0 inH <sub>2</sub> O (-750 Pa)	NA	NA	NA	NA	NA	NA	NA
1	0.5 inH <sub>2</sub> O (0,12 kPa)	NA	25 inH <sub>2</sub> O (6,22 kPa)	-25 inH <sub>2</sub> O (-6,22 kPa)	NA	NA	NA	NA	NA	NA	NA
2	2.5 inH <sub>2</sub> O (0,62 kPa)	25 inH <sub>2</sub> O (6,22 kPa)	250 inH <sub>2</sub> O (62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)	-250 inH <sub>2</sub> O (-62,2 kPa)
3	10 inH <sub>2</sub> O (2,48 kPa)	100 inH <sub>2</sub> O (24,8 kPa)	1000 inH <sub>2</sub> O (248 kPa)	-1000 inH <sub>2</sub> O (-248 kPa)	0.5psia (3,5 kPa abs)	-1000 inH <sub>2</sub> O (-248 kPa)	-1000 inH <sub>2</sub> O (-248 kPa)	0.5 psia (3,5 kPa abs)	-1000 inH <sub>2</sub> O (-248 kPa)	0.5 psia (3,5 kPa abs)	
4	3 psi (20,7 kPa)	30 psi (207 kPa)	300 psi (2 070 kPa)	-300 psi (-2 070 kPa)	0.5psia (3,5 kPa abs)	-300 psi (-2 070 kPa)	-300 psi (-2 070 kPa)	0.5 psia (3,5 kPa abs)	-300 psi (-2 070 kPa)	0.5 psia (3,5 kPa abs)	
5	20 psi (138 kPa)	200 psi (1 380 kPa)	2000 psi (13 800 kPa)	-2000 psi (-13 800 kPa)	0.5 psia (3,5 kPa abs)	-2000 psi (-13 800 kPa)	NA	NA	-2000 psi (-13 800 kPa)	0.5 psia (3,5 kPa abs)	

TABLE 5-2. Model 3051CA Range and Sensor Limits

Range	Minimum Span	Range and Sensor Limits	
		Upper (URL)	Lower (LRL)
0	0.167 psia (8,6 mmHga)	5 psia (260 mmHga)	0 psia (0 mmHga)
1	0.3 psia (2,07 kPa)	30 psia (206,8 kPa)	0 psia (0 kPa)
2	1.5 psia (10,34 kPa)	150 psia (1 034,2 kPa)	0 psia (0 kPa)
3	8 psia (55,16 kPa)	800 psia (5 515,8 kPa)	0 psia (0 kPa)
4	40 psia (275,8 kPa)	4000 psia (27 580 kPa)	0 psia (0 kPa)

TABLE 5-3. Model 3051T Range and Sensor Limits

Range	Minimum Span	Range and Sensor Limits		
		Upper (URL)	Lower (LRL) (Abs.)	Lower <sup>(1)</sup> (LRL) (Gage)
1	0.3 psi (2 kPa)	30 psi (207 kPa)	0 psia (0 kPa)	-14.7 psig (-101 kPa)
2	1.5 psi (10 kPa)	150 psi (1 034 kPa)	0 psia (0 kPa)	-14.7 psig (-101 kPa)
3	8 psi (55 kPa)	800 psi (5 516 kPa)	0 psia (0 kPa)	-14.7 psig (-101 kPa)
4	40 psi (276 kPa)	4000 psi (27 579 kPa)	0 psia (0 kPa)	-14.7 psig (-101 kPa)
5	2000 psi (13 790 kPa)	10000 psi (68 948 kPa)	0 psia (0 kPa)	-14.7 psig (-101 kPa)

(1) Assumes atmospheric pressure of 14.7 psig.

**Zero and Span Adjustment Requirements**

- Zero and span values can be set anywhere within the range limits stated in Table 5-1 through 5-3.
- Span must be greater than or equal to the minimum span stated in Table 5-1 through 5-3.

**Service**

Liquid, gas, and vapor applications.

**4–20 mA (Output Code A)**

**Output**

Two-wire 4–20 mA, user-selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to the HART protocol.

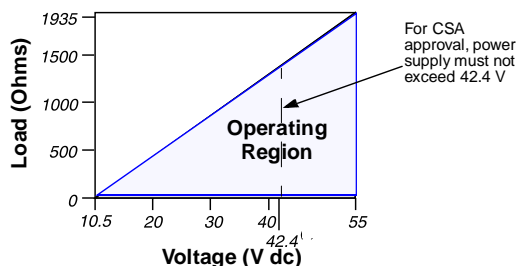
**Power Supply**

External power supply required. Standard transmitter (4–20 mA) operates on 10.5 to 55 V dc with no load.

*Load Limitations*

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

Max. Loop Resistance =  $43.5(\text{Power Supply Voltage} - 10.5)$



Communication requires a minimum loop resistance of 250 ohms.

**Low Power (Output Code M)**

**Output**

Three wire 1–5 V dc or 0.8–3.2 V dc (Option Code C2) user-selectable output. Also user selectable for linear or square root output configuration. Digital process variable superimposed on voltage signal, available to any host conforming to the HART protocol. Low-power transmitter operates on 6–12 V dc with no load.

**Power Consumption**

3,0 mA, 18–36 mW

**Minimum Load Impedance**

100 kΩ (V<sub>out</sub> wiring)

**Indication**

Optional 5-digit LCD meter



**Overpressure Limits**

Transmitters withstand the following limits without damage:

**Model 3051CD/CG**

- Range 0: 750 psi (5 171 kPa)
- Range 1: 2000 psig (13,8 MPa)
- Ranges 2–5: 3626 psig (25 MPa)

**Model 3051CA**

- Range 0: 60 psia (413,7 kPa)
- Range 1: 120 psia (827,4 kPa)
- Range 2: 300 psia (2 070 kPa)
- Range 3: 1600 psia (11 030 kPa)
- Range 4: 6000 psia (41 370 kPa)

**Model 3051H**

All Ranges: 3626 psig (25 MPa)

**Model 3051TG/TA**

- Range 1: 750 psi (5,2 MPa)
- Range 2: 1500 psi (10,3 MPa)
- Range 3: 1600 psi (11,0 MPa)
- Range 4: 6000 psi (41,4 MPa)
- Range 5: 15000 psi (103,4 MPa)

**Model 3051PG**

Ranges 2-5: 3626 psig (25 MPa)

**Model 3051 PD**

Ranges 2 and 3: 2000 psig (13,8 MPa)

For Model 3051L or Level Flange Option Codes FA, FB, FC, and FD, limit is 0 psia to the flange rating or sensor rating, whichever is lower.

TABLE 5-4. Model 3051L and Level Flange Rating Limits

Standard	Type	CS Rating	SST Rating
ANSI/ASME	Class 150	285 psig	275 psig
ANSI/ASME	Class 300	740 psig	720 psig
ANSI/ASME	Class 600	1480 psig	1440 psig
<i>At 100 °F (38 °C), rating decreases with increasing temperature.</i>			
DIN	PN 10–40	40 bar	40 bar
DIN	PN 10/16	16 bar	16 bar
DIN	PN 25/40	40 bar	40 bar
<i>At 248 °F (120 °C), rating decreases with increasing temperature.</i>			

**Static Pressure Limit**

**Model 3051CD Only**

Operates within specifications between static line pressures of 0.5 psia and 3626 psig (4500 psig for Option Code P9).

- Range 0: 0.5 psia and 750 psig
- Range 1: 0.5 psia and 2000 psig

**Model 3051PD Only**

Operates within specifications between static line pressures of 0.5 psia and 2000 psig.

**Burst Pressure Limits**

Burst pressure on Coplanar, traditional, or Model 3051H process flange is 10000 psig (69 MPa).

Burst pressure for the Model 3051T is

Ranges 1–4: 11000 psi (75,8 MPa)

Range 5: 26000 psig (179 MPa)

**Failure Mode Alarm**

**Output Code A**

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven  $\leq 3.75$  mA or  $\geq 21.75$  mA to alert the user. Also, NAMUR-Compliant alarm limits are installed through the C4 or CN option. NAMUR-Compliant limits are  $\leq 3.6$  mA for low alarm, and  $\geq 22.5$  mA for high alarm. High or low alarm signal is user-selectable by internal jumper.

**Output Code M**

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 0.94 V or above 5.4 V to alert the user (below 0.75 V or above 4.4 V for Option C2). High or low alarm signal is user-selectable by internal jumper.

**Temperature Limits**

**Ambient**

–40 to 185 °F (–40 to 85 °C).

With integral meter: –4 to 175 °F (–20 to 80 °C)

**Storage**

–50 to 230 °F (–46 to 110 °C)

With integral meter: –40 to 185 °F (–40 to 85 °C)

**Process**

At atmospheric pressures and above. See Table 5-5.

TABLE 5-5. Model 3051 Process Temperature Limits

Model 3051CD, 3051CG, 3051CA, 3051P	
Silicone Fill Sensor <sup>(1)</sup>	
with Coplanar Flange	–40 to 250 °F (–40 to 121 °C) <sup>(2)</sup>
with Traditional Flange	–40 to 300 °F (–40 to 149 °C) <sup>(2)</sup>
with Level Flange	–40 to 300 °F (–40 to 149 °C) <sup>(2)</sup>
with Model 305 Integral Manifold	–40 to 300 °F (–40 to 149 °C) <sup>(2)</sup>
Inert Fill Sensor <sup>(1)</sup>	0 to 185 °F (–18 to 85 °C) <sup>(3)(4)</sup>
Model 3051H (Process Fill Fluid)	
D.C. Silicone 200 <sup>(1)</sup>	–40 to 375 °F (–40 to 191 °C)
Inert <sup>(1)</sup>	–50 to 350 °F (–45 to 177 °C)
Neobee M-20 <sup>®(1)</sup>	0 to 375 °F (–18 to 191 °C)
Model 3051T (Process Fill Fluid)	
Silicone Fill Sensor <sup>(1)</sup>	–40 to 250 °F (–40 to 121 °C) <sup>(2)</sup>
Inert Fill Sensor <sup>(1)</sup>	–22 to 250 °F (–30 to 121 °C) <sup>(2)</sup>
Model 3051L Low-Side Temperature Limits	
Silicone Fill Sensor <sup>(1)</sup>	–40 to 250 °F (–40 to 121 °C) <sup>(2)</sup>
Inert Fill Sensor <sup>(1)</sup>	0 to 185 °F (–18 to 85 °C) <sup>(2)</sup>

TABLE 5-5. Model 3051 Process Temperature Limits

Model 3051L High-Side Temperature Limits (Process Fill Fluid)	
Syltherm® XLT	-100 to 300 °F (-73 to 149 °C)
D.C. Silicone 704 <sup>®(5)</sup>	60 to 600 °F (15 to 315 °C)
D.C. Silicone 200	-40 to 400 °F (-40 to 205 °C)
Inert	-50 to 350 °F (-45 to 177 °C)
Glycerin and Water	0 to 200 °F (-18 to 93 °C)
Neobee M-20	0 to 400 °F (-18 to 205 °C)
Propylene Glycol and Water	0 to 200 °F (-18 to 93 °C)
Syltherm 800	-50 to 400 °F (-45 to 205 °C)

- (1) Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio (0.6:1 ratio for the Model 3051H).  
 (2) 220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.  
 (3) 160 °F (71 °C) limit in vacuum service.  
 (4) Not available for Model 3051CA.  
 (5) Upper limit is for seal assemblies mounted away from the transmitter with the use of capillaries.

**Humidity Limits**

0–100% relative humidity

**Turn-On Time**

Performance within specifications less than 2.0 seconds after power is applied to the transmitter

**Volumetric Displacement**

Less than 0.005 in<sup>3</sup> (0,08 cm<sup>3</sup>)

**Damping**

Analog output response to a step input change is user-selectable from 0 to 36 seconds for one time constant. This software damping is in addition to sensor module response time.

**PHYSICAL SPECIFICATIONS**

**Electrical Connections**

1/2–14 NPT, PG 13.5, G1/2, and M20 × 1.5 (CM20) conduit. HART interface connections fixed to terminal block.

**Process Connections**

**All Models except 3051L and 3051T**

- 1/4–18 NPT on 2 1/8-in. centers
- 1/2–14 NPT on 2-, 2 1/8-, or 2 1/4-in. centers

**Model 3051L**

High pressure side: 2-, 3-, or 4-in., ASME B 16.5 (ANSI) Class 150, 300 or 600 flange; 50, 80 or 100 mm, PN 40 or 10/16 flange

Low pressure side: 1/4–18 NPT on flange

1/2–14 NPT on adapter

**Model 3051T**

1/4–18 NPT, 1/2–14 NPT female, G1/2 A DIN 16288 Male (available in SST for Range 1–4 transmitters only), or Autoclave type F-250-C (Pressure relieved 9/16–18 gland thread; 1/4 OD high pressure tube 60° cone; available in SST for Range 5 transmitters only).

**Process-Wetted Parts**

**Process Isolating Diaphragms**

Isolating Diaphragm Material	3051CD/CG	3051T	3051CA	3051P	3051H	3051L
316L SST	•	•	•	•	•	See Below
Hastelloy C-276	•	•	•		•	
Monel	•		•		•	
Tantalum	•				•	
Gold-plated Monel	•		•			
Gold-plated SST	•		•			

**Drain/Vent Valves**

316 SST, Hastelloy C, or Monel material (Monel not available with Model 3051L or 3051H)

**Process Flanges and Adapters**

Plated carbon steel, CF-8M (Cast version of 316 SST, material per ASTM-A743), Hastelloy C, or Monel

**Wetted O-rings**

Glass-filled TFE (Graphite-filled TFE with isolating diaphragm Option Code C6)

**Model 3051L Process Wetted Parts**

**Flanged Process Connection  
(Transmitter High Side)**

**Process Diaphragms, Including Process  
Gasket Surface:**

316L SST, Hastelloy C-276, or Tantalum

**Extension**

CF-3M (Cast version of 316L SST, material per ASTM-A743), or Hastelloy C. Fits schedule 40 and 80 pipe.

**Mounting Flange**

Zinc-cobalt plated CS or SST

**Reference Process Connection  
(Transmitter Low Side)**

**Isolating Diaphragms**

316L SST or Hastelloy C-276

**Reference Flange and Adapter**

CF-3M (Cast version of 316L SST, material per ASTM-A743)

**Non-Wetted Parts**

**Electronics Housing**

Low-copper aluminum or CF-8M (Cast version of 316 SST, material per ASTM-A743). NEMA 4X, IP 65, IP 66

**Coplanar Sensor Module Housing**

CF-3M (Cast version of 316L SST, material per ASTM-A743)

**Bolts**

Plated carbon steel per ASTM A449, Type 1: Austenitic 316 SST, ASME B 16.5 (ANSI)/ASTM-A-193-B7M, or Monel

**Sensor Module Fill Fluid**

Silicone or inert halocarbon (inert not available with Model 3051CA or Model 3051H). Model 3051T uses Fluorinert® FC-43

**Process Fill Fluid (Model 3051L and 3051H only)**

3051L: Syltherm XLT, D.C. Silicone 704, D.C. Silicone 200, inert, glycerin and water, Neobee M-20, propylene glycol and water, or Syltherm 800  
 3051H: inert, Neobee M-20, or D.C. Silicone 200

**Paint**

Polyurethane

**Cover O-rings**

Buna-N

**Shipping Weights**

“Shipping Weights” on page 5-28.

**CERTIFICATIONS**

Stainless steel certification tag provided when optional approval is specified.

**Factory Mutual (FM) Approvals**

- E5** Explosion proof for Class I, Division 1, Groups B, C, and D. Dust-Ignition Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for indoor and outdoor (NEMA 4X) hazardous locations. Factory Sealed.
- I5** Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected in accordance with Rosemount drawings 03031-1019 and 00275-0081 (when used with HART Communicator Model 275), or 00268-0031 (when used with Rosemount Model 268 Communicator). Temperature Code T4. Non-incendive for Class I, Division 2, Groups A, B, C, and D. NEMA 4X. Factory Sealed.

FM Approved Entity Parameters for Model 3051C	FM Approved for Class I, II, III, Division 1 and 2, Groups:
$V_{max} = 40 \text{ V dc}$	A-G
$I_{max} = 165 \text{ mA}$	A-G
$I_{max} = 225 \text{ mA}$	C-G
$I_{max} = 160 \text{ mA}$ (Option Code T1)	A-G
$P_{max} = 1 \text{ W}$	A-G
$C_i = 0.01 \text{ }\mu\text{F}$ (Output Code A)	A-G
$C_i = 0.042 \text{ }\mu\text{F}$ (Output Code M)	A-G
$L_i = 10 \text{ }\mu\text{H}$	A-G
$L_i = 1,05 \text{ mH}$ (Output Code A with T1)	A-G
$L_i = 0,75 \text{ mH}$ (Output Code M with T1)	A-G

**BASEEFA/CENELEC Intrinsic Safety Certification**

- I1** EEx ia IIC T5 ( $T_{amb} = -60$  to  $+40$  °C)  
EEx ia IIC T4 ( $T_{amb} = -60$  to  $+70$  °C)

**CENELEC Approved Entity Parameters**

- $U_{Max:in} = 30$  V
- $I_{Max:in} = 200$  mA
- $W_{Max:in} = 0.9$  W
- $C_{eq} = 0.012$   $\mu$ F

**BASEEFA Non-incendive/Type N Certification**

- N1** Ex N IIC T5 ( $T_{amb} = -40$  to  $+70$  °C)

**Special Conditions for Safe Use:**

When the optional transient protection terminal block is installed, the apparatus is not capable of withstanding a 500 V rms test to case. This must be taken into account in installations in which the transient protection terminal block is used. One method of taking this into account is to ensure that the supply to the apparatus is galvanically isolated.

**CESI/CENELEC Flameproof Certification**

- E8** EEx d IIC T6 ( $T_{amb} = 40$  °C)  
EEx d IIC T5 ( $T_{amb} = 70$  °C)

**Japanese Industrial Standard (JIS) Flameproof Certification**

- E4** (3051C/H/L/P) Ex d IIC T5 + G5  
(3051T) Ex d IIC T5

**Canadian Standards Association (CSA) Approvals**

- C6** Explosion Proof for Class I, Division 1, Groups B, C, and D.  
Dust-Ignition Proof for Class II and Class III, Division 1, Groups E, F, and G. Suitable for indoor and outdoor hazardous locations, CSA Enclosure Type 4X. Factory Sealed.

Intrinsically Safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03031-1024 and 00275-0082 (when used with the Model 275 HART Communicator). Temperature Code T3C.

	CSA Approved Barriers for Model 3051C	CSA Approved for Class I, Division 1 and 2, Groups:
Output Code A	$\leq 30$ V, $\geq 330$ $\Omega$	A–D
	$\leq 28$ V, $\geq 300$ $\Omega$	
Output Code M	$\leq 25$ V, $\geq 200$ $\Omega$	C–D
	$\leq 22$ V, $\geq 180$ $\Omega$	
	$\leq 30$ V, $\geq 150$ $\Omega$	A–D
	Supply $\leq 28$ V, $\geq 300$ $\Omega$ Return $\leq 10$ V, $\geq 47$ $\Omega$	
	Supply $\leq 30$ V, $\geq 150$ $\Omega$ Return $\leq 10$ V, $\geq 47$ $\Omega$	C–D

**Standards Association of Australia (SAA)**

**Intrinsic Safety Certification**

- I7** Ex ia IIC T4 ( $T_{amb} = 70\text{ °C}$ )  
Ex ia IIC T5 ( $T_{amb} = 40\text{ °C}$ )

**Special Conditions for Safe Use**

Observe barriers/entity parameters during installation. Connect per Rosemount drawing 03031 1026.

**SAA Approved Entity Parameters**

$$U_{Max} = 30\text{ V}$$

$$I_{Max} = 200\text{ mA}$$

$$I_{Max} = 160\text{ mA (Option Code T1)}$$

$$P_{Max} = 0.9\text{ W}$$

$$C_i = 0.01\text{ }\mu\text{F (Output Code A)}$$

$$C_i = 0.042\text{ }\mu\text{F (Output Code M)}$$

$$L_i = 10\text{ }\mu\text{H}$$

$$L_i = 1,05\text{ mH (Output Code A with T1)}$$

$$L_i = 0,75\text{ mH (Output Code M with T1)}$$

**Explosion Proof (Flameproof) Certification**

- E7** Ex d IIC T6 ( $T_{amb} = 40\text{ °C}$ )  
Ex d IIC T5 ( $T_{amb} = 80\text{ °C}$ )  
DIP T6 ( $T_{amb} = 40\text{ °C}$ )  
DIP T5 ( $T_{amb} = 80\text{ °C}$ )

**Type N (Non-sparking) Certification**

- N7** Ex n IIC T4 ( $T_{amb} = 70\text{ °C}$ )  
Ex n IIC T5 ( $T_{amb} = 40\text{ °C}$ )

**Combinations of Approvals**

- K5** Combination of **E5** and **I5**  
**KB** Combination of **K5** and **C6**  
FM and CSA Explosionproof and Intrinsic Safety.  
**K6** Combination **C6**, **I1**, and **E8**

**ORDERING INFORMATION**

TABLE 5-6. Model 3051C Differential, Gage, and Absolute Pressure Transmitters  
 — = Not Applicable • = Applicable

Model	Transmitter Type (Select One)					CD	CG	CA	
3051CD	Differential Pressure Transmitter					•	—	—	
3051CG	Gage Pressure Transmitter					—	•	—	
3051CA	Absolute Pressure Transmitter					—	—	•	
Pressure Ranges and Minimum Spans—English Units (SI Units)									
Code	Model 3051CD		Model 3051CG		Model 3051CA		CD	CG	CA
	Range	Min. Span	Range	Min. Span	Range	Min. Span			
0 <sup>(1)</sup>	–3 to 3 inH <sub>2</sub> O (–747 to 747 Pa)	0.1 inH <sub>2</sub> O (25 Pa)	Not Applicable		0 to 5 psia (0 to 259 mmHg)	0.167 psia (8,6 mmHg)	•	—	•
1	–25 to 25 inH <sub>2</sub> O (–6,22 to 6,22 kPa)	0.5 inH <sub>2</sub> O (0,12 kPa)	Not Applicable		0 to 30 psia (0 to 207 kPa)	0.3 psia (2,1 kPa)	•	—	•
2	–250 to 250 inH <sub>2</sub> O (–62,2 to 62,2 kPa)	2.5 inH <sub>2</sub> O (0,6 kPa)	–250 to 250 inH <sub>2</sub> O (–62,2 to 62,2 kPa)	2.5 inH <sub>2</sub> O (0,6 kPa)	0 to 150 psia (0 to 1 034 kPa)	1.5 psia (10,34 kPa)	•	•	•
3	–1000 to 1000 inH <sub>2</sub> O (–248 to 248 kPa)	10 inH <sub>2</sub> O (2,5 kPa)	–407 to 1000 inH <sub>2</sub> O (–101 to 249 kPa)	10 inH <sub>2</sub> O (2,5 kPa)	0 to 800 psia (0 to 5 516 kPa)	8 psia (55,16 kPa)	•	•	•
4	–300 to 300 psi (–2070 to 2070 kPa)	3 psi (20,7 kPa)	–14.7 to 300 psi (–101 to 2 070 kPa)	3 psi (20,7 kPa)	0 to 4000 psia (0 to 27 580 kPa)	40 psia (276 kPa)	•	•	•
5	–2000 to 2000 psi (– 13800 to 13800 kPa)	20 psi (138 kPa)	–14.7 to 2000 psig (–101 to 13800 kPa)	20 psi (138 kPa)	Not Applicable		•	•	—
NOTE: 3051CG lower range limit varies with atmospheric pressure.									
Code	Output					CD	CG	CA	
A	4–20 mA with Digital Signal Based on HART Protocol					•	•	•	
M	Low-Power, 1–5 V dc with Digital Signal Based on HART Protocol (See Option C2 for 0.8–3.2 V dc)					•	•	•	
NOTE: Not available with hazardous locations certification Options Codes I1, N1, E4, and K6.									
Materials of Construction									
Code	Process Flange Type	Flange Material	Drain/Vent	Flange Adapters	CD	CG	CA		
2	Coplanar	SST	SST	SST	•	•	•		
3	Coplanar	Hastelloy C	Hastelloy C	Hastelloy C	•	•	•		
4	Coplanar	Monel	Monel	Monel	•	•	•		
5	Coplanar	Plated CS	SST	Plated CS	•	•	•		
7	Coplanar	SST	Hastelloy C	SST	•	•	•		
8	Coplanar	Plated CS	Hastelloy C	Plated CS	•	•	•		
0	Alternate Flange—See Options H2, H3, H4, H7, F1, G1, G2, FA, FB, FC, FD, or S5					•	•	•	
NOTE: Materials of Construction Codes 3, 7, and 8 meet NACE material recommendations per MR 01-75.									
Code	Isolating Diaphragm					CD	CG	CA	
2	316L SST					•	•	•	
3	Hastelloy C-276 (Meets NACE material recommendations per MR 01-75)					•	•	•	
4	Monel					•	•	•	
5	Tantalum (Available on Model 3051CD and CG, Ranges 2–5 only. Not available on Model 3051CA)					•	•	•	
6	Gold-plated Monel (Use in combination with O-ring Option Code B.)					•	•	•	
7	Gold-plated SST					•	•	•	
Code	O-ring					CD	CG	CA	
A	Glass-filled TFE					•	•	•	
B	Graphite-filled TFE					•	•	•	
Code	Fill Fluid					CD	CG	CA	
1	Silicone					•	•	•	
2	Inert fill (Halocarbon)					•	•	•	
Code	Housing Material		Conduit Entry Size		CD	CG	CA		
A	Polyurethane-covered Aluminum		½–14 NPT		•	•	•		
B	Polyurethane-covered Aluminum		M20 × 1.5 (CM20)		•	•	•		
C	Polyurethane-covered Aluminum		PG 13.5		•	•	•		
D	Polyurethane-covered Aluminum		G½		•	•	•		
J	SST		½–14 NPT		•	•	•		
K	SST		M20 × 1.5 (CM20)		•	•	•		
L	SST		PG 13.5		•	•	•		



## Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement

TABLE 5-6. Model 3051C Differential, Gage, and Absolute Pressure Transmitters (continued)  
 — = Not Applicable • = Applicable

Code	Alternate Flange Options (Requires Materials of Construction Code 0)	CD	CG	CA
H2	Traditional Flange, 316 SST, SST Drain/Vent, SST Flange Adapter	•	•	•
H3	Traditional Flange, <i>Hastelloy C</i> , <i>Hastelloy C</i> Drain/Vent, <i>Hastelloy C</i> Flange Adapter	•	•	•
H4	Traditional Flange, <i>Monel</i> , <i>Monel</i> Drain/Vent, <i>Monel</i> Flange Adapter	•	•	•
H7	Traditional Flange, 316 SST, <i>Hastelloy C</i> Drain/Vent, 316 SST Flange Adapter	•	•	•
HJ	DIN Compliant Traditional Flange, SST, 7/16 in. Adapter/Manifold Bolting	•	•	•
HK	DIN Compliant Traditional Flange, SST, 10 mm Adapter/Manifold Bolting	•	•	•
HL	DIN Compliant Traditional Flange, SST, 12mm Adapter/Manifold Bolting	•	•	•
FA	Level Flange, SST, 2 in., ANSI Class 150, Vertical Mount	•	•	•
FB	Level Flange, SST, 2 in., ANSI Class 300, Vertical Mount	•	•	•
FC	Level Flange, SST, 3 in., ANSI Class 150, Vertical Mount	•	•	•
FD	Level Flange, SST, 3 in., ANSI Class 300, Vertical Mount	•	•	•
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount	•	•	•
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount	•	•	•
<i>NOTE: Option Codes H3 and H7 meet NACE material recommendations per MR 01-75.</i>				
Code	Integral Mount Manifold Options	CD	CG	CA
S5	Assemble to Model 305 Integral Manifold	•	•	•
Code	Integral Mount Primary Elements (Optional)	CD	CG	CA
S4	Factory Assembly to Rosemount Primary Element ( <i>Annubar</i> or Model 1195 Integral Orifice) <i>NOTE: With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 1–4 transmitters only.</i>	•	•	•
Code	Diaphragm Seal Assemblies (Optional) <i>NOTE: Standard flange and adapter bolts are austenitic 316 SST.</i>	CD	CG	CA
S1	One Diaphragm Seal (Direct Mount or Capillary Connection Type)	•	•	•
S2	Two Diaphragm Seals (Direct Mount or Capillary Connection Type)	•	•	•
Code	Optional All Welded Diaphragm Seal Systems (for high vacuum applications) <i>NOTE: Standard flange and adapter bolts are austenitic 316 SST.</i>	CD	CG	CA
S7	One Diaphragm Seal, All-Welded System (Capillary Connection Type)	•	•	•
S8	Two Diaphragm Seals, All-Welded System (Capillary Connection Type)	•	•	•
S0	One Diaphragm Seal, All-Welded System (Direct Mount Connection Type)	•	•	•
S9	Two Diaphragm Seals, All-Welded System (One Direct Mount and One Capillary Connection Type)	•	•	•
Code	Mounting Bracket Options	CD	CG	CA
B4	<i>Coplanar</i> Flange Bracket for 2-in. Pipe or Panel Mounting, all SST	•	•	•
B1	Traditional Flange Bracket for 2-in. Pipe Mounting, CS Bolts	•	•	•
B2	Traditional Flange Bracket for Panel Mounting, CS Bolts	•	•	•
B3	Traditional Flange Flat Bracket for 2-in. Pipe Mounting, CS Bolts	•	•	•
B7	B1 Bracket with Series 300 SST Bolts	•	•	•
B8	B2 Bracket with Series 300 SST Bolts	•	•	•
B9	B3 Bracket with Series 300 SST Bolts	•	•	•
BA	SST B1 Bracket with Series 300 SST Bolts	•	•	•
BC	SST B3 Bracket with Series 300 SST Bolts	•	•	•
Code	Hazardous Locations Certification Options	CD	CG	CA
E5	FM Explosionproof Approval	•	•	•
I5	FM Non-incendive and Intrinsic Safety Approval	•	•	•
K5	FM Explosionproof and Intrinsic Safety Approval	•	•	•
I1	BASEEFA/CENELEC Intrinsic Safety Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•	•
N1	BASEEFA Type N Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•	•
E8	CESI/CENELEC Flameproof Certification	•	•	•
E4	JIS Flameproof Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•	•
C6	Canadian Standards Association (CSA) Explosionproof and Intrinsic Safety Approval (Requires 42.4 V dc maximum power supply)	•	•	•
K6	Combination of CSA and CENELEC Explosionproof and Intrinsic Safety Approval <i>NOTE: Not available with low-power Option Code M.</i>	•	•	•
KB	Combination of FM and CSA Explosionproof and Intrinsic Safety Approvals <i>NOTE: Not available with low-power Option Code M.</i>	•	•	•
I7	SAA Intrinsic Safety Certification	•	•	•
E7	SAA Flameproof Certification	•	•	•
N7	SAA Type N Certification	•	•	•

TABLE 5-6. Model 3051C Differential, Gage, and Absolute Pressure Transmitters (continued)  
 — = Not Applicable • = Applicable

Code	Bolting Options	CD	CG	CA
L4	Austenitic 316 SST Bolts	•	•	•
L5	ANSI/ASTM-A-193-B7M Bolts	•	•	•
L6	Monel Bolts	•	•	•
Code	Meters (Optional)	CD	CG	CA
M5	LCD Meter for Aluminum Housing (Housing Codes A, B, C, and D only)	•	•	•
M6	LCD Meter for SST Housing (Housing Codes J, K, and L only)	•	•	•
Code	Other Options	CD	CG	CA
Q4	Calibration Data Sheet	•	•	•
Q8	Material Traceability Certification per EN 10204 3.1B <i>NOTE: This option is available for the sensor module housing and Coplanar or traditional flanges and adapters (Model 3051C), and for the sensor module housing and low-volume Coplanar flange and adapter (Model 3051C with Option Code S1).</i>	•	•	•
J1	Local Zero Adjustment Only <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•	•
J3	No Local Zero or Span Adjustment <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•	•
T1	Transient Protection Terminal Block <i>NOTE: Not available with hazardous locations certification Option Code I1 or K6.</i>	•	•	•
C1	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•	•	•
C2	0.8–3.2 V dc Output with Digital Signal Based on HART Protocol (Output Code M only)	•	•	•
C3	Gage Calibration (Model 3051CA4 only)	•	•	•
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•	•
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Alarm Configuration—Low <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•	•
P1	Hydrostatic Testing	•	•	•
P2	Cleaning for Special Service	•	•	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•	•	•
D3	¼–18 NPT Process Connections (No flange adapters)	•	•	•
D7	Coplanar Flange Without Drain/Vent Ports	•	•	•
D8	Ceramic Ball Drain/Vents	•	•	•
D9	JIS Process Connection—RC ¼ Flange with RC ½ Flange Adapter	•	•	•
P9	4500 psig Static Pressure Limit (Model 3051CD Ranges 2–5 only)	•	•	•
V5	External Ground Screw Assembly	•	•	•
<b>Typical Model Number: 3051CD 2 A 2 2 A 1 A B4</b>				

(1) *NOTE: Model 3051CD0 is available only with Output Code A, Process Flange Code 0 (Alternate Flange H2), Isolating Diaphragm Code 2, O-ring Code A, and Bolting Option L4. For Multiple Options selections, contact your Rosemount representative or see Rosemount PDS 00813-0600-4001.*

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

TABLE 5-7. Model 3051T Gage and Absolute Pressure Transmitter

Model	Transmitter Type		Available
3051T	Pressure Transmitter		•
Code	Pressure Type		
G	Gage		•
A	Absolute		•
PRESSURE RANGES (RANGE/MIN. SPAN)			
Code	3051TG	3051TA	Available
1	-14.7 to 30 psi/0.3 psi (-101 to 207 kPa/2,1 kPa)	0 to 30 psia/0.3 psia (0 to 207 kPa/2,1 kPa)	•
2	-14.7 to 150 psi/1.5 psi (-101 to 1 034 kPa/10,3 kPa)	0 to 150 psia/1.5 psia (0 to 1 034 kPa/10,3 kPa)	•
3	-14.7 to 800 psi/8 psi (-101 to 5 516 kPa/55 kPa)	0 to 800 psia/8 psia (0 to 5 516 kPa/55 kPa)	•
4	-14.7 to 4000 psi/40 psi (-101 to 27 580 kPa/276 kPa)	0 to 4000 psia/40 psia (0 to 27 580 kPa/276 kPa)	•
5	-14.7 to 10000 psi/2000 psi (-101 to 68 900 kPa/13 800 kPa)	0 to 10000 psia/2000 psia (0 to 68 900 kPa/13 790 kPa)	•
<i>NOTE: 3051TG lower range limit varies with atmospheric pressure.</i>			
Code	Output		Available
A	4–20 mA with Digital Signal Based on <i>HART</i> Protocol		•
M	Low-Power 1–5 V dc with Digital Signal Based on <i>HART</i> Protocol (See Option Code C2 for 0.8–3.2 V dc Output)		•
<i>NOTE: Not available with hazardous certification Option Codes I1 or N1.</i>			
Code	Process Connection Style		Available
2A	¼–18 NPT Female		•
2B	½–14 NPT Female		•
2C	G½ A DIN 16288 Male (Available in SST for Range 1–4 only)		•
2F	Coned and Threaded, Compatible with Autoclave Type F-250-C <i>(Includes Gland and Collar, Available in SST for Range 5 only)</i>		•
Code	Isolating Diaphragm	Process Connection Wetted Parts Material	Available
2	316L SST	316L SST	•
3	Hastelloy	Hastelloy	•
<i>NOTE: Meets NACE requirements per MR 01-75.</i>			
Code	Fill Fluid		Available
1	Silicone		•
2	Inert		•
Code	Housing Material	Conduit Entry Size	Available
A	Polyurethane-covered Aluminum	½–14 NPT	•
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	•
C	Polyurethane-covered Aluminum	PG 13.5	•
D	Polyurethane-covered Aluminum	G½	•
J	SST	½–14 NPT	•
K	SST	M20 × 1.5 (CM20)	•
L	SST	PG 13.5	•
Code	Integral Mount Manifold (Optional)		Available
S5	Assemble to Model 306 Integral Manifold (Requires ½ in. process connection code 2B—Refer to PPL 00814-0100-4733)		•
Code	Remote Diaphragm Seal Assemblies (Optional)		Available
S1	One Remote Diaphragm Seal (Direct Mount or Capillary Connection Type)		•
Code	Mounting Brackets (Optional)		Available
B4	Bracket for 2-in. Pipe or Panel Mounting, All SST		•

TABLE 5-7. (continued) Model 3051T Gage and Absolute Pressure Transmitter

Code	Hazardous Locations Certifications (Optional)	Available
E5	FM Explosionproof Approval	•
I5	FM Non-incendive and Intrinsic Safety Approval	•
K5	FM Explosionproof and Intrinsic Safety Approval	•
C6	CSA Explosionproof and Intrinsic Safety Approval (Requires 42.4 V dc maximum power supply)	•
K6	Combination of CSA and CENELEC Explosionproof and Intrinsic Safety Approval <i>NOTE: Not available with low-power Option Code M.</i>	•
KB	Combination of FM and CSA Explosionproof and Intrinsic Safety Approvals <i>NOTE: Not available with low-power Option Code M.</i>	•
I7	SAA Intrinsic Safety Certification	•
E7	SAA Flameproof Certification	•
N7	SAA Type N Certification	•
I1	BASEEFA/CENELEC Intrinsic Safety Certification <i>NOTE: Not available with low-power Option Code M.</i>	•
N1	BASEEFA Type N Certification <i>NOTE: Not available with low-power Option Code M.</i>	•
E8	CESI/CENELEC Flameproof Certification	•
Code	Other Options	Available
Q4	Calibration Data Sheet	•
Q8	Material Traceability Certification per EN 10204 3.1B <i>NOTE: This option applies to the threaded process connection only.</i>	•
J1	Local Zero Adjustment Only <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•
J3	No Local Zero or Span Adjustment <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•
M5	LCD Meter for Aluminum Housing (Housing Codes A, B, C, and D only)	•
M6	LCD Meter for SST Housing (Housing Codes J, K, and L only)	•
T1	Transient Protection Terminal Block <i>NOTE: Not available with hazardous locations certification Option Code I1 or K6.</i>	•
C1	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•
C2	0.8–3.2 V dc Output with Digital Signal Based on HART Protocol (Output Code M only)	•
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Low Alarm Configuration <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•
P1	Hydrostatic Testing	•
P2	Cleaning for Special Service	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•
V5	External Ground Screw Assembly	•
<b>Typical Model Number: 3051T G 5 F 2A 2 1 A B4</b>		

TABLE 5-8. Model 3051L Flange-Mounted Liquid Level Transmitter

Model	Transmitter Type			Available	
3051L	Flange-Mounted Liquid Level Transmitter			•	
Code	PRESSURE RANGES (RANGE/MIN. SPAN)			Available	
2	–250 to 250 inH <sub>2</sub> O/2.5 inH <sub>2</sub> O (–62,2 to 62,2 kPa/0,62 kPa)			•	
3	–1000 to 1000 inH <sub>2</sub> O/10 inH <sub>2</sub> O (–248 to 248 kPa/2,5 kPa)			•	
4	–8310 to 8310 inH <sub>2</sub> O/83.1 inH <sub>2</sub> O (–2 070 to 2 070 Pa/20,7 kPa)			•	
Code	Output			Available	
A	4–20 mA with Digital Signal Based on HART Protocol			•	
M	Low-Power 1–5 V dc with Digital Signal Based on HART Protocol (See Option Code C2 for 0.8–3.2 V dc Output) <i>NOTE: Not available with hazardous certification Option Codes I1, N1, E4, and K6.</i>			•	
HIGH PRESSURE SIDE					
Code	Diaphragm Size	Material	Extension Length	Available	
G0	2 in./DN 50	316L SST	Flush Mount Only	• • • When specifying this option code, a lower housing must be selected from the flushing connection options table.	
H0	2 in./DN 50	Hastelloy	Flush Mount Only		
J0	2 in./DN 50	Tantalum	Flush Mount Only		
A0	3 in./DN 80	316L SST	Flush Mount	• • • NOTE Extension diameters are sized to fit Schedule 80 pipe. • • • • • • • • • • • • • • • •	
A2	3 in./DN 80	316L SST	2 in./50 mm		
A4	3 in./DN 80	316L SST	4 in./100 mm		
A6	3 in./DN 80	316L SST	6 in./150 mm		
B0	4 in./DN 100	316L SST	Flush Mount		
B2	4 in./DN 100	316L SST	2 in./50 mm		
B4	4 in./DN 100	316L SST	4 in./100 mm		
B6	4 in./DN 100	316L SST	6 in./150 mm		
C0	3 in./DN 80	Hastelloy	Flush Mount		
C2	3 in./DN 80	Hastelloy	2 in./50 mm		
C4	3 in./DN 80	Hastelloy	4 in./100 mm		
C6	3 in./DN 80	Hastelloy	6 in./150 mm		
D0	4 in./DN 100	Hastelloy	Flush Mount		
D2	4 in./DN 100	Hastelloy	2 in./50 mm		
D4	4 in./DN 100	Hastelloy	4 in./100 mm		
D6	4 in./DN 100	Hastelloy	6 in./150 mm		
E0	3 in./DN 80	Tantalum	Flush Mount Only		
F0	4 in./DN 100	Tantalum	Flush Mount Only		
MOUNTING FLANGE					
Code	Size	ASME B 16.5 (ANSI) or DIN Flange Rating	Material	Applicable With These High Pressure Side Diaphragm Sizes	Available
M	2 in.	Class 150	CS	2 in./DN 50	•
A	3 in.	Class 150	CS	3 in./DN 80	•
B	4 in.	Class 150	CS	4 in./DN 100	•
N	2 in.	Class 300	CS	2 in./DN 50	•
C	3 in.	Class 300	CS	3 in./DN 80	•
D	4 in.	Class 300	CS	4 in./DN 100	•
P	2 in.	Class 600	CS	2 in./DN 50	•
E	3 in.	Class 600	CS	3 in./DN 80	•
X	2 in.	Class 150	SST	2 in./DN 50	•
F	3 in.	Class 150	SST	3 in./DN 80	•
G	4 in.	Class 150	SST	4 in./DN 100	•
Y	2 in.	Class 300	SST	2 in./DN 50	•
H	3 in.	Class 300	SST	3 in./DN 80	•
J	4 in.	Class 300	SST	4 in./DN 100	•
Z	2 in.	Class 600	SST	2 in./DN 50	•
L	3 in.	Class 600	SST	3 in./DN 80	•
Q	DIN DN 50	PN 10–40	CS	2 in./DN 50	•
R	DIN DN 80	PN 40	CS	3 in./DN 80	•
S	DIN DN 100	PN 40	CS	4 in./DN 100	•
V	DIN DN 100	PN 10/16	CS	4 in./DN 100	•
K	DIN DN 50	PN 10–40	SST	2 in./DN 50	•
T	DIN DN 80	PN 40	SST	3 in./DN 80	•
U	DIN DN 100	PN 40	SST	4 in./DN 100	•
W	DIN DN 100	PN 10/16	SST	4 in./DN 100	•

TABLE 5-8. (continued) Model 3051L Flange-Mounted Liquid Level Transmitter

Code	Process Fill-High Pressure Side	Temperature Limits			Available
A	Syltherm XLT	-100 to 300 °F (-73 to 135 °C)			•
C	D. C. Silicone 704	60 to 600 °F (15 to 316 °C)			•
D	D. C. Silicone 200	-40 to 400 °F (-40 to 205 °C)			•
H	Inert (Halocarbon)	-50 to 350 °F (-45 to 177 °C)			•
G	Glycerine and Water	0 to 200 °F (-17 to 93 °C)			•
N	Neobee M-20	0 to 400 °F (-17 to 205 °C)			•
P	Propylene Glycol and Water	0 to 200 °F (-17 to 93 °C)			•
LOW PRESSURE SIDE					
Code	Configuration	Flange Adapter	Diaphragm Material	Sensor Fill Fluid	Available
11	Gage	SST	316L SST	Silicone	•
21	Differential	SST	316L SST	Silicone	•
22	Differential	SST	Hastelloy C-276	Silicone	•
2A	Differential	SST	316L SST	Inert (Halocarbon)	•
2B	Differential	SST	Hastelloy C-276	Inert (Halocarbon)	•
31	Remote Seal	SST	316L SST	Silicone (Requires Option Code S1)	•
Code	O-ring Material				Available
A	Glass-filled TFE				•
Code	Housing Material	Conduit Entry Size			Available
A	Polyurethane-covered Aluminum	½-14 NPT			•
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)			•
C	Polyurethane-covered Aluminum	PG 13.5			•
D	Polyurethane-covered Aluminum	G½			•
J	SST	½-14 NPT			•
K	SST	M20 × 1.5 (CM20)			•
L	SST	PG 13.5			•
Code	Diaphragm Seal Assemblies (Optional)				Available
S1	One Diaphragm Seal (requires low pressure side Option Code 31 capillary connection type)				•
Code	Hazardous Locations Certification Options				Available
E5	FM Explosionproof Approval				•
I5	FM Non-incendive and Intrinsic Safety Approval				•
K5	FM Explosionproof and Intrinsic Safety Approval				•
I1	BASEEFA/CENELEC Intrinsic Safety Certification (NOTE: Not available with low-power Option Code M.)				•
N1	BASEEFA Type N Certification (NOTE: Not available with low-power Option Code M.)				•
E8	CESI/CENELEC Flameproof Certification				•
E4	JIS Flameproof Certification (NOTE: Not available with low-power Option Code M.)				•
C6	CSA Explosionproof and Intrinsic Safety Approval (Requires 42.4 V dc maximum power supply)				•
K6	Combination of CSA and CENELEC Explosionproof and Intrinsic Safety Approval NOTE: Not available with low-power Option Code M.)				•
KB	Combination of FM and CSA Explosionproof and Intrinsic Safety Approvals NOTE: Not available with low-power Option Code M.				•
I7	SAA Intrinsic Safety Certification				•
E7	SAA Flameproof Certification				•
N7	SAA Type N Certification				•
Code	Bolt for Flange and Adapters (Optional)				Available
L4	Austenitic 316 SST Bolts				•
L5	ASME B 16.5 (ANSI)/ASTM-A-193-B7M Bolts				•
Code	Meter Options				Available
M5	LCD Meter for Aluminum Housing (Housing Codes A, B, C, and D only)				•
M6	LCD Meter for SST Housing (Housing Codes J, K, and L only)				•

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

TABLE 5-8. (continued) Model 3051L Flange-Mounted Liquid Level Transmitter

Code	Other Options	Available				
Q4	Calibration Data Sheet	•				
Q8	Material Traceability Certification per EN 10204 3.1B <i>NOTE: This options is available with the diaphragm, upper housing, Coplanar flange, adapter, sensor module housing, lower housing/flushing connection, and extension.</i>	•				
J1	Local Zero Adjustment Only <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•				
J3	No Local Zero or Span Adjustment <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•				
T1	Transient Protection Terminal Block <i>NOTE: Not available with hazardous locations certification Option Code I1 or K6.</i>	•				
C1	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•				
C2	0.8–3.2 V dc Output with Digital Signal Based on HART Protocol (Output Code M only)	•				
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•				
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Alarm Configuration–Low <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•				
D8	Ceramic Ball Drain/Vents	•				
V5	External Ground Screw Assembly	•				
Lower Housing Flushing Connections						
Code	Ring Material	Number	Size	Diaphragm Size		
				2 in.	3 in.	4 in.
F1	SST	1	¼	•	•	•
F2	SST	2	¼	•	•	•
F3	Hastelloy	1	¼	•	•	•
F4	Hastelloy	2	¼	•	•	•
FA	SST	0	—	•		
FC	Hastelloy	0	—	•		
F7	SST	1	½	•	•	•
F8	SST	2	½	•	•	•
F9	Hastelloy	1	½	•	•	•
F0	Hastelloy	2	½	•	•	•
<i>NOTE: Flushing Codes F3 and F4 are not available with Option Codes A0, B0, and G0.</i>						
<i>NOTE: Flushing Code FC is not available with Option Code G0.</i>						

TABLE 5-9. Model 3051H Pressure Transmitter for High-Temperature Processes

Model	Transmitter Type (Select One)	Available			
		HD	HG		
3051HD	Differential Pressure Transmitter for High-Temperature Processes	•			
3051HG	Gage Pressure Transmitter for High-Temperature Processes		•		
<b>PRESSURE RANGES (RANGE/MIN. SPAN)</b>					
<b>Code</b>	<b>3051HD</b>	<b>3051HG</b>			
2	-250 to 250 inH <sub>2</sub> O/2.5 inH <sub>2</sub> O (-62,2 to 62,2 kPa/0,62 kPa)	-250 to 250 inH <sub>2</sub> O/2.5 inH <sub>2</sub> O (-62,2 to 62,2 kPa/0,6 kPa)	•	•	
3	-1000 to 1000 inH <sub>2</sub> O/10 inH <sub>2</sub> O (-248 to 248 kPa/2,5 kPa)	-407 to 1000 inH <sub>2</sub> O/10 in H <sub>2</sub> O (-101 to 249 kPa/2,5 kPa)	•	•	
4	-300 to 300 inH <sub>2</sub> O/3 psi (-13 800 to 13 800 kPa/20,1 kPa)	-14.7 to 300 psi/3 psi (-101 to 2 070 kPa/20,7 kPa)	•	•	
5	-2000 to 2000 psi/20 psi (-207 to 207 kPa/2,5 kPa)	-14.7 to 2000 psig/20 psi (-101 to 13 800 kPa/138 kPa)	•	•	
<i>NOTE: 3051HG lower range limit varies with atmospheric pressure.</i>					
<b>Code</b>	<b>Output</b>	<b>HD</b>	<b>HG</b>		
A	4-20 mA with Digital Signal Based on HART Protocol	•	•		
M	Low-Power 1-5 V dc with Digital Signal Based on HART Protocol (See Option Code C2 for 0.8-3.2 V dc Output) <i>NOTE: Not available with hazardous certification Option Codes I1, N1, E4, and K6.</i>	•	•		
<b>PROCESS CONNECTION</b>					
<b>Code</b>	<b>Process Flange Material</b>	<b>Drain/Vent</b>	<b>Flange Adapters</b>	<b>HD</b>	<b>HG</b>
2	SST	SST	SST	•	•
7	SST	Hastelloy	SST	•	•
<i>NOTE: Process Connection Code 7 meets NACE material recommendations per MR 01-75.</i>					
<b>Code</b>	<b>Process Isolating Diaphragm</b>	<b>HD</b>	<b>HG</b>		
2	316L SST	•	•		
3	Hastelloy C-276 (Meets NACE material recommendations per MR 01-75)	•	•		
5	Tantalum	•	•		
<b>Code</b>	<b>O-ring Material</b>	<b>HD</b>	<b>HG</b>		
A	Glass-Filled TFE	•	•		
<b>Code</b>	<b>Process Fill Fluid</b>	<b>HD</b>	<b>HG</b>		
D	D.C. 200 Silicone	•	•		
H	Inert	•	•		
N	Neobee M-20	•	•		
<b>Code</b>	<b>Sensor Module Isolator Material</b>	<b>HD</b>	<b>HG</b>		
2	SST	•	•		
<b>Code</b>	<b>Sensor Module Fill Fluid</b>	<b>HD</b>	<b>HG</b>		
1	Silicone	•	•		
2	Inert (Halocarbon)	•	•		
<b>Code</b>	<b>Housing Material</b>	<b>Conduit Entry Size</b>	<b>HD</b>	<b>HG</b>	
A	Polyurethane-covered Aluminum	½-14 NPT	•	•	
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	•	•	
C	Polyurethane-covered Aluminum	PG 13.5	•	•	
D	Polyurethane-covered Aluminum	G½	•	•	
J	SST	½-14 NPT	•	•	
K	SST	M20 × 1.5 (CM20)	•	•	
L	SST	PG 13.5	•	•	
<b>Code</b>	<b>Integral Mount Manifold Options</b>	<b>HD</b>	<b>HG</b>		
S4	Factory Assembly to Rosemount Primary Element (Diamond II+Annubar/Model 1195 Integral Orifice) <i>NOTE: With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 1-4 transmitters only.</i>	•			
<b>Code</b>	<b>Mounting Bracket Options</b>	<b>HD</b>	<b>HG</b>		
B5	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, CS Bolts	•	•		
B6	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, SST Bolts	•	•		



# Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement

TABLE 5-9. (continued) Model 3051H Pressure Transmitter for High-Temperature Processes

Code	Hazardous Locations Certification Options	HD	HG
E5	FM Explosionproof Approval	•	•
I5	FM Non-incendive and Intrinsic Safety Approval	•	•
K5	FM Explosionproof and Intrinsic Safety Approval	•	•
I1	BASEEFA/CENELEC Intrinsic Safety Certification ( <i>NOTE: Not available with low-power Option Code M.</i> )	•	•
N1	BASEEFA Type N Certification ( <i>NOTE: Not available with low-power Option Code M.</i> )	•	•
E8	CESI/CENELEC Flameproof Certification	•	•
E4	JIS Flameproof Certification ( <i>NOTE: Not available with low-power Option Code M.</i> )	•	•
C6	CSA Explosionproof and Intrinsic Safety Approval (Requires 42.4 V dc maximum power supply)	•	•
K6	Combination of CSA and CENELEC Explosionproof and Intrinsic Safety Approval <i>NOTE: Not available with low-power Option Code M.</i>	•	•
KB	Combination of FM and CSA Explosionproof and Intrinsic Safety Approvals <i>NOTE: Not available with low-power Option Code M.</i>	•	•
I7	SAA Intrinsic Safety Certification	•	•
E7	SAA Flameproof Certification	•	•
N7	SAA Type N Certification	•	•
Code	Bolt for Flange and Adapter Options	HD	HG
L4	Austenitic 316 SST Bolts	•	•
Code	Meter Options	HD	HG
M5	LCD Meter for Aluminum Housing (Housing Codes A, B, C, and D only)	•	•
M6	LCD Meter for SST Housing (Housing Codes J, K, and L only)	•	•
Code	Other Options	HD	HG
Q4	Calibration Data Sheet	•	•
J1	Local Zero Adjustment Only <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•
J3	No Local Zero or Span Adjustment <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•
T1	Transient Protection Terminal Block <i>NOTE: Not available with hazardous locations certification Option Code I1 or K6.</i>	•	•
C1	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•	•
C2	0.8–3.2 V dc Output with Digital Signal Based on HART Protocol (Output Code M only)	•	•
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Alarm Configuration–Low <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•
P1	Hydrostatic Testing	•	•
P2	Cleaning for Special Service	•	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•	•
D3	¼–18 NPT Process Connections (No flange adapters)	•	•
D8	Ceramic Ball Drain/Vents	•	•
V5	External Ground Screw Assembly	•	•
<b>Typical Model Number: 3051HG 2 A 2 2 A H 2 1 A B5</b>			

TABLE 5-10. Model 3051P Reference Class Transmitter

Model	Transmitter Type (Select One)				PD	PG
3051PD	Model 3051P Reference Class Differential Pressure Transmitter				•	
3051PG	Model 3051P Reference Class Gage Pressure Transmitter					•
PRESSURE RANGES (RANGE/MIN. SPAN)						
Code	3051PD	3051PG			PD	PG
2	-250 to 250 inH <sub>2</sub> O/25 inH <sub>2</sub> O (-62,2 to 62,2 kPa/6,2 kPa)	-250 to 250 inH <sub>2</sub> O/2.5 inH <sub>2</sub> O (-62,2 to 62,2 kPa/0,6 kPa)			•	•
3	-1000 to 1000 inH <sub>2</sub> O/100 inH <sub>2</sub> O (-248 to 248 kPa/25 kPa)	-407 to 1000 inH <sub>2</sub> O/10in H <sub>2</sub> O (-101 to 249 kPa/2,5 kPa)			•	•
4	Not Applicable	-14.7 to 300 psi/3 psi (-101 to 2 070 kPa/20,7 kPa)				•
5	Not Applicable	-14.7 to 2000 psig/20 psi (-101 to 13 800 kPa/138 kPa)				•
<i>NOTE: 3051PG lower range limit varies with atmospheric pressure.</i>						
Code	Output				PD	PG
A	4–20 mA with Digital Signal Based on HART Protocol				•	•
MATERIALS OF CONSTRUCTION						
Code	Process Flange Type	Flange Material	Drain/Vent	Flange Adapters	PD	PG
2	Coplanar	SST	SST	SST	•	•
0 <sup>(1)</sup>	Alternate Flange—See Option H2, HJ, HK, HL, FA, FB, FC, FD, FP, FQ, S5				•	•
Code	Isolating Diaphragm				PD	PG
2	316L SST				•	•
Code	O-ring Material				PD	PG
A	Glass-Filled TFE				•	•
Code	Fill Fluid				PD	PG
1	Silicone				•	•
2	Inert (Halocarbon)				•	•
Code	Housing Material	Conduit Entry Size			PD	PG
A	Polyurethane-covered Aluminum	½–14 NPT			•	•
B	Polyurethane-covered Aluminum	M20 x 1.5 (CM20)			•	•
C	Polyurethane-covered Aluminum	PG 13.5			•	•
D	Polyurethane-covered Aluminum	G½			•	•
J	SST	½–14 NPT			•	•
K	SST	M20 x 1.5 (CM20)			•	•
L	SST	PG 13.5			•	•
Code	Alternate Flange Options (Requires Materials of Construction Code 0)				PD	PG
H2	Traditional Flange, 316 SST Drain/Vent, SST Flange Adapter				•	•
HJ	DIN Compliant Traditional Flange, SST, 7/16 in. Adapter/Manifold Bolting				•	•
HK	DIN Compliant Traditional Flange, SST, 10 mm Adapter/Manifold Bolting				•	•
HL	DIN Compliant Traditional Flange, SST, 12mm Adapter/Manifold Bolting				•	•
FA	Level Flange, SST, 2 in., ANSI Class 150, Vertical Mount				•	•
FB	Level Flange, SST, 2 in., ANSI Class 300, Vertical Mount				•	•
FC	Level Flange, SST, 3 in., ANSI Class 150, Vertical Mount				•	•
FD	Level Flange, SST, 3 in., ANSI Class 300, Vertical Mount				•	•
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount				•	•
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount				•	•
Code	Integral Mount Manifold Options				PD	PG
S5	Assemble to Model 305 Integral Manifold (Refer to PPL 00814-0100-4733 for Pricing Information)				•	•
Code	Integral Mount Primary Elements (Optional)				PD	PG
S4	Factory Assembly to Rosemount Primary Element (Diamond II+Annubar/Model 1195 Integral Orifice)				•	•
<i>NOTE: With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 2–3 transmitters only.</i>						

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

TABLE 5-10. (continued) Model 3051P Reference Class Transmitter

Code	Mounting Bracket Options	PD	PG
B4	Coplanar Flange Bracket for 2-in. Pipe or Panel Mounting, All SST	•	•
B1	Traditional Flange Bracket for 2-in. Pipe or Panel Mounting, CS Bolts	•	•
B2	Traditional Flange Bracket for Panel Mounting, CS Bolts	•	•
B7	B1 Bracket with Series 300 SST Bolts	•	•
B8	B2 Bracket with Series 300 SST Bolts	•	•
BA	SST B1 Bracket with Series 300 SST Bolts	•	•
BC	SST B3 Bracket with Series 300 SST Bolts	•	•
Code	Hazardous Locations Certification Options	PD	PG
E5	FM Explosionproof Approval	•	•
I5	FM Non-incendive and Intrinsic Safety Approval	•	•
K5	FM Explosionproof and Intrinsic Safety Approval	•	•
I1	BASEEFA/CENELEC Intrinsic Safety Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•
N1	BASEEFA Type N Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•
E8	CESI/CENELEC Flameproof Certification	•	•
E4	JIS Flameproof Certification <i>NOTE: Not available with low-power Option Code M.</i>	•	•
C6	Canadian Standards Association (CSA) Explosionproof and Intrinsic Safety Approval (Requires 42.4 V dc maximum power supply)	•	•
K6	Combination of CSA and CENELEC Explosionproof and Intrinsic Safety Approval <i>NOTE: Not available with low-power Option Code M.</i>	•	•
KB	Combination of FM and CSA Explosionproof and Intrinsic Safety Approvals <i>NOTE: Not available with low-power Option Code M.</i>	•	•
I7	SAA Intrinsic Safety Certification	•	•
E7	SAA Flameproof Certification	•	•
N7	SAA Type N Certification	•	•
Code	Other Options	PD	PG
Q4	Calibration Data Sheet	•	•
Q8	Material Traceability Certification per EN 10204 3.1B <i>NOTE: This option is available for the sensor module housing and Coplanar or traditional flanges and adapters.</i>	•	•
L4	Austenitic 316 SST Bolts	•	•
L5	ANSI/ASTM-A-193-B7M Bolts	•	•
L6	Monel Bolts	•	•
M5	LCD Meter for Aluminum Housing (Housing Codes A, B, C, and D only)	•	•
M6	LCD Meter for SST Housing (Housing Codes J, K, and L only)	•	•
J1	Local Zero Adjustment Only <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•
J3	No Local Zero or Span Adjustment <i>NOTE: Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.</i>	•	•
T1	Transient Protection Terminal Block <i>NOTE: Not available with hazardous locations certification Option Code I1.</i>	•	•
C1	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	•	•
C4	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996 <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•
CN	Analog Output Levels Compliant with NAMUR Recommendation NE43, 27-June-1996: Alarm Configuration—Low <i>NOTE: NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.</i>	•	•
P1	Hydrostatic Testing	•	•
P2	Cleaning for Special Service	•	•
P3	Cleaning for <1 PPM Chlorine/Fluorine	•	•
D3	¼–18 NPT Process Connections (No flange adapters)	•	•
D7	Coplanar Flange Without Drain/Vent Ports	•	•
V5	External Ground Screw Assembly	•	•
<b>Typical Model Number: 3051PD 3 A 2 2 A 1 A B4</b>			

(1) *NOTE: May impact temperature performance under certain conditions.*

## CONFIGURATION INFORMATION

### Standard Configuration

Unless otherwise specified, transmitter is shipped as follows:

#### Engineering Units

<b>Differential/Gage:</b>	inH <sub>2</sub> O (Range 0, 1, 2, and 3) psi (Range 4 and 5)
<b>Absolute/3051T:</b>	psi (all ranges)
<b>4 mA (1 V dc):</b>	0 (engineering units above)
<b>20 mA (5 V dc):</b>	Upper range limit
<b>Output:</b>	Linear
<b>Flange type:</b>	Specified model code option
<b>Flange material:</b>	Specified model code option
<b>O-ring material:</b>	Specified model code option
<b>Drain/vent:</b>	Specified model code option
<b>Integral meter:</b>	Installed or none
<b>Alarm:</b>	Upscale
<b>Software tag:</b>	(Blank)

### Custom Configuration (Option Code C1)

If Option Code C1 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Output Information
- Transmitter Information
- LCD Meter Configuration
- Hardware Selectable Information
- Signal Selection

Refer to Configuration Data Sheet 00806-0100-4001.

### Tagging

Three customer tagging options are available:

1. Standard SST hardware tag is wired to the transmitter. Tag character height is 0.125 in. (3,18 mm), 56 characters maximum.
2. Tag may be permanently stamped on transmitter nameplate upon request, 56 characters maximum.
3. Tag may be stored in transmitter memory (30 characters maximum). Software tag is left blank unless specified.

### Optional Model 305 or Model 306 Integral Manifolds

Factory assembled to Model 3051C and Model 3051T transmitters. Refer to the following Rosemount documents for more information:

Product Data Sheet 00813-0100-4773

Product Data Sheet 00813-0200-4733

### Optional Conventional Manifolds (Packaged Separately)

A wide offering of two-, three-, and five-valve manifolds manufactured by Anderson Greenwood and PGI International are available.

#### Part No. 01151-0150-0001

3-Valve Manifold, Carbon Steel  
(Anderson, Greenwood & Co., M4AVIC)

#### Part No. 01151-0150-0002

3-Valve Manifold, 316 SST  
(Anderson, Greenwood & Co., M4AVIS)

Please consult your Rosemount representative.

**Optional Diaphragm and Sanitary Seals**

Refer to Product Data Sheet 00813-0100-4016 or 00813-0201-4016.

**Output Information**

Output range points must be the same unit of measure. Available units of measure include:

inH <sub>2</sub> O	inH <sub>2</sub> O@4 °C <sup>(1)</sup>	psi	Pa
inHg	ftH <sub>2</sub> O	bar	kPa
mmH <sub>2</sub> O	mmH <sub>2</sub> O@4 °C <sup>(1)</sup>	mbar	torr
mmHg	g/cm <sup>2</sup>	kg/cm <sup>2</sup>	atm

(1) Not available on low power or previous versions.

**Shipping Weights**

TABLE 5-11. Transmitter Weights without Options

Transmitter	Add Weight In lb (kg)
Model 3051C/P	6.0 (2,7)
Model 3051L	See Table 5-12
Model 3051H	13.6 (6,2)
Model 3051T	3.0 (1,4)

TABLE 5-12. Model 3051L Weights without Options

Flange	Flush lb. (kg)	2-in. Ext. lb (kg)	4-in. Ext. lb (kg)	6-in. Ext. lb (kg)
2-in., 150	12.5 (5,7)	—	—	—
3-in., 150	17.5 (7,9)	19.5 (8,8)	20.5 (9,3)	21.5 (9,7)
4-in., 150	23.5 (10,7)	26.5 (12,0)	28.5 (12,9)	30.5 (13,8)
2-in., 300	17.5 (7,9)	—	—	—
3-in., 300	22.5 (10,2)	24.5 (11,1)	25.5 (11,6)	26.5 (12,0)
4-in., 300	32.5 (14,7)	35.5 (16,1)	37.5 (17,0)	39.5 (17,9)
2-in., 600	15.3 (6,9)	—	—	—
3-in., 600	25.2 (11,4)	27.2 (12,3)	28.2 (12,8)	29.2 (13,2)
DN 50 / PN 40	13.8 (6,2)	—	—	—
DN 80 / PN 40	19.5 (8,8)	21.5 (9,7)	22.5 (10,2)	23.5 (10,6)
DN 100 / PN 10/16	17.8 (8,1)	19.8 (9,0)	20.8 (9,5)	21.8 (9,9)
DN 100 / PN 40	23.2 (10,5)	25.2 (11,5)	26.2 (11,9)	27.2 (12,3)

TABLE 5-13. Transmitter Options Weights

Code	Option	Add lb (kg)
J, K, L	Stainless Steel Housing (T)	3.9 (1,8)
J, K, L	Stainless Steel Housing (C, L, H, P)	3.1 (1,4)
M5	LCD Meter for Aluminum Housing	0.5 (0,2)
M6	LCD Meter for SST Housing	1.25 (0,6)
B4	SST Mounting Bracket for <i>Coplanar</i> Flange	1.0 (0,5)
B1, B2, B3	Mounting Bracket for Traditional Flange	2.3 (1,0)
B7, B8, B9	Mounting Bracket for Traditional Flange	2.3 (1,0)
BA, BC	SST Bracket for Traditional Flange	2.3 (1,0)
B5, B6	Mounting Bracket for Model 3051H	2.9 (1,3)
H2	Traditional Flange	2.4 (1,1)
H3	Traditional Flange	2.7 (1,2)
H4	Traditional Flange	2.6 (1,2)
H7	Traditional Flange	2.5 (1,1)
F1, G1, FC	Level Flange—3 in., 150	10.8 (4,9)
F2, G2, FD	Level Flange—3 in., 300	14.3 (6,5)
FA	Level Flange—2 in., 150	10.7 (4,8)
FB	Level Flange—2 in., 300	14.0 (6,3)
FP	DIN Level Flange, SST, DN 50, PN 40	8.3 (3,8)
FQ	DIN Level Flange, SST, DN 80, PN 40	13.7 (6,2)

**ROSEMOUNT SMART  
FAMILY® INSTRUMENTS**

Rosemount SMART FAMILY® instruments may be installed in pressure, temperature, level, and flow applications.

All SMART FAMILY instruments are designed to communicate using Highway Addressable Remote Transducer (HART) protocol with the hand-held HART Communicator and Fisher-Rosemount Control Systems.

**Related Product Data  
Sheets**

Model 1195 Integral Orifice: PDS 00813-0100-4686

Model 305/Model 306 Integral Manifolds: PDS 00813-0100-4733 and PDS 00813-0200-4733

Model 1199 Diaphragm Seals: PDS 00813-0100-4016 (Worldwide) and PDS 00813-0201-4016 (European)

Diamond II+Annubar: PDS 00813-0100-4760

Model 3051 with FOUNDATION fieldbus: PDS 00813-0100-4774

Model 3051 Draft Range Transmitter (CD0):  
PDS 00813-0600-4001

**PARTS LIST**

Item numbers are references to figure callouts (pages 42–46).

TABLE 5-14. Model 3051C Differential Sensor Modules .

Model 3051C Sensor Modules (Min. Span/Range)	Silicone Fill		Inert Fill	
	Part Number		Part Number	
<i>Note: One spare part is recommended for every 50 transmitters.</i>				
<i>Note: Listed by Range and Process Isolator Order Numbers.</i>				
<b>-3 to 3/0.1 inH<sub>2</sub>O, Range 0 (includes Traditional SST flange and SST bolts).</b>				
316L SST	03031-1045-0002	•	03031-1145-0002	•
<b>-25 to 25 inH<sub>2</sub>O/0.5 inH<sub>2</sub>O, Range 1</b>				
316L SST	03031-1045-0012	•	03031-1145-0012	•
Hastelloy C-276	03031-1045-0013	•	03031-1145-0013	•
Monel	03031-1045-0014	•	03031-1145-0014	•
Gold-plated Monel	03031-1045-0016	•	03031-1145-0016	•
Gold-plated 316 SST	03031-1045-0017	•	03031-1145-0017	•
<b>-250 to 250 inH<sub>2</sub>O/2.5 inH<sub>2</sub>O, Range 2</b>				
316L SST	03031-1045-0022	•	03031-1145-0022	•
Hastelloy C-276	03031-1045-0022	•	03031-1145-0022	•
Monel	03031-1045-0024	•	03031-1145-0024	•
Tantalum	03031-1045-0025	•	03031-1145-0025	•
Gold-plated Monel	03031-1045-0026	•	03031-1145-0026	•
Gold-plated 316 SST	03031-1045-0027	•	03031-1145-0027	•
<b>-1000 to 1000 inH<sub>2</sub>O/10 inH<sub>2</sub>O, Range 3</b>				
316L SST	03031-1045-0032	•	03031-1145-0032	•
Hastelloy C-276	03031-1045-0033	•	03031-1145-0033	•
Monel	03031-1045-0034	•	03031-1145-0034	•
Tantalum	03031-1045-0035	•	03031-1145-0035	•
Gold-plated Monel	03031-1045-0036	•	03031-1145-0036	•
Gold-plated 316 SST	03031-1045-0037	•	03031-1145-0037	•
<b>-300 to 300 psi/3 psi, Range 4</b>				
316L SST	03031-1045-2042	•	03031-1145-2042	•
Hastelloy C-276	03031-1045-2043	•	03031-1145-2043	•
Monel	03031-1045-2044	•	03031-1145-2044	•
Tantalum	03031-1045-2045	•	03031-1145-2045	•
Gold-plated Monel	03031-1045-2046	•	03031-1145-2046	•
Gold-plated 316 SST	03031-1045-2047	•	03031-1145-2047	•
<b>-2000 to 2000/20 psi, Range 5</b>				
316L SST	03031-1045-2052	•	03031-1145-2052	•
Hastelloy C-276	03031-1045-2053	•	03031-1145-2053	•
Monel	03031-1045-2054	•	03031-1145-2054	•
Tantalum	03031-1045-2055	•	03031-1145-2055	•
Gold-plated Monel	03031-1045-2056	•	03031-1145-2056	•
Gold-plated 316 SST	03031-1045-2057	•	03031-1145-2057	•

TABLE 5-15. Model 3051C Gage Sensor Modules

Model 3051C Gage Modules (Min. Span/Range)	Silicone Fill		Inert Fill	
	Part Number		Part Number	
Note: One spare part is recommended for every 50 transmitters.				
Note: Listed by Range and Process Isolator Order Numbers.				
<b>-250 to 250 inH<sub>2</sub>O/2.5 inH<sub>2</sub>O, Range 2</b>				
316L SST	03031-1045-0022	•	03031-1145-0022	•
<i>Hastelloy C-276</i>	03031-1045-0023	•	03031-1145-0023	•
<i>Monel</i>	03031-1045-0024	•	03031-1145-0024	•
Tantalum	03031-1045-0025	•	03031-1145-0025	•
Gold-plated <i>Monel</i>	03031-1045-0026	•	03031-1145-0026	•
Gold-plated 316 SST	03031-1045-0027	•	03031-1145-0027	•
<b>-335 to 1000 inH<sub>2</sub>O/10 inH<sub>2</sub>O, Range 3</b>				
316L SST	03031-1045-0032	•	03031-1145-0032	•
<i>Hastelloy C-276</i>	03031-1045-0033	•	03031-1145-0033	•
<i>Monel</i>	03031-1045-0034	•	03031-1145-0034	•
Tantalum	03031-1045-0035	•	03031-1145-0035	•
Gold-plated <i>Monel</i>	03031-1045-0036	•	03031-1145-0036	•
Gold-plated 316 SST	03031-1045-0037	•	03031-1145-0037	•
<b>-12 to 300 psi/3 psi, Range 4</b>				
316L SST	03031-1045-1042	•	03031-1145-1042	•
<i>Hastelloy C-276</i>	03031-1045-1043	•	03031-1145-1043	•
<i>Monel</i>	03031-1045-1044	•	03031-1145-1044	•
Tantalum	03031-1045-1045	•	03031-1145-1045	•
Gold-plated <i>Monel</i>	03031-1045-1046	•	03031-1145-1046	•
Gold-plated 316 SST	03031-1045-1047	•	03031-1145-1047	•
<b>-12 to 2000 psi/20 psi, Range 5</b>				
316L SST	03031-1045-1052	•	03031-1145-1052	•
<i>Hastelloy C-276</i>	03031-1045-1053	•	03031-1145-1053	•
<i>Monel</i>	03031-1045-1054	•	03031-1145-1054	•
Tantalum	03031-1045-1055	•	03031-1145-1055	•
Gold-plated <i>Monel</i>	03031-1045-1056	•	03031-1145-1056	•
Gold-plated 316 SST	03031-1045-1057	•	03031-1145-1057	•



TABLE 5-16. Model 3051C Absolute Sensor Modules

Model 3051C Absolute Sensor Modules (Min. Span/Range)	Silicone Fill		Inert Fill	
	Part Number		Part Number	
Note: One spare part is recommended for every 50 transmitters.				
Note: Listed by Range and Process Isolator Order Numbers.				
<b>0 to 0.167 psia/5 psia, Range 0 (includes Traditional SST flange and SST bolts).</b>				
316L SST	03031-2020-0002	•	—	—
<i>Hastelloy C-276</i>	03031-2020-0003	•	—	—
<i>Monel</i>	03031-2020-0004	•	—	—
Gold-plated <i>Monel</i>	03031-2020-0006	•	—	—
Gold-plated 316 SST	03031-2020-0007	•	—	—
<b>0 to 30 psia/0.3 psia, Range 1</b>				
316L SST	03031-2020-0012	•	—	—
<i>Hastelloy C-276</i>	03031-2020-0013	•	—	—
<i>Monel</i>	03031-2020-0014	•	—	—
Gold-plated <i>Monel</i>	03031-2020-0016	•	—	—
Gold-plated 316 SST	03031-2020-0017	•	—	—
<b>0 to 150/1.5 psia, Range 2</b>				
316L SST	03031-2020-0022	•	—	—
<i>Hastelloy C-276</i>	03031-2020-0023	•	—	—
<i>Monel</i>	03031-2020-0024	•	—	—
Gold-plated <i>Monel</i>	03031-2020-0026	•	—	—
Gold-plated 316 SST	03031-2020-0027	•	—	—
<b>0 to 800 psia/8 psia, Range 3</b>				
316L SST	03031-2020-0032	•	—	—
<i>Hastelloy C-276</i>	03031-2020-0033	•	—	—
<i>Monel</i>	03031-2020-0034	•	—	—
Gold-plated <i>Monel</i>	03031-2020-0036	•	—	—
Gold-plated 316 SST	03031-2020-0037	•	—	—

TABLE 5-17. Model 3051T Gage and Absolute Pressure Transmitters.

Item No.	Model 3051T Sensor Modules <sup>(1)</sup>	Isolating Diaphragm	Housing Material	Silicone Fill		Inert Fill																																							
				Part Number		Part Number																																							
8	<b>Gage Sensor Module<sup>(2)</sup></b> <b>0-0.3/30 psig, Range 1</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i> 316L SST	Aluminum Aluminum Aluminum Aluminum Aluminum	03031-3112-3112 03031-3112-3113 03031-3102-3112 03031-3102-3113 03031-3132-3112	• • • • •	03031-3112-1112 03031-3112-1113 03031-3102-1112 03031-3102-1113 03031-3132-1112	• • • • •																																						
								316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i>	SST SST SST SST	03031-3111-3112 03031-3111-3113 03031-3101-3112 03031-3101-3113	• • • • • • • • •	03031-3111-1112 03031-3111-1113 03031-3101-1112 03031-3101-1113	• • • • • • • • •																																
														8	<b>Gage Sensor Module<sup>(2)</sup></b> <b>0-1.5/150 psig, Range 2</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i> 316L SST	Aluminum Aluminum Aluminum Aluminum Aluminum	03031-3112-3122 03031-3112-3123 03031-3102-3122 03031-3102-3123 03031-3132-3122	• • • • •	03031-3112-1122 03031-3112-1123 03031-3102-1122 03031-3102-1123 03031-3132-1122	• • • • •																								
																						316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i>	SST SST SST SST	03031-3111-3122 03031-3111-3123 03031-3101-3122 03031-3101-3123	• • • • • • • • •	03031-3111-1122 03031-3111-1123 03031-3101-1122 03031-3101-1123	• • • • • • • • •																		
																												8	<b>Gage Sensor Module<sup>(2)</sup></b> <b>0-8/800 psig, Range 3</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i> 316L SST	Aluminum Aluminum Aluminum Aluminum Aluminum	03031-3112-3132 03031-3112-3133 03031-3102-3132 03031-3102-3133 03031-3132-3132	• • • • •	03031-3112-1132 03031-3112-1133 03031-3102-1132 03031-3102-1133 03031-3132-1132	• • • • •										
		316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i>	SST SST SST SST	03031-3111-3132 03031-3111-3133 03031-3101-3132 03031-3101-3133	• • • • • • • • •	03031-3111-1132 03031-3111-1133 03031-3101-1132 03031-3101-1133	• • • • • • • • •																																						
																																				8	<b>Gage Sensor Module<sup>(2)</sup></b> <b>0-40/4000 psig, Range 4</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i> 316L SST	Aluminum Aluminum Aluminum Aluminum Aluminum	03031-3112-3142 03031-3112-3143 03031-3102-3142 03031-3102-3143 03031-3132-3142	• • • • •	03031-3112-1142 03031-3112-1143 03031-3102-1142 03031-3102-1143 03031-3132-1142	• • • • •		
																316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i>	SST SST SST SST	03031-3111-3142 03031-3111-3143 03031-3101-3142 03031-3101-3143	• • • • • • • • •	03031-3111-1142 03031-3111-1143 03031-3101-1142 03031-3101-1143	• • • • • • • • •																								
																																												8	<b>Absolute Sensor Module<sup>(2)</sup></b> <b>0-0.3/30 psig, Range 1</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female
																														316L SST <i>Hastelloy C</i> 316L SST <i>Hastelloy C</i>	SST SST SST SST	03031-3111-3012 03031-3111-3013 03031-3101-3012 03031-3101-3013	• • • • • • • • •	03031-3111-1012 03031-3111-1013 03031-3101-1012 03031-3101-1013	• • • • • • • • •										

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

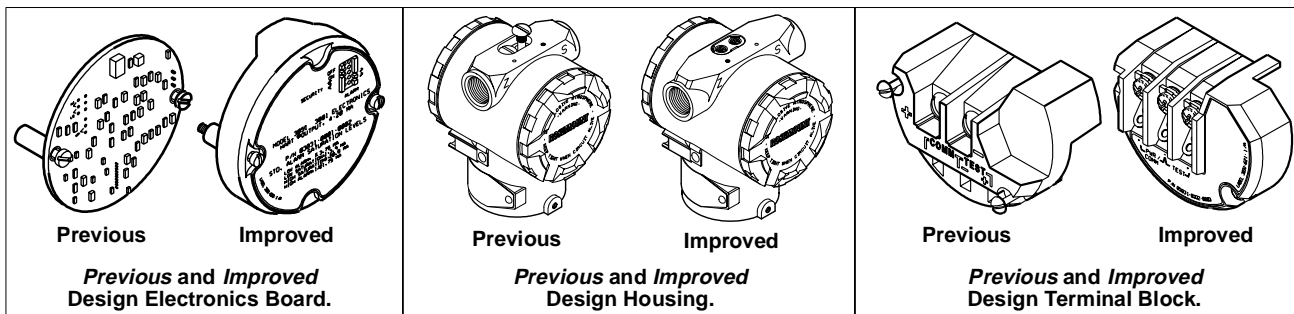
TABLE 5-17. (continued) Model 3051T Gage and Absolute Pressure Transmitters.

		Silicone Fill				Inert Fill			
Item No.	Model 3051T Sensor Modules <sup>(1)</sup>	Isolating Diaphragm	Housing Material	Part Number		Part Number			
8	<b>Absolute Sensor Module<sup>(2)</sup></b> <b>0-1.5/150 psig, Range 2</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G 1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST	Aluminum	03031-3112-3022	•	03031-3112-1022	•		
		Hastelloy C	Aluminum	03031-3112-3023	•	03031-3112-1023	•		
		316L SST	Aluminum	03031-3102-3022	•	03031-3102-1022	•		
		Hastelloy C	Aluminum	03031-3102-3023	•	03031-3102-1023	•		
		316L SST	Aluminum	03031-3132-3022	•	03031-3132-1022	•		
		316L SST	SST	03031-3111-3022	•	03031-3111-1022	•		
		Hastelloy C	SST	03031-3111-3023	•	03031-3111-1023	•		
		316L SST	SST	03031-3101-3022	•	03031-3101-1022	•		
		Hastelloy C	SST	03031-3101-3023	•	03031-3101-1023	•		
		8	<b>Absolute Sensor Module<sup>(2)</sup></b> <b>0-8/800 psig, Range 3</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G 1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST	Aluminum	03031-3112-3032	•	03031-3112-1032	•
				Hastelloy C	Aluminum	03031-3112-3033	•	03031-3112-1033	•
				316L SST	Aluminum	03031-3102-3032	•	03031-3102-1032	•
Hastelloy C	Aluminum			03031-3102-3033	•	03031-3102-1033	•		
316L SST	Aluminum			03031-3132-3032	•	03031-3132-1032	•		
316L SST	SST			03031-3111-3032	•	03031-3111-1032	•		
Hastelloy C	SST			03031-3111-3033	•	03031-3111-1033	•		
316L SST	SST			03031-3101-3032	•	03031-3101-1032	•		
Hastelloy C	SST			03031-3101-3033	•	03031-3101-1033	•		
8	<b>Absolute Sensor Module<sup>(2)</sup></b> <b>0-40/4000 psig, Range 4</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G 1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female			316L SST	Aluminum	03031-3112-3042	•	03031-3112-1042	•
				Hastelloy C	Aluminum	03031-3112-3043	•	03031-3112-1043	•
				316L SST	Aluminum	03031-3102-3042	•	03031-3102-1042	•
		Hastelloy C	Aluminum	03031-3102-3043	•	03031-3102-1043	•		
		316L SST	Aluminum	03031-3132-3042	•	03031-3132-1042	•		
		316L SST	SST	03031-3111-3042	•	03031-3111-1042	•		
		Hastelloy C	SST	03031-3111-3043	•	03031-3111-1043	•		
		316L SST	SST	03031-3101-3042	•	03031-3101-1042	•		
		Hastelloy C	SST	03031-3101-3043	•	03031-3101-1043	•		
		8	<b>Absolute Sensor Module<sup>(2)</sup></b> <b>0-2000/10000 psig, Range 5</b> 1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female G 1/2A DIN 16288 Male  1/4-18 NPT Female 1/4-18 NPT Female 1/2-14 NPT Female 1/2-14 NPT Female	316L SST	Aluminum	03031-3112-3052	•	03031-3112-1052	•
				Hastelloy C	Aluminum	03031-3112-3053	•	03031-3112-1053	•
				316L SST	Aluminum	03031-3102-3052	•	03031-3102-1052	•
Hastelloy C	Aluminum			03031-3102-3053	•	03031-3102-1053	•		
316L SST	Aluminum			03031-3122-3052	•	03031-3122-1052	•		
316L SST	SST			03031-3111-3052	•	03031-3111-1052	•		
Hastelloy C	SST			03031-3111-3053	•	03031-3111-1053	•		
316L SST	SST			03031-3101-3052	•	03031-3101-1052	•		
Hastelloy C	SST			03031-3121-3053	•	03031-3121-1053	•		

(1) For Model 3051TG Range 5 spare module, order absolute configuration and perform zero trim for gage calibrations.  
 (2) One spare part is recommended for every 50 transmitters.

TABLE 5-18. Model 3051C Differential, Gage, Absolute, and Liquid Level Transmitters.

Item No.	Part Description	Part Number						
<b>Electronics Board—Assembly Required</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
6	Improved Standard (4–20 mA/HART protocol) <sup>(1)</sup>	03031-0001-0002	•	•	•	•	•	•
6	Improved NAMUR Compliant (4–20 mA/HART protocol) <sup>(1)</sup>	03031-0001-0003	•	•	•	•	•	•
6	Low Power (1–5/0.8–3.2 Volts) <sup>(1)</sup>	03031-0001-1001	•	•	•	•	•	•



Electronics Board, Housing, and Terminal Block, Previous and Improved Design.

3051-OVERG01A, N01A, E01A

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

TABLE 5-18. (continued) Model 3051C Differential, Gage, Absolute, and Liquid Level Transmitters.

Item No.	Part Description	Part Number	CD	CG	CA	L	H	T
<b>Electronics Housing, Covers, Terminal Block</b>								
<i>NOTE: See drawings below for Previous and Improved Electronics Boards, Housings, and Terminal Blocks. For information on ordering "Previous Design" spare parts, contact your local Rosemount office. In the U.S., call the Response Center at 1-800-654-7768.</i>								
<b>Improved Standard (4–20 mA) Aluminum Housing</b>								
4	Electronics Housing without Terminal Block ½–14 NPT conduit, Includes RFI Filters	03031-0635-0001	•	•	•	•	•	•
	M20×1.5 (CM20) conduit, Includes RFI filters	03031-0635-0002	•	•	•	•	•	•
	PG 13.5 conduit, Includes RFI Filters	03031-0635-0003	•	•	•	•	•	•
	G½ conduit, Includes RFI Filters	03031-0635-0004	•	•	•	•	•	•
1	Electronics Cover (Includes wiring label) <sup>(2)</sup>	03031-0292-0001	•	•	•	•	•	•
3	Standard Terminal Block Assembly <sup>(1)</sup>	03031-0332-0003	•	•	•	•	•	•
3	Transient Terminal Block Assy. (Option T1) <sup>(2)</sup>	03031-0332-0004	•	•	•	•	•	•
5	Local Zero and Span Kit <sup>(1)</sup>	03031-0293-0002	•	•	•	•	•	•
	External Ground Assembly (Option V5) <sup>(1)</sup>	03031-0398-0001	•	•	•	•	•	•
<b>Improved Standard (4–20 mA) 316 SST Housing</b>								
4	Electronics Housing without Terminal Block ½–14 NPT conduit, Includes RFI Filters	03031-0635-0041	•	•	•	•	•	•
	M20×1.5 (CM20) conduit, Includes RFI Filters	03031-0635-0042	•	•	•	•	•	•
	PG 13.5 conduit, Includes RFI Filters	03031-0635-0043	•	•	•	•	•	•
1	Electronics Cover (Includes wiring label) <sup>(2)</sup>	03031-0292-0002	•	•	•	•	•	•
3	Standard Terminal Block Assembly <sup>(1)</sup>	03031-0332-0003	•	•	•	•	•	•
3	Transient Terminal Block Assy. (Option T1) <sup>(2)</sup>	03031-0332-0004	•	•	•	•	•	•
5	Local Zero and Span Kit <sup>(1)</sup>	03031-0293-0002	•	•	•	•	•	•
	External Ground Assembly (Option V5) <sup>(1)</sup>	03031-0398-0001	•	•	•	•	•	•
<b>Improved Low Power Aluminum Housing</b>								
4	Electronics Housing without Terminal Block ½–14 NPT conduit, Includes RFI Filters	03031-0635-0101	•	•	•	•	•	•
1	Electronics Cover (Includes wiring label) <sup>(2)</sup>	03031-0292-0001	•	•	•	•	•	•
3	Low Power Terminal Block Assembly <sup>(1)</sup>	03031-0332-1001	•	•	•	•	•	•
3	Low Power Transient Terminal Block Assembly (Option T1) <sup>(2)</sup>	03031-0332-1002	•	•	•	•	•	•
5	Local Zero and Span Kit <sup>(1)</sup>	03031-0293-0002	•	•	•	•	•	•
	External Ground Assembly (Option V5) <sup>(1)</sup>	03031-0398-0001	•	•	•	•	•	•
<b>Improved Low Power 316 SST Housing</b>								
4	Electronics Housing without Terminal Block ½–14 NPT conduit, Includes RFI Filters	03031-0635-0141	•	•	•	•	•	•
1	Electronics Cover (Includes wiring label) <sup>(2)</sup>	03031-0292-0002	•	•	•	•	•	•
3	Low Power Terminal Block Assembly <sup>(1)</sup>	03031-0332-1001	•	•	•	•	•	•
3	Low Power Transient Terminal Block Assembly (Option T1) <sup>(2)</sup>	03031-0332-1002	•	•	•	•	•	•
5	Local Zero and Span Kit <sup>(1)</sup>	03031-0293-0002	•	•	•	•	•	•
	External Ground Assembly (Option V5) <sup>(1)</sup>	03031-0398-0001	•	•	•	•	•	•

TABLE 5-18. (continued) Model 3051C Differential, Gage, Absolute, and Liquid Level Transmitters.

Item No.	Part Description	Part Number	CD	CG	CA	L	H	T
<b>Flanges</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
11	<b>Process Flanges</b>							
	Differential Coplanar Flange							
	Nickel-plated Carbon Steel	03031-0388-0025	•	—	—	—	—	—
	316 SST	03031-0388-0022	•	—	—	—	—	—
11	Hastelloy C	03031-0388-0023	•	—	—	—	—	—
	Monel	03031-0388-0024	•	—	—	—	—	—
	Gage/Absolute Coplanar Flange							
	Nickel-plated Carbon Steel	03031-0388-1025	—	•	•	—	—	—
11	316 SST	03031-0388-1022	—	•	•	—	—	—
	Hastelloy C	03031-0388-1023	—	•	•	—	—	—
	Monel	03031-0388-1024	—	•	•	—	—	—
	Coplanar Flange Alignment Screw (package of 2 screws)	03031-0309-0001	•	•	•	—	—	—
	Traditional Flange							
	316 SST	03031-0320-0002	•	•	•	—	—	—
	Hastelloy C	03031-0320-0003	•	•	•	—	—	—
	Monel	03031-0320-0004	•	•	•	—	—	—
	22	Level Flange, Vertical Mount						
		2 in., Class 150, SST	03031-0393-0221	•	•	•	—	—
2 in., Class 300, SST		03031-0393-0222	•	•	•	—	—	—
3 in., Class 150, SST		03031-0393-0231	•	•	•	—	—	—
3 in., Class 300, SST		03031-0393-0232	•	•	•	—	—	—
DIN, DN 50, PN 40		03031-0393-1002	•	•	•	—	—	—
35	DIN, DN 80, PN 40	03031-0393-1012	•	•	•	—	—	—
	3051H Flanges							
35	Process Flange	02051-0072-0002	—	—	—	—	•	—
	Blank Flange (GP Low Side)	02051-0236-0002	—	—	—	—	•	—
<b>Flange Adapter Union</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
15	Nickel-plated Carbon Steel	02024-0069-0005	•	•	•	—	—	—
	316 SST	02024-0069-0002	•	•	•	—	—	—
	Hastelloy C	02024-0069-0003	•	•	•	—	—	—
	Monel	02024-0069-0004	•	•	•	—	—	—
<b>Drain/Vent Valve Kits</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
9	<b>Differential Drain/Vent Kits<sup>(1)</sup></b>							
	316 SST Stem and Seat Kit	01151-0028-0022	•	—	—	—	•	—
	Hastelloy C Stem and Seat Kit	01151-0028-0023	•	—	—	—	•	—
	Monel Stem and Seat Kit	01151-0028-0024	•	—	—	—	•	—
	316 SST Ceramic Ball Drain/Vent Kit	01151-0028-0122	•	—	—	—	•	—
	Hastelloy C Ceramic Ball Drain/Vent Kit	01151-0028-0123	•	—	—	—	•	—
	Monel Ceramic Ball Drain/Vent Kit	01151-0028-0124	•	—	—	—	•	—
	<b>Gage/Absolute Drain/Vent Kits<sup>(1)</sup></b>							
	316 SST Stem and Seat Kit	01151-0028-0012	—	•	•	•	•	—
	Hastelloy C Stem and Seat Kit	01151-0028-0013	—	•	•	•	•	—
	Monel Stem and Seat Kit	01151-0028-0014	—	•	•	•	•	—
	316 SST Ceramic Ball Drain/Vent Kit	01151-0028-0112	—	•	•	•	•	—
	Hastelloy C Ceramic Ball Drain/Vent Kit	01151-0028-0113	—	•	•	•	•	—
	Monel Ceramic Ball Drain/Vent Kit (Each kit contains parts for one transmitter.)	01151-0028-0114	—	•	•	•	•	—
<b>O-Ring Packages</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
2	Electronic Housing, Cover (Std. and Meter) <sup>(1)</sup>	03031-0232-0001	•	•	•	•	•	•
7	Electronics Housing, Module <sup>(1)</sup>	03031-0233-0001	•	•	•	•	•	•
10	Process Flange, Glass-filled Teflon <sup>(1)</sup>	03031-0234-0001	•	•	•	—	—	—
	Process Flange, Graphite-filled Teflon <sup>(1)</sup>	03031-0234-0002	•	•	•	—	—	—
12	Flange Adapter, Glass-filled Teflon <sup>(1)</sup>	03031-0242-0001	•	•	•	—	—	—
	Flange Adapter, Graphite-filled Teflon <sup>(1)</sup>	03031-0242-0002	•	•	•	—	—	—
38	3051H Process Flange, TFE	02051-0167-0001	—	—	—	—	•	—

**Rosemount Model 3051 Transmitter for Flow, Level, and Pressure Measurement**

TABLE 5-18. (continued) Model 3051C Differential, Gage, Absolute, and Liquid Level Transmitters.

Item No.	Part Description	Part Number						
<b>Mounting Brackets</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
	Coplanar Flange Bracket Kit B4 Bracket, SST, 2-in. Pipe Mount, SST Bolts	03031-0189-0003	•	•	•	—	—	—
	3051T Bracket Kit B4 Bracket, SST, 2-in. Pipe Mount, SST Bolts	02088-0071-0001	—	—	—	—	—	•
	Traditional Flange Bracket Kits							
	B1 Bracket, 2-in. Pipe Mount, CS Bolts	03031-0313-0001	•	•	•	—	—	—
	B2 Bracket, Panel Mount, CS Bolts	03031-0313-0002	•	•	•	—	—	—
	B3 Flat Bracket for 2-in. Pipe Mount, CS Bolts	03031-0313-0003	•	•	•	—	—	—
	B7 (B1 Style Bracket with SST Bolts)	03031-0313-0007	•	•	•	—	—	—
	B8 (B2 Style Bracket with SST Bolts)	03031-0313-0008	•	•	•	—	—	—
	B9 (B3 Style Bracket with SST Bolts)	03031-0313-0009	•	•	•	—	—	—
	BA (SST B1 Bracket with SST Bolts)	03031-0313-0011	•	•	•	—	—	—
	BC (SST B3 Bracket with SST Bolts)	03031-0313-0013	•	•	•	—	—	—
	3051H Bracket Kits							
	B5 Universal Bracket for 2-in. Pipe and Panel Mount, CS Bolts	03051-1081-0001	—	—	—	—	•	—
	B6 Universal Bracket for 2-in. Pipe or Panel Mount, SST Bolts	03051-1081-0002	—	—	—	—	•	—

TABLE 5-18. (continued) Model 3051C Differential, Gage, Absolute, and Liquid Level Transmitters.

Item No.	Part Description	Part Number						
			CD	CG	CA	L	H	T
<b>Bolt Kits</b>								
25	<b>Coplanar Flange</b> Flange Bolt Kit {44 mm (1.75 in.)} Carbon Steel (set of 4)	03031-0312-0001	•	•	•	—	—	—
	316 SST (set of 4)	03031-0312-0002	•	•	•	—	—	—
	ANSI/ASTM-A-193-B7M	03031-0312-0003	•	•	•	—	—	—
	Monel	03031-0312-0004	•	•	•	—	—	—
26	Flange/Adapter Bolt Kit {73 mm (2.88 in.)} Carbon Steel (set of 4)	03031-0306-0001	•	•	•	—	—	—
	316 SST (set of 4)	03031-0306-0002	•	•	•	—	—	—
	ANSI/ASTM-A-193-B7M	03031-0306-0003	•	•	•	—	—	—
	Monel	03031-0306-0004	•	•	•	—	—	—
27	Manifold/Flange Kit {57 mm (2.25 in.)} Carbon Steel (set of 4)	03031-0311-0001	•	—	—	—	—	—
	316 SST (set of 4)	03031-0311-0002	•	—	—	—	—	—
	ANSI/ASTM-A-193-B7M	03031-0311-0003	•	—	—	—	—	—
	Monel	03031-0311-0004	•	—	—	—	—	—
28	<b>Traditional Flange</b> Differential Flange and Adapter Bolt Kit {44 mm (1.75 in.)} Carbon Steel (set of 8)	03031-0307-0001	•	—	—	—	—	—
	316 SST (set of 8)	03031-0307-0002	•	—	—	—	—	—
	ANSI/ASTM-A-193-B7M	03031-0307-0003	•	—	—	—	—	—
	Monel	03031-0307-0004	•	—	—	—	—	—
	Gage/Absolute Flange and Adapter Bolt Kit Carbon Steel (set of 6)	03031-0307-1001	—	•	•	—	—	—
	316 SST (set of 6)	03031-0307-1002	—	•	•	—	—	—
	ANSI/ASTM-A-193-B7M	03031-0307-1003	—	•	•	—	—	—
	Monel	03031-0307-1004	—	•	•	—	—	—
	Manifold/Traditional Flange Bolts Carbon Steel	Use Bolts Supplied with Anderson Greenwood Manifold						
	316 SST	Use Bolts Supplied with Anderson Greenwood Manifold						
23	<b>Level Flange, Vertical Mount</b> Flange Bolt Kit Carbon Steel (set of 4)	03031-0395-0001	•	•	•	—	—	—
	316 SST (set of 4) (Each kit contains bolts for one transmitter.)	03031-0395-0002	•	•	•	—	—	—
36	<b>3051H Flange</b> Process Flange Bolt Kit, Carbon Steel Flange Bolt (set of 4)	02051-0164-0001	—	—	—	—	•	—
	Flange Nut (set of 4)							
37	Adapter Bolts (set of 4)							
	Process Flange Bolt Kit, 316 SST Bolt for Process Flange (set of 4)	02051-0164-0002	—	—	—	—	•	—
37	Nut for Process Flange (set of 4)							
	Adapter Bolts (set of 4)							

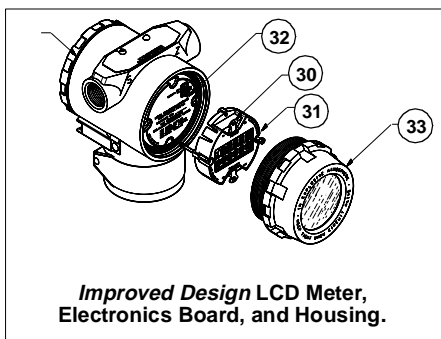
(1) One spare part is recommended for every 25 transmitters.

(2) One spare part is recommended for every 50 transmitters

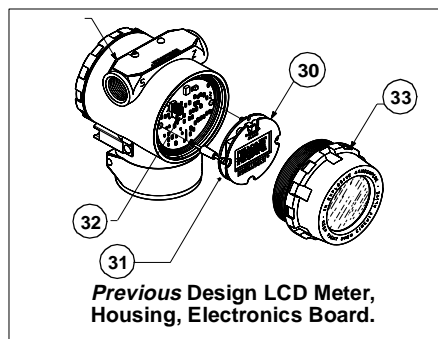


TABLE 5-19. Indicating Meter Option

Item No.	Part Description	Part Number	CD	CG	CA	L	H	T
<b>Meter for Improved Aluminum Housing</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
	<i>Meter Kit</i>	03031-0193-0101	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
33	Cover Assembly							
	<i>Meter Hardware Only</i>	03031-0193-0103	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
	<i>Cover Assembly Kit</i>	03031-0193-0002	•	•	•	•	•	•
<b>Meter for Improved 316 SST Housing</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
	<i>Meter Kit</i> <sup>(1)</sup>	03031-0193-0111	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
33	Cover Assembly							
	<i>Meter Hardware Only</i>	03031-0193-0103	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
	<i>Cover Assembly Kit</i>	03031-0193-0012	•	•	•	•	•	•
<b>Meter for Previous Aluminum Housing</b>			<b>CD</b>	<b>CG</b>	<b>CA</b>	<b>L</b>	<b>H</b>	<b>T</b>
30–33	<i>Previous Meter Kit</i> <sup>(1)</sup>	03031-0193-0001	•	•	•	•	•	•
<i>NOTE: Previous Meter Kit includes meter display, captive mounting hardware, 6-pin interconnection header, and cover assembly.</i>								
	<i>Improved Kit for Previous Aluminum Housing</i> <sup>(1)</sup>	03031-0193-1101	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
33	Cover Assembly							
30–32	<i>Previous Meter Hardware Only</i> <sup>(1)</sup>	03031-0193-0003	•	•	•	•	•	•
<i>NOTE: Previous Meter Hardware includes meter display, captive mounting hardware, and 6-pin interconnection header only.</i>								
	<i>Improved Meter for Previous Housing</i>	03031-0193-1103	•	•	•	•	•	•
30	Meter Display							
31	Captive Mounting Hardware							
32	10-pin Interconnection Header							
	<i>Cover Assembly Kit</i>	03031-0193-0002	•	•	•	•	•	•



3051-3031A05A



3051-3031B05A

LCD Meter and Housing Exploded Views, Improved and Previous Design.

TABLE 5-19. Indicating Meter Option

Item No.	Part Description	Part Number	CD	CG	CA	L	H	T
<b>Meter for Previous 316 SST Housing</b>								
30-33	Previous Meter Kit <sup>(1)</sup>	03031-0193-0011	•	•	•	•	•	•
<i>NOTE: Previous Meter Kit includes meter display, captive mounting hardware, 6-pin interconnection header, and cover assembly.</i>								
30	Improved Kit for Previous SST Housing <sup>(1)</sup>	03031-0193-1111	•	•	•	•	•	•
31	Meter Display							
32	Captive Mounting Hardware							
33	10-pin Interconnection Header							
33	Cover Assembly							
30-32	Previous Meter Hardware Only <sup>(1)</sup>	03031-0193-0003	•	•	•	•	•	•
<i>NOTE: Previous Meter Hardware includes meter display, captive mounting hardware, and 6-pin interconnection header only.</i>								
30	Improved Meter for Previous Housing <sup>(1)</sup>	03031-0193-1103	•	•	•	•	•	•
31	Meter Display							
32	Captive Mounting Hardware							
32	10-pin Interconnection Header							
	Cover Assembly Kit	03031-0193-0012	•	•	•	•	•	•

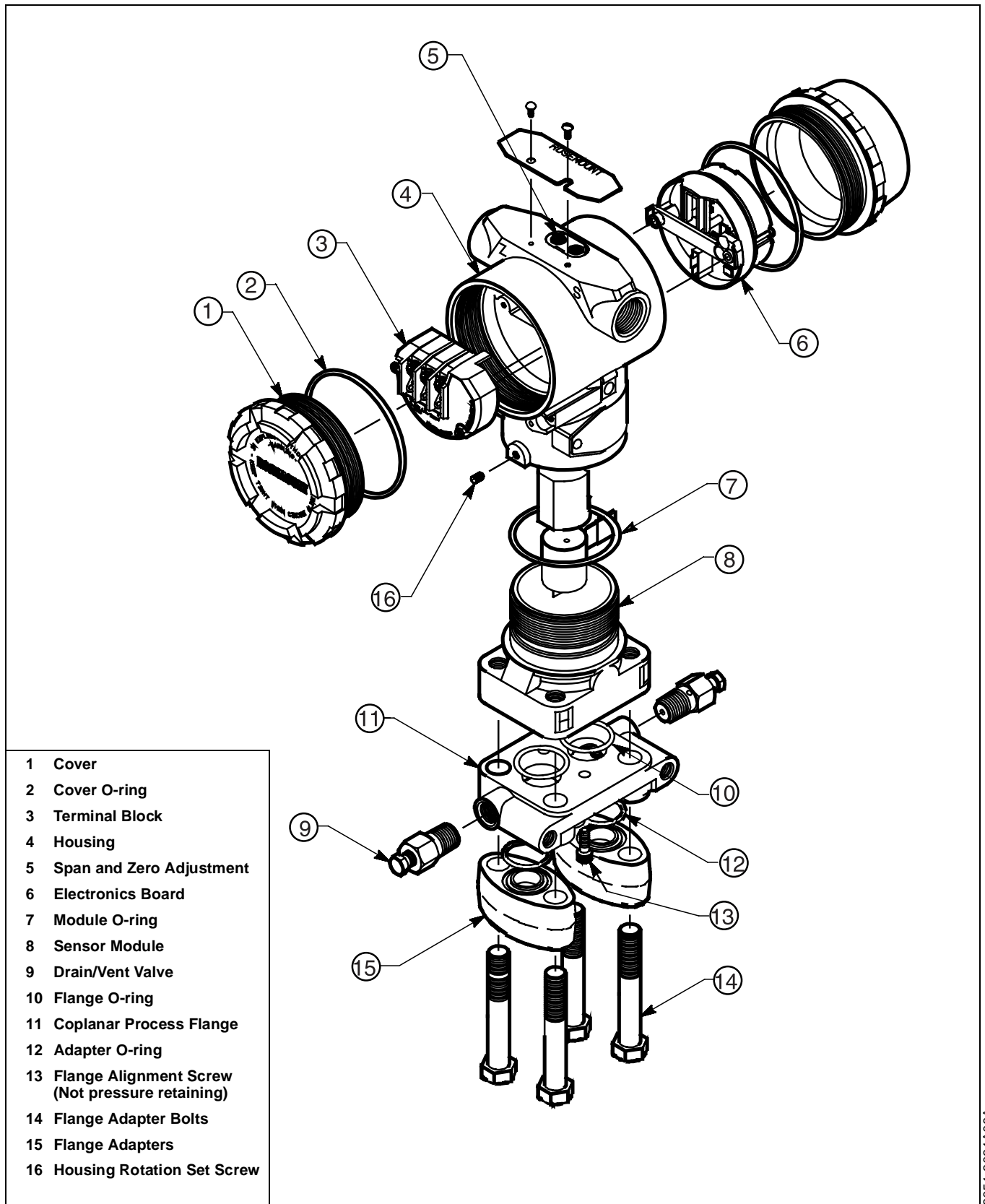


Figure 5-2. Model 3051C Exploded View (with Coplanar Flange).

3051-3031A08A

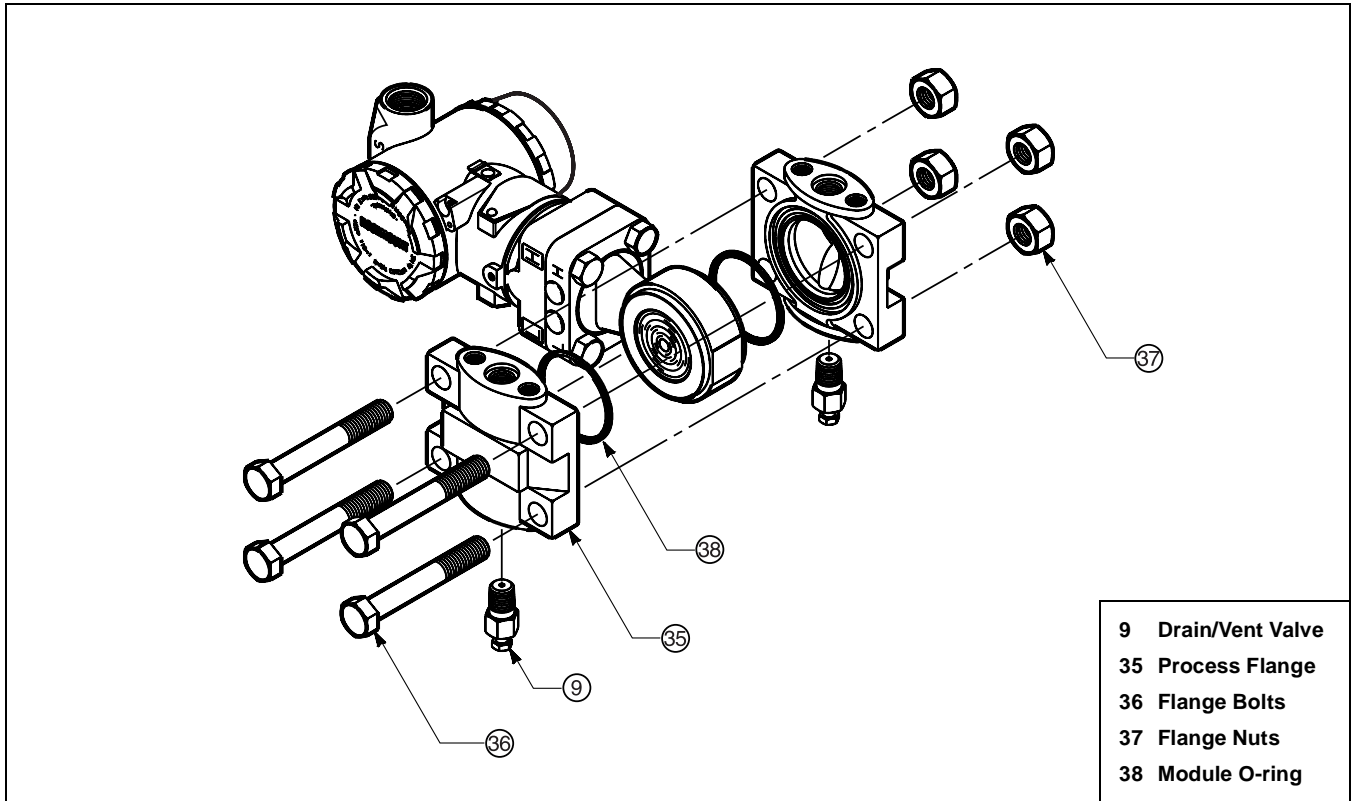


Figure 5-3. Model 3051H Exploded View.

3051-3051HB2A

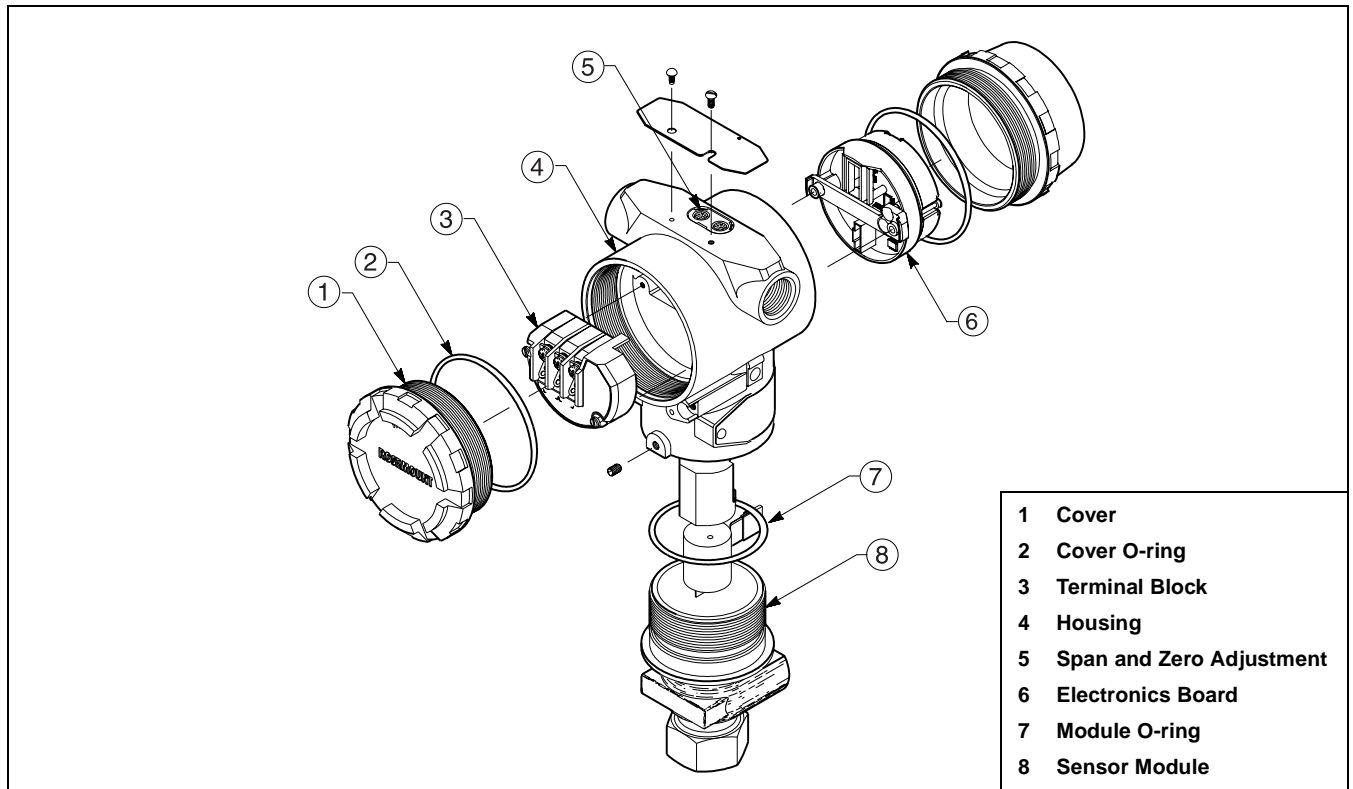
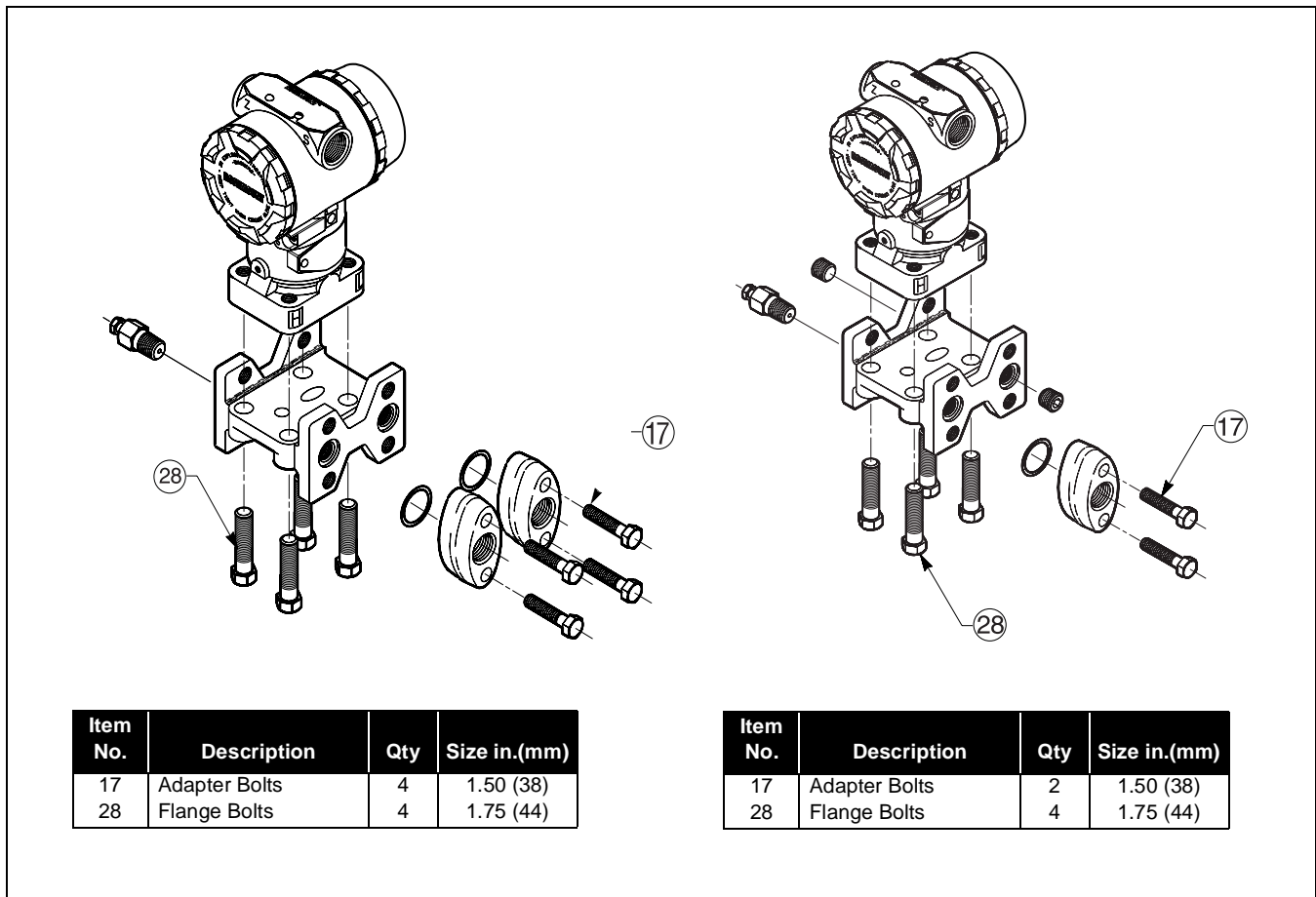


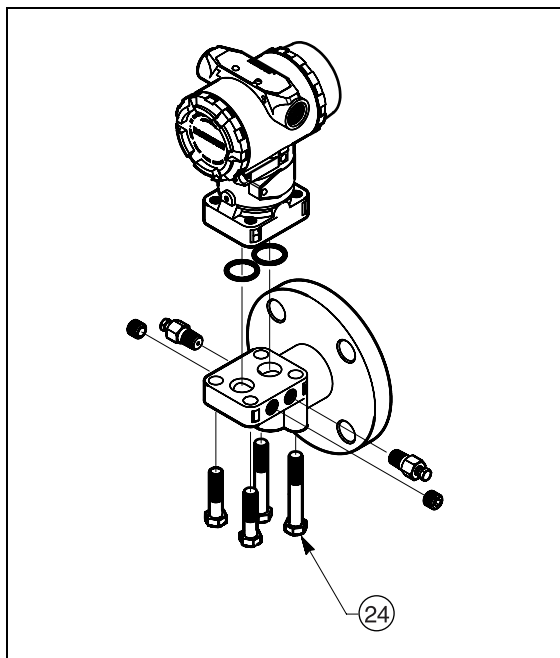
Figure 5-4. Model 3051T Exploded View.

3051-3051A08A



3051-3031B07M 3051-3051B07L

Figure 5-5. Traditional Flange Configuration.

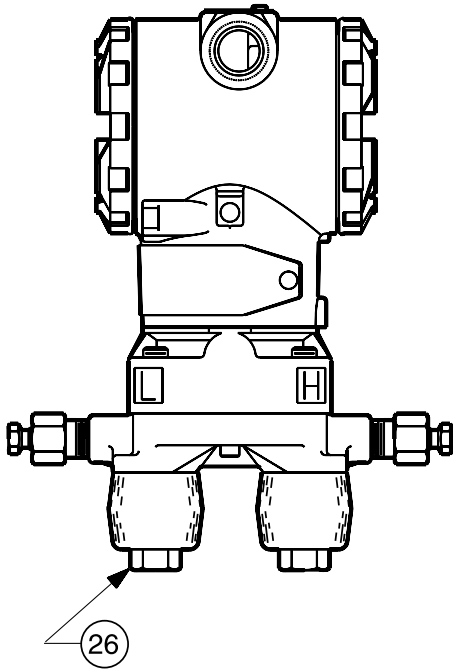


3001-3001A01G

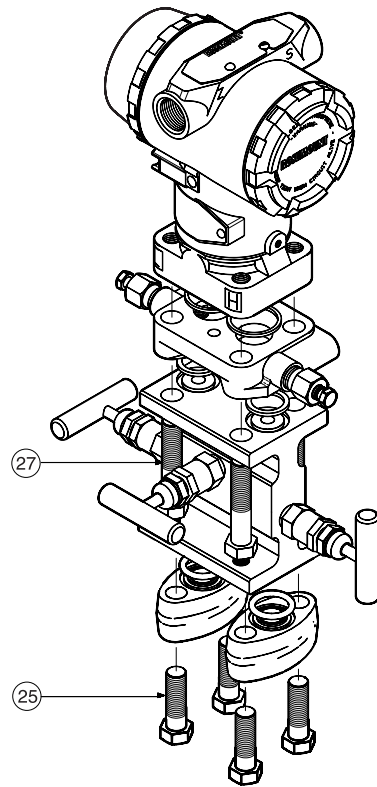
Item No.	Description	Qty	Size in.(mm)
24	Flange Bolts	2	1.75 (44)
		2	2.875 (73)

Figure 5-6. Level Flange, Vertical Mount.

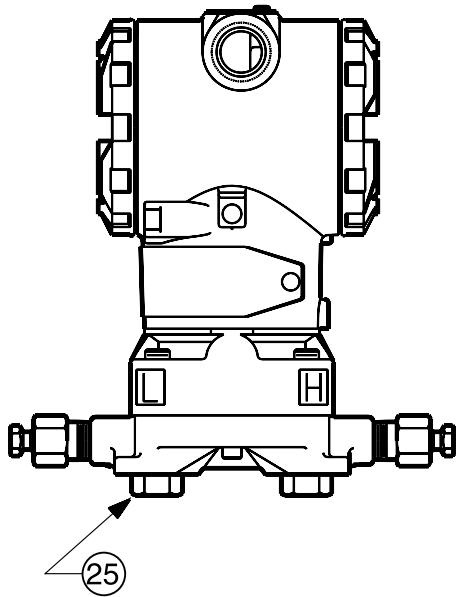
Transmitter with Coplanar Flange and Flange/Adapter Bolts



Transmitter with Coplanar Flange, 3-Valve Manifold, and Flange Adapters (Differential Version)



Transmitter with Coplanar Flange and Flange Bolts



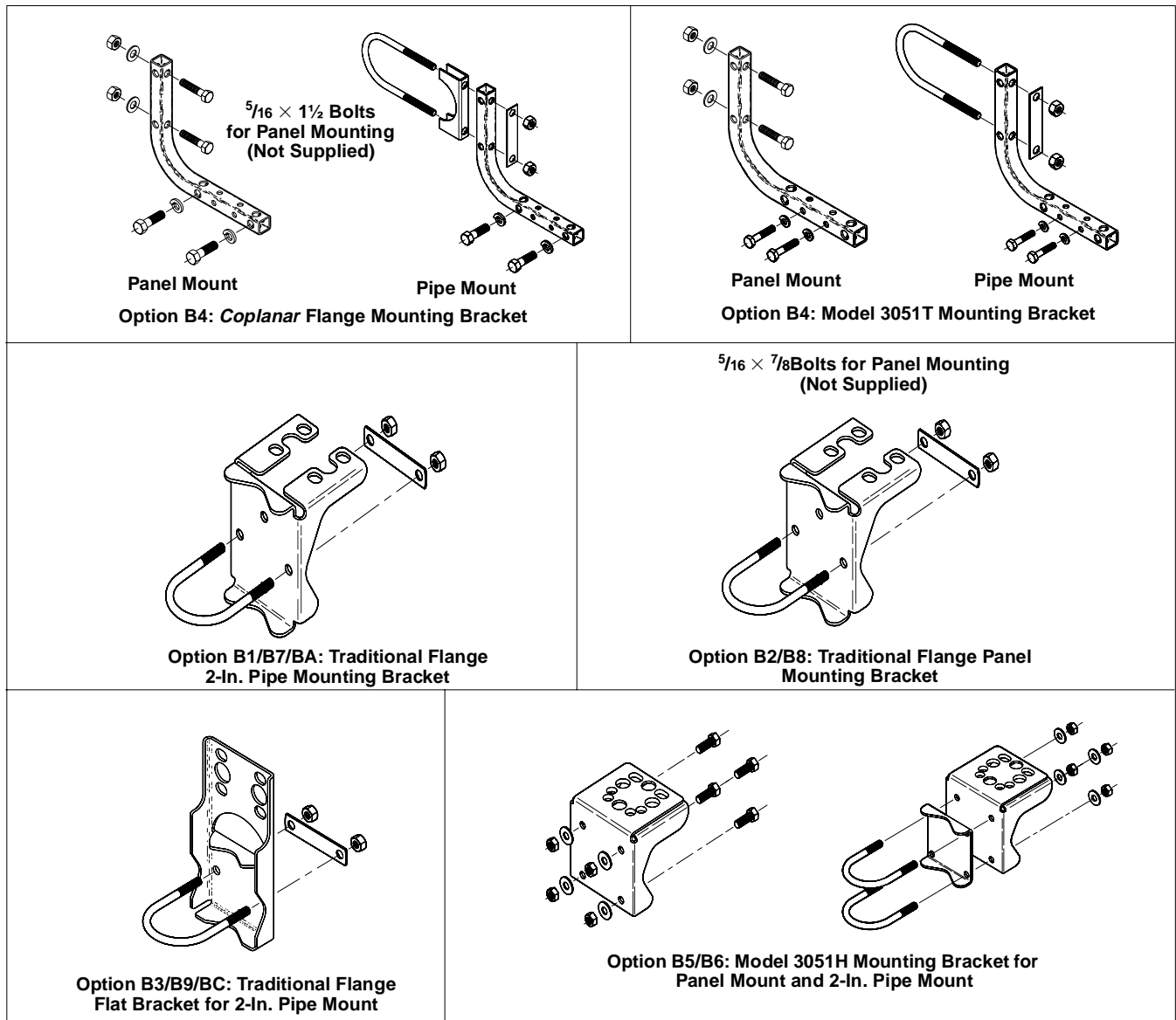
Item No.	Description	Qty	Size in.(mm)
25	Adapter Bolts	4	1.50 (38)
26	Flange/Adapter Bolts	4	2.88 (73)
27	Manifold/Flange Bolts	4	2.25 (57)

Item No.	Description	Qty	Size in.(mm)
25	Flange Bolts	4	1.75 (44)

Figure 5-7. Bolting Configurations for Coplanar Flange (Top–Differential/Bottom–Gage/Absolute).

3051-3031E06D 3051-305-3031A29P

3051-3031E06F



3051-3031-I04B, J04B, I04B, I04B, 2088-2088A04A, 3051-3031C19A, H19A, F19A, F19B, G19A

Figure 5-8. Mounting Bracket Kits.

# Options

## OVERVIEW

The options available with the Model 3051 can ease installation, improve the security of control systems, and simplify use. Included in this section is a description of LCD meter diagnostic messages.

## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

### Warnings (⚠)

#### ⚠ WARNING

##### Explosions can result in death or serious injury.

- Do not remove the instrument cover in explosive environments when the circuit is alive.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

#### ⚠ WARNING

##### Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals.

## LOCAL ZERO AND SPAN ADJUSTMENT OPTIONS

The integral zero and span adjustments can be used for adjusting the analog output without the use of a HART communicator. Option Code J1 provides only external local zero adjustment. Option Code J3 excludes both the local zero and span adjustments.

The push-button span and zero adjustments are hidden by the certification label on top of the transmitter. Loosen the label screw and rotate the label counterclockwise to expose the adjustments.

### Activating Local Zero and Span Adjustments

To activate local zero and span adjustments, locate the Z and S buttons on top of the transmitter. Press and hold either button for two seconds.

#### NOTE

On previous style Model 3051 transmitters, the zero and span settings are magnetic screws. To activate the previous style adjustments, unscrew the magnetic zero or span screw until it pops up. Leave it popped up for two seconds, then screw it back down.



## Disabling Local Zero and Span Adjustments

The local zero and span adjustments on the Model 3051 can be controlled three ways:

1. **Transmitter Security Jumper.** Enabling the transmitter security jumper on the circuit board prevents all changes to the transmitter's configuration data. The security jumper prevents configuration changes from HART communicators and from the local zero and span adjustments. See "Transmitter Security" on page 2-4.
2. **Communicator Software Lockout Sequence.** The communicator software lockout sequence disables only the span and zero adjustments. Changes can still be made using the HART communicator. See "Local Zero and Span Adjustment Options" on page 6-1.
3. **Remove the Zero and Span Buttons.** To remove the local zero and span buttons, use a small screwdriver to remove the blue plastic cover plate securing the buttons to the transmitter housing. After removing the cover plate, the button assemblies—including buttons, springs, and magnets—will slide out. For future use, store the buttons separately to ensure that the magnets maintain their proper strength.

## LCD METER

The LCD meter provides local indication of the output and abbreviated diagnostic messages governing transmitter operation. The meter is located on the electronics module side of the transmitter, maintaining direct access to the signal terminals. An extended cover is required to accommodate the meter.

The meter features a two-line display with five digits for reporting the process variable on the top line and six characters for displaying engineering units on the bottom line<sup>(1)</sup>. The new LCD meter can also display flow and level scales. The meter uses both lines to display diagnostic messages. The meter can be configured to display the following information:

- engineering units
- percent of range
- user-configurable LCD scale<sup>(2)</sup>
- alternating between any two of the above

(1) Previous versions differ slightly.

(2) Not available on previous versions of the LCD meter or with low-power transmitters.

## Custom Meter Configuration

The user-configurable scale is a feature that enables the LCD meter to display flow, level, or custom pressure units. The meter can be configured using a Model 275 HART Communicator (see Table A-1 on page A-3) or AMS.

The user-configurable scale feature can define:

- decimal point position
- upper range values
- lower range values
- engineering units
- transfer function

To configure the meter using AMS, click the **LOCAL DISPLAY** tab on the **CONFIGURATION PROPERTIES** screen. To configure the meter with a HART communicator, perform the following procedure:

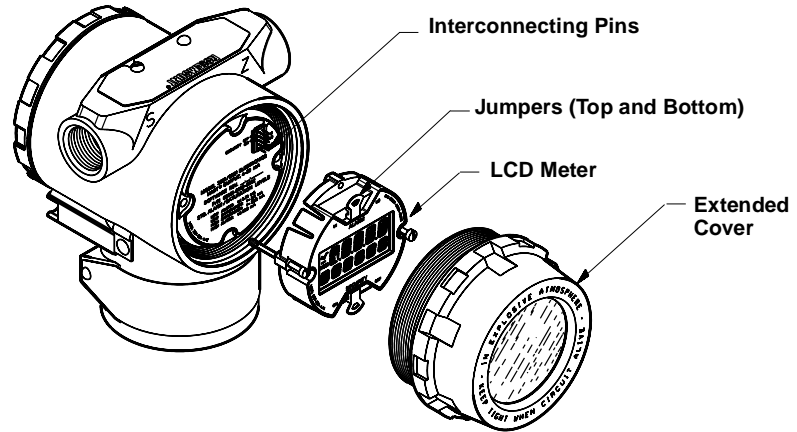


1. Connect the communicator to the transmitter. Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed according to intrinsically safe or nonincendive field wiring practices.
2. From the **ONLINE** screen, select *1 Device Setup, 3 Basic Setup, 7 Meter Options, 2 Custom Meter Setup*.
3. To specify decimal point position:
  - a. Select *1 Sel dec pt pos*. Choose the decimal point representation that will provide the most accurate output for your application. For example, when outputting between 0 and 75 GPM, choose *XX.XXX*.
  - b. Go to step 8.
4. To specify a custom upper range value:
  - a. Select *2 CM Upper Value*. Type the value that you want the transmitter to read at the 20 mA point.
  - b. Go to step 8.
5. To specify a custom lower range value:
  - a. Select *3 CM Lower Value*. Type the value that you want the transmitter to read at the 4 mA point.
  - b. Go to step 8.
6. To define custom units:
  - a. Select *4 CM Units*. Enter the custom units (five characters maximum) that you want the meter to display.
  - b. Go to step 8.
7. To choose the transmitter transfer function for the meter:
  - a. Select *5 CM xfer fnct*. Enter the transmitter transfer function for the meter. Select *sq root* to display flow units. The custom meter transfer function is independent of the analog output transfer function.
8. Select **F2 SEND** to upload the configuration to the transmitter.



See "Safety Messages" on page 6-1 for complete warning information.

FIGURE 6-1. Exploded View of the Model 3051 with Optional LCD Meter.



3051-A05E

### Installing the Meter

For transmitters ordered with the LCD meter, the meter is shipped installed. Installing the meter on an existing Model 3051 transmitter requires a small instrument screwdriver and the meter kit.

The kits vary depending on the version of transmitter electronics. Examine the following numbers carefully to ensure you are installing the correct kit.

#### For Use with Shrouded Electronics Board

##### Meter Kits

Option M5: P/N 03031-0193-0101

Option M6: P/N 03031-0193-0111

#### For Use with Non-Shrouded Electronics Board

##### Meter Kits


Option M5: P/N 03031-0193-0001

Option M6: P/N 03031-0193-0011

The meter kit includes:

- one LCD meter assembly
- one extended cover with O-ring installed
- two nylon standoffs
- two captive screws
- one ten-pin interconnection header

Use the following procedure and Figure 6-1 to install the LCD meter. If the meter is an upgrade from a previous version, upgrade the electronics board before attempting to install the meter.


1. **IF** the transmitter is installed in a loop, **THEN** secure the loop and disconnect power.
-  2. Remove the transmitter cover opposite the field terminal side. Do not remove the instrument covers in explosive environments when the circuit is alive.
3. Remove the failure mode and alarm jumpers from the electronics module and insert them in their new positions above and below the meter readout on the meter assembly.

---


**NOTE**

On previous versions, remove only the alarm jumper.

---

4. Insert the interconnection header in the ten-pin socket exposed by removal of the jumpers. (Previous versions of the meter use a six-pin connector.)
5. Remove the two captive screws from the electronics module. To do so, loosen the screws to release the module, then pull out the screws until they are stopped by the captive thread inside of the circuit board standoffs. Continue loosening the screws and remove them.
6. If necessary, rotate the electronics housing up to 180 degrees (left or right) to improve field access or to better view the LCD meter. To rotate the housing:
  - a. Loosen the housing rotation set screw using a  $\frac{9}{64}$ -in. hex wrench.
  - b. Turn the housing up to 180 degrees to the left or right of its original (as shipped) position. **Do not rotate the housing more than 180 degrees without first performing a disassembly procedure (see “Disassembly Procedures” on page 4-3). Over-rotation will sever the electrical connection between the sensor module and the electronics module.**
  - c. Retighten the housing rotation set screw.
7. Decide which direction to orient the meter. Insert the long meter screws into the two holes on the meter assembly that coincide with the holes on the electronics module. You can install the meter in 90-degree increments for easy viewing. Position one of the four connectors on the back of the meter assembly to accept the interconnection header.
8. Attach the meter assembly to the electronics module by threading the screws into the captive threads and attaching the meter assembly to the interconnection pins. Tighten the screws to secure the meter assembly and electronics board in place.
-  9. Attach and tighten the extended cover. Transmitter covers must be fully engaged to meet explosion proof requirements and to achieve the proper environmental seal.

Note the following LCD temperature limits:

 See “Safety Messages” on page 6-1 for complete warning information.

**Operating:** -4 to 175 °F (-20 to 80 °C)

**Storage:** -40 to 185 °F (-40 to 85 °C)

---

**NOTE**

Electronics board revision 5.3.163 or later (all shrouded designs) are able to verify alarm current levels. After replacing the transmitter electronics board, sensor module, or LCD meter, an alarm level test is recommended before returning the transmitter to service (see “Alarm Level Verification” on page 2-3).

---

FIGURE 6-2. Model 3051 with Optional LCD Meter.



## Diagnostic Messages

In addition to the output, the LCD meter displays abbreviated operation, error, and warning messages for troubleshooting the transmitter. Messages appear according to their priority, with normal operating messages appearing last. To determine the cause of a message, use a Model 275 HART Communicator to further interrogate the transmitter. A description of each LCD diagnostic message follows.

### Error

Error messages appear on the LCD meter display to inform you of serious problems effecting the operation of the transmitter. The meter displays an error message until the error condition is corrected, and the analog output is driven to the specified alarm level. No other transmitter information is displayed during an alarm condition.

#### **FAIL<sup>(1)</sup>**

The transmitter CPU board and the sensor module are incompatible. If you encounter this message, contact Rosemount Customer Central at 800-999-9307 if you need assistance.

(1) For previous versions of the meter, FAIL MODULE and FAIL ELECT were also grouped into the FAIL message. When dealing with a FAIL message on a previous version meter, review the information in the FAIL MODULE and FAIL ELECT sections as well.

## FAIL MODULE

The sensor module is disconnected or is malfunctioning. Verify that the sensor module ribbon cable is connected to the back of the electronics board. If the ribbon cable is properly connected, there is a problem within the sensor module. Possible sources of problems include:

- Pressure or temperature updates are not being received in the sensor module.
- A non-volatile memory fault that will effect transmitter operation has been detected in the module by the memory verification routine.

Some non-volatile memory faults are user-repairable. Use a Model 275 HART Communicator to diagnose the error and determine if it is repairable. Any error message that ends in “FACTORY” is not repairable. In cases of non user-repairable errors, you must replace the sensor module. See “**Disassembly Procedures**” on page 4-3 or contact Rosemount Customer Central at 800-999-9307 if you need assistance.

## FAIL ELECT

The transmitter electronics board is malfunctioning due to an internal fault. Some of the FAIL ELECT errors are user-repairable. Use a Model 275 HART Communicator to diagnose the error and determine if it is repairable. Any error message that ends in “FACTORY” is not repairable. In cases of non user-repairable errors, you must replace the electronics board. See “Remove the Electronics Board” on page 4-4 or contact Rosemount Customer Central at 800-999-9307 if you need assistance.

## FAIL CONFIG

A memory fault has been detected in a location that could effect transmitter operation, and is user-accessible. To correct this problem, use a Model 275 HART Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory. Contact Rosemount Customer Central at 800-999-9307 if you need assistance.

## Warnings

Warnings appear on the LCD meter display to alert you of user-repairable problems with the transmitter, or current transmitter operations. Warnings appear alternately with other transmitter information until the warning condition is corrected or the transmitter completes the operation that warrants the warning message.

---

## NOTE

The warning messages on previous versions of the LCD meter may vary slightly from those listed here, but they represent the same warning.

---

## PRESS LIMIT

The process variable read by the transmitter is outside of the transmitter’s range.

## TEMP LIMIT

The secondary temperature variable read by the transmitter is outside of the transmitter’s range.

**CURR FIXED**

The transmitter is in multidrop mode. The analog output is not tracking pressure changes.

**CURR SATURD**

The pressure read by the module is outside of the specified range, and the analog output has been driven to saturation levels. See “Failure Mode Alarm” on page 2-2.

**LOOP TEST**

A loop test is in progress. During a loop test or 4–20 mA trim, the analog output is set to a fixed value. The meter display alternates between the current selected in milliamps and “LOOP TEST.”

**XMTR INFO**

A non-volatile memory fault has been detected in the transmitter memory by the memory verification routine. The memory fault is in a location containing transmitter information. To correct this problem, use a Model 275 HART Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory. This warning does not effect the transmitter operation. Contact Rosemount Customer Central at 800-999-9307 if you need assistance.

**Operation**

Normal operation messages appear on the LCD meter to confirm actions or inform you of transmitter status. Operation messages are displayed with other transmitter information, and warrant no action to correct or alter the transmitter settings.

**ZERO PASS**

The zero value, set with the local zero adjustment button, has been accepted by the transmitter, and the output should change to 4 mA.

**ZERO FAIL**

The zero value, set with the local zero adjustment button, exceeds the maximum rangedown allowed for a particular range, or the pressure sensed by the transmitter exceeds the sensor limits.

**SPAN PASS**

The span value, set with the local span adjustment button, has been accepted by the transmitter, and the output should change to 20 mA.

**SPAN FAIL**

The span value, set with the local span adjustment button, exceeds the maximum rangedown allowed for a particular range, or the pressure sensed by the transmitter exceeds the sensor limits.

**LOCAL DSBLD**

This message appears during reranging with the integral zero and span buttons and indicates that the transmitter local zero and span adjustments have been disabled. The adjustments may have been disabled by the transmitter security jumper on the transmitter circuit board or through software commands from the Model 275. See “Transmitter Security” on page 2-4 for information on the position of the security jumper, and “Disabling Local Zero and Span Adjustments” on page 6-2 for information on the software lockout.

**WRITE PROTECT**

This message appears if you attempt to change the transmitter configuration data while the security jumper is in the **ON** position. See “Transmitter Security” on page 2-4 for more information about the security jumper.

**MOUNTING BRACKETS**

Optional mounting brackets available with the Model 3051 facilitate mounting to a 2-inch pipe or to a panel. The standard bracket (Option B4) for use with the Coplanar flange and the Model 3051T is stainless steel with stainless steel bolts. Figure 3-10 on page 3-14 shows bracket dimensions and mounting configurations for the B4 option.

Options B1–B3 and B7–B9 are sturdy, epoxy-polyester-painted brackets designed for use with the traditional flange. The B1–B3 brackets have carbon steel bolts, while the B7–B9 brackets have stainless steel bolts. The BA and BC brackets are stainless steel with stainless steel bolts. The B1/B7/BA and B3/B9/BC style brackets support 2-inch pipe mounting installations, and the B2/B8 style brackets support panel mounting. Figures 3-12 and 3-13 on page 3-16 show these optional mounting brackets.

When installing the transmitter to one of the optional mounting brackets, torque the bolts to 125 inch-pounds. See “Mounting” on page 3-9 for additional mounting considerations.

**Custom Configuration (C1)**

The C1 option allows the customer to specify the following data in addition to the standard configuration parameters in the software memory:

Descriptor	Message
Date	Damping
Remote Seal	Write Protect Jumper Setting
Burst Mode Configuration	Multidrop Configuration
Alarm Jumper Setting	Local Zero and Span Control
Custom Meter Display Configuration	

A Model 3051 Configuration Data Sheet (CDS) begins on page 6-15. Use the CDS to record configuration data and options.

**Level Flange (F1, F2, G1, G2, FA, FB, FC, and FD)**

This option provides a flange for the Model 3051C that converts it to a horizontal mount level transmitter or a vertical mount level transmitter. A vented fitting on the low pressure side of the flange makes it suitable for use with a gage pressure transmitter. The fitting can be removed and replaced with impulse piping or wet leg connections when a low pressure reference is required for differential pressure measurements.

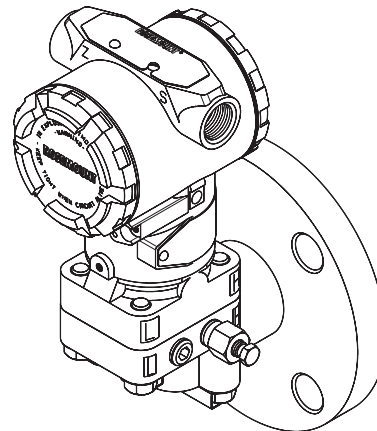


**Vertical Mount (FA, FB, FC, FD, FP, and FQ)**

Figure 6-3 shows the vertical mount level flange. Flanges are available in the sizes and ratings indicated by the following option codes:

Option	Description	Flange Rating
FA	316 SST, 2 in., ANSI Class 150, Vertical Mount	275 psi at 100 °F
FB	316 SST, 2 in., ANSI Class 300, Vertical Mount	720 psi at 100 °F
FC	316 SST, 3 in., ANSI Class 150, Vertical Mount	275 psi at 100 °F
FD	316 SST, 3 in., ANSI Class 300, Vertical Mount	720 psi at 100 °F
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount	40 bar at 120 °C
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount	40 bar at 120 °C

FIGURE 6-3. Vertical Mount Level Flange.



3001-3001A01A

**Traditional Flange (H2, H3, H4, H7, HJ, HK, and HL)**

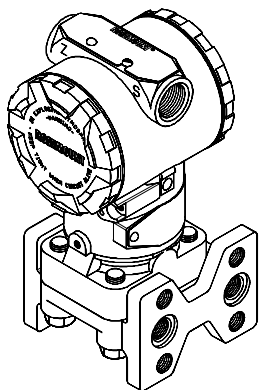
The traditional flange option converts the mounting configuration of the Model 3051 to one similar to traditional style transmitters. This allows the Model 3051 to replace traditional transmitters without changing existing manifolds, impulse piping, or bracket arrangements. The traditional flange also allows a higher process temperature at the process ports (300 °F [149 °C]) because of its ability to dissipate heat. Process ports on the traditional flange meet DIN STD. 19213 with 2.13 ± 0.008 in. (54 ± 0,203 mm) connection centers. Different traditional flange materials of construction are as follows:

TABLE 6-1. Traditional Flange Materials and Bolt Sizes.

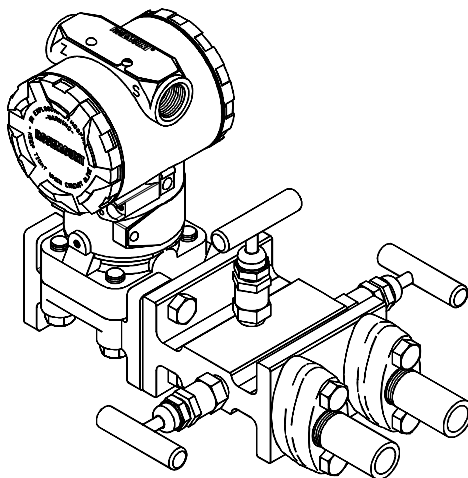
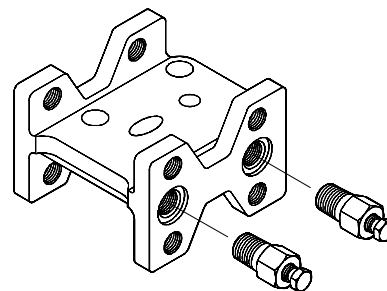
Option Code	Flange Material	Drain/Vent Valve Material	Flange Adapter Material	Flange to Adapter Bolt Size Length/Diameter
H2	316 SST	SST	SST	7/16-in.
H3	Hastelloy C	Hastelloy C	Hastelloy C	7/16-in.
H4	Monel	Monel	Monel	7/16-in.
H7	316 SST	Hastelloy C	SST	7/16-in.
HJ	SST	SST	SST	7/16-in.
HK	SST	SST	N/A	10 mm
HL	SST	SST	N/A	12 mm

The traditional flange fits most existing mounting brackets. If a new bracket is required, use one of the bracket options described earlier. Figure 6-5 shows the traditional flange.

FIGURE 6-4. Traditional Flange.

TRADITIONAL FLANGE  
AND MODEL 3051C

CONNECTION TO A MANIFOLD

TRADITIONAL FLANGE WITH  
DRAIN/VENTS

3051-3031B07A, B07C, A35A

Figure 3-16 on page 3-20 shows the bolts used to mount the traditional flange to the transmitter. The  $\frac{3}{4}$ -inch bolts supplied with the standard Anderson, Greenwood & Co. manifold (Rosemount Part No. 1151-0150-0001 or 1151-0150-0002) will fit the traditional flange and manifold. Bolts supplied with other manifolds may need a  $\frac{7}{16}$ -inch washer to accommodate the extra length. The user should make sure the mounting bolt in the upper corner of the traditional flange does not push against the module. A clearance of at least  $\frac{1}{16}$ -in. (4,2 mm) should be allowed. Install the manifold bolts as in Section 3: Installation.

### Optional Flange and Adapter Bolts (L4, L5, and L6)

Option Codes L4, L5, and L6 replace the standard carbon steel flange and adapter bolts with alternative materials as described:

- L4:** Austenitic 316SST bolts
- L5:** ASTM-A-193-B7M bolts
- L6:** Monel bolts

## Transient Protection Terminal Block (T1)

The transient protection terminal block option increases the Model 3051 Pressure Transmitter's ability to withstand electrical transients induced by lightning, welding, heavy electrical equipment, or switch gears. Model 3051 Pressure Transmitters, with integral transient protection installed, meet the standard performance specifications as outlined in this product manual. In addition, the transient protection circuitry meets IEEE Standard 587, Category B and IEEE Standard 472, Surge Withstand Capability.

Transient protection terminal blocks can be ordered as an option (Option Code T1), or as a spare part to retrofit existing Model 3051 transmitters in the field. The spare part number for the transient protection terminal block assembly is 03031-0332-0002.

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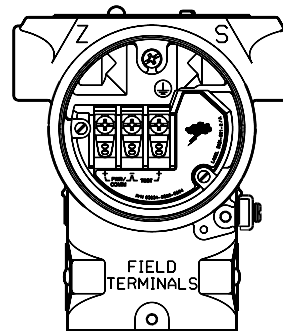
### NOTE

Installation of the transient protection terminal block does not provide transient protection unless the Model 3051 transmitter case is properly grounded. See page 3-22 for grounding information.

---

The transient protection terminal block option is not offered with Option Code I1 (BASEEFA/CENELEC Intrinsic Safety Certification).

FIGURE 6-5. Transient Protection Terminal Block (Option Code T1).



3051-F02A

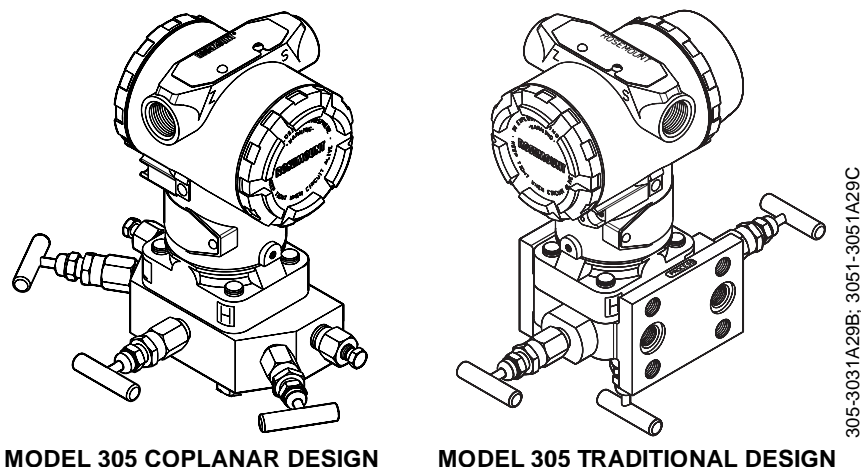
## Installation Procedure

Option Code T1 is shipped installed when ordered at the same time as the Model 3051. To install the transient protection terminal block on an existing transmitter, refer to "Remove the Terminal Block" on page 4-3 to remove the existing terminal block, and refer to "Install the Terminal Block" on page 4-8 to install the transient protection terminal block.

## MODEL 305 AND 305 INTEGRAL MANIFOLDS

The Model 305 is available in two designs: the traditional and the Coplanar. The traditional Model 305 Integral Manifold can be mounted to the Rosemount Model 1195 Integral Orifice or to most primary elements with mounting adapters in the market today. The Model 306 Integral Manifold is used with a Model 3051T transmitter to provide block and bleed valve capabilities of up to 10,000 psi (690 bar).

FIGURE 6-6. Model 305 Integral Manifold.



### Model 305 Integral Manifold Installation Procedure

To install a Model 305 Integral Manifold to a Model 3051 transmitter:



1. Inspect the Teflon sensor module O-rings. If the O-rings are undamaged, reusing them is recommended. If the O-rings are damaged (if they have nicks or cuts, for example), replace them with new O-rings.

#### IMPORTANT

If replacing the O-rings, take care not to scratch or deface the O-ring grooves or the surface of the isolating diaphragm while you remove the damaged O-rings.

2. Install the Integral Manifold on the sensor module. Use the four 2.25-in. manifold bolts for alignment. Finger tighten the bolts, then tighten the bolts incrementally in a cross pattern to final torque value. See “Bolt Installation” on page 3-18 for complete bolt installation information and torque values. When fully tightened, the bolts should extend through the top of the module housing.



See “Safety Messages” on page 6-1 for complete warning information.

3. If the Teflon sensor module O-rings have been replaced, the flange bolts should be re-tightened after installation to compensate for cold flow of the O-rings.

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**NOTE**

Always perform a zero trim on the transmitter/manifold assembly after installation to eliminate any mounting effects.

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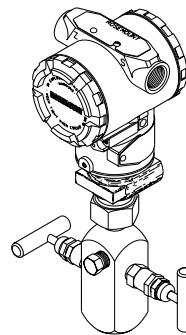
4. Install drain/vent valves:
  - a. Starting at the base of the valve with the threaded end pointing toward the installer, apply two clockwise turns of the sealing tape. Tighten the seat into the Integral Manifold to 250 in-lb (28,3 N-m).
  - b. Orient the opening on the valve so that the process fluid will drain toward the ground and away from personnel when the valve is opened. Tighten the drain/vent valve stem into the seat to  $70 \pm 10$  in-lb (7,9 N-m).

**Model 306 Integral Manifold Installation Procedure**

The Model 306 Manifold is for use only with a Model 3051T transmitter.

 Assemble the Model 306 Manifold to the Model 3051T with a thread sealant.

FIGURE 6-7. Model 306 Integral Manifold.



3051-3051A01A



HARDWARE SELECTABLE INFORMATION	
Alarm Option: <input type="checkbox"/> High★ <input type="checkbox"/> Low Transmitter Security: <input type="checkbox"/> Off★ <input type="checkbox"/> On	<b>NOTE:</b> Specify C4 Option in model structure when ordering NAMUR-compliant alarm and saturation limits. <sup>(1)</sup>
SIGNAL SELECTION: (Software Selectable)	
<input type="checkbox"/> 4–20 mA with simultaneous digital signal based on HART protocol★ <input type="checkbox"/> Burst mode of HART digital process variable <sup>(2)</sup> Burst mode output options: <input type="checkbox"/> Primary variable in engineering units <input type="checkbox"/> Primary variable in percent of range <input type="checkbox"/> All dynamic variables in engineering units <input type="checkbox"/> All dynamic variables in engineering units and the primary variable mA value <input type="checkbox"/> Multidrop Communication <sup>(2)(3)</sup> Choose transmitter address (1-15) <sup>(4)</sup> : _____	

(1) Not available with low power output.  
 (2) C1 Option required for configuration of this parameter  
 (3) This option fixes the transmitter analog output at 4mA.  
 (4) Default address is 1 if multidrop communication is selected.

Model 3051C Differential/Gage Pressure Transmitter Range Limits												
Units	Range 0 Span		Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span	
	min	max	min	max	min	max	min	max	min	max	min	max
inH <sub>2</sub> O	-3.0	3.0	0.5	25	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	-0.22027	0.22027	0.03678	1.8389	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH <sub>2</sub> O	-0.25	0.25	0.04167	2.08333	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH <sub>2</sub> O	-76.19996	76.19996	12.7	635.5	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	-5.59492	5.59492	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	-0.10819	1.10819	0.01806	0.903	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	-0.00746	0.00746	0.00125	0.06227	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	-7.45927	7.45927	1.2454	62.2723	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm <sup>2</sup>	-7.60634	7.60634	1.26775	63.3875	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm <sup>2</sup>	-0.00761	0.00761	0.00127	0.0635	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	-745.92724	745.92724	124.545	6227.23	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	-0.74593	0.74593	0.12545	6.2272	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	-5.59491	5.59491	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	-0.00736	0.00736	0.00123	0.06146	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

**NOTE**  
 When used with the HART Communicator Model 275 or the Rosemount Model 268 Communicator, ±5% adjustment ability is allowed on the sensor limit to allow for unit conversions.

Model 3051P Differential/Gage Pressure Transmitter Range Limits								
Units	Range 2 Span		Range 3 Span		Range 4 Span <sup>(1)</sup>		Range 5 Span <sup>(1)</sup>	
	min	max	min	max	min	max	min	max
inH <sub>2</sub> O	25	250	100	1000	830.40	8304	5536.0	55360
inHg	1.8389	18.389	7.3559	73.559	61.081	610.81	407.20	4072.04
ftH <sub>2</sub> O	2.08333	20.8333	8.3333	83.3333	69.200	691.997	461.3	4613.31
mmH <sub>2</sub> O	635.5	6355	2542	25421	21109.5	211095	140730	1407301
mmHg	46.7082	467.082	186.833	1868.33	1551.45	15514.5	10343	103430
psi	0.903	9.03183	3.6127	36.127	30	300	200	2000
bar	0.06227	0.62272	0.2491	2.491	2.0684	20.6843	13.7895	137.895
mbar	62.2723	622.723	249.089	2490.89	2068.43	20684.3	13789.5	137895
g/cm <sup>2</sup>	63.3875	633.875	253.55	2535.45	2105.47	21054.7	14061.4	140614
kg/cm <sup>2</sup>	0.0635	0.635	0.254	2.54	2.1092	21.0921	14.0614	140.614
Pa	6216.06	62160.6	24908.9	249089	206843	2068430	1378950	13789500
kPa	6.2272	62.2723	24.9089	249.089	206.843	2068.43	1378.95	13789.5
torr	46.7082	467.082	186.833	1868.33	1551.45	15514.5	10343	103430
atm	0.06146	0.61460	0.2458	2.458	2.0414	20.4138	13.6092	136.092

**NOTE**  
When used with the HART Communicator Model 275 or the Rosemount Model 268 Communicator, ±5% adjustment ability is allowed on the sensor limit to allow for unit conversions.

(1) Range 4 and 5 spans are only available with gage pressure transmitters.

Model 3051L/3051H Pressure Transmitter Range Limits								
Units	Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span (3051H Only)	
	min	max	min	max	min	max	min	max
inH <sub>2</sub> O	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH <sub>2</sub> O	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH <sub>2</sub> O	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm <sup>2</sup>	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm <sup>2</sup>	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

**NOTE**  
When used with the HART Communicator Model 275 or the Rosemount Model 268 Communicator, ±5% adjustment ability is allowed on the sensor limit to allow for unit conversions.



## Rosemount Model 3051 Smart Pressure Transmitters

Model 3051T Gage and Absolute Pressure Transmitter Range Limits										
Units	Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span		Range 5 Span	
	min	max	min	max	min	max	min	max	min	max
inH <sub>2</sub> O	8.30397	831.889	41.5198	4159.45	221.439	22143.9	1107.2	110720	55360	276799
inHg	0.61081	61.0807	3.05403	305.403	16.2882	1628.82	81.441	8144.098	4072.04	20360.2
ftH <sub>2</sub> O	0.69199	69.3241	3.45998	345.998	18.4533	1845.33	92.2663	9226.63	4613.31	23066.6
mmH <sub>2</sub> O	211.10	21130	1054.60	105460.3	5634.66	563466	28146.1	2814613	1407301	7036507
mmHg	15.5145	1551.45	77.5723	7757.23	413.72	41372	2068.6	206860.0	103430	517151
psi	0.3	30	1.5	150	8	800	40	4000	2000	10000
bar	0.02068	3.06843	0.10342	10.3421	0.55158	55.1581	2.75791	275.7905	137.895	689.476
mbar	20.6843	2068.43	103.421	10342.11	551.581	55158.1	2757.91	275790.5	137895	689476
g/cm <sup>2</sup>	21.0921	2109.21	105.461	10546.1	561.459	56145.9	2807.31	280730.6	140614	703067
kg/cm <sup>2</sup>	0.02109	2.10921	0.10546	10.5461	0.56246	56.2456	2.81228	281.228	140.614	701.82
Pa	2068.43	206843	10342.1	1034212	55158.1	5515811	275791	27579054	13789500	68947600
kPa	2.06843	206.843	10.3421	1034.21	55.1581	5515.81	275.791	27579.05	13789.5	68947.6
torr	15.5145	1551.45	77.5726	7757.26	413.721	413721	2068.6	206859.7	103430	517151
atm	0.02041	2.04138	0.10207	10.2069	0.54437	54.4368	2.72184	272.1841	136.092	680.46

**NOTE**  
When used with the HART Communicator Model 275 or the Rosemount Model 268 Communicator, ±5% adjustment ability is allowed on the sensor limit to allow for unit conversions.

Model 3051C Absolute Pressure Transmitter Range Limits										
Units	Range 0 Span		Range 1 Span		Range 2 Span		Range 3 Span		Range 4 Span	
	min	max	min	max	min	max	min	max	min	max
inH <sub>2</sub> O	4.62254	138.399	8.30397	831.889	41.5198	4151.98	221.439	22143.9	1107.2	110720
inHg	0.34002	10.1801	0.61081	61.0807	3.05403	305.403	16.2882	1628.82	81.441	8144.098
ftH <sub>2</sub> O	0.38521	11.5333	0.69199	69.3241	3.45998	345.998	18.4533	1845.33	92.2663	9226.63
mmH <sub>2</sub> O	117.510	3518.2	211.10	21130	6.35308	635.308	5634.66	563466	28146.1	2814613
mmHg	8.63642	258.575	15.5145	1551.45	1055.47	105547	413.72	41372	2068.6	206860.0
psi	0.16667	5	0.3	30	1.5	150	8	800	40	4000
bar	0.01151	0.34474	0.02068	2.06843	0.10342	10.342	0.55158	55.1581	2.75791	275.7905
mbar	11.5142	344.738	20.6843	2068.43	103.421	10342.1	551.581	55158.1	2757.91	275790.5
g/cm <sup>2</sup>	11.74	350.91	21.0921	2109.21	105.27	105.27	561.459	56145.9	2807.31	280730.6
kg/cm <sup>2</sup>	0.01174	0.35154	0.02109	2.10921	0.10546	10.546	0.56246	56.2456	2.81228	281.228
Pa	1151.42	34473.8	2068.43	206843	10342.1	1034210	55158.1	5515811	275791	27579054
kPa	1.15142	34.4738	2.06843	206.843	10.3421	1034.21	55.1581	5515.81	275.791	27579.05
torr	8.63642	258.575	15.5145	1551.45	77.5726	7757.26	413.721	413721	2068.6	206859.7
atm	0.01136	0.34023	0.02041	2.04138	0.10207	10.207	0.54437	54.4368	2.72184	272.1841

**NOTE**  
When used with the HART Communicator Model 275 or the Rosemount Model 268 Communicator, ±5% adjustment ability is allowed on the sensor limit to allow for unit conversions.

# HART Communicator

## INTRODUCTION

This appendix provides basic communicator information on the Model 275 HART Communicator when used with a Model 3051 Smart Pressure Transmitter.

This brief appendix will familiarize you with the HART Communicator but is not meant to replace the HART Communicator product manual. For complete information on the HART Communicator, refer to the HART Communicator Product Manual, publication number 00809-0100-4275.

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### NOTE

You must upgrade the software in your HART Communicator in order to take advantage of the additional features of the improved Model 3051. If you initiate communication with an improved Model 3051 using a Communicator that has a previous version of the transmitter Device Descriptors (DDs), the communicator will display the following message:


NOTICE: Upgrade 275 software to access XMTR function.  
Continue with old description?

If you select **YES**, the communicator will communicate properly with the transmitter using the existing Model 3051 DDs. However, software features added since the revision of the DDs in the communicator will not be accessible. If you select **NO**, the communicator will default to a generic transmitter functionality

Contact your nearest Rosemount Service Center or Sales Representative to upgrade your communicator.

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## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (). Refer to the following safety messages before performing an operation preceded by this symbol.

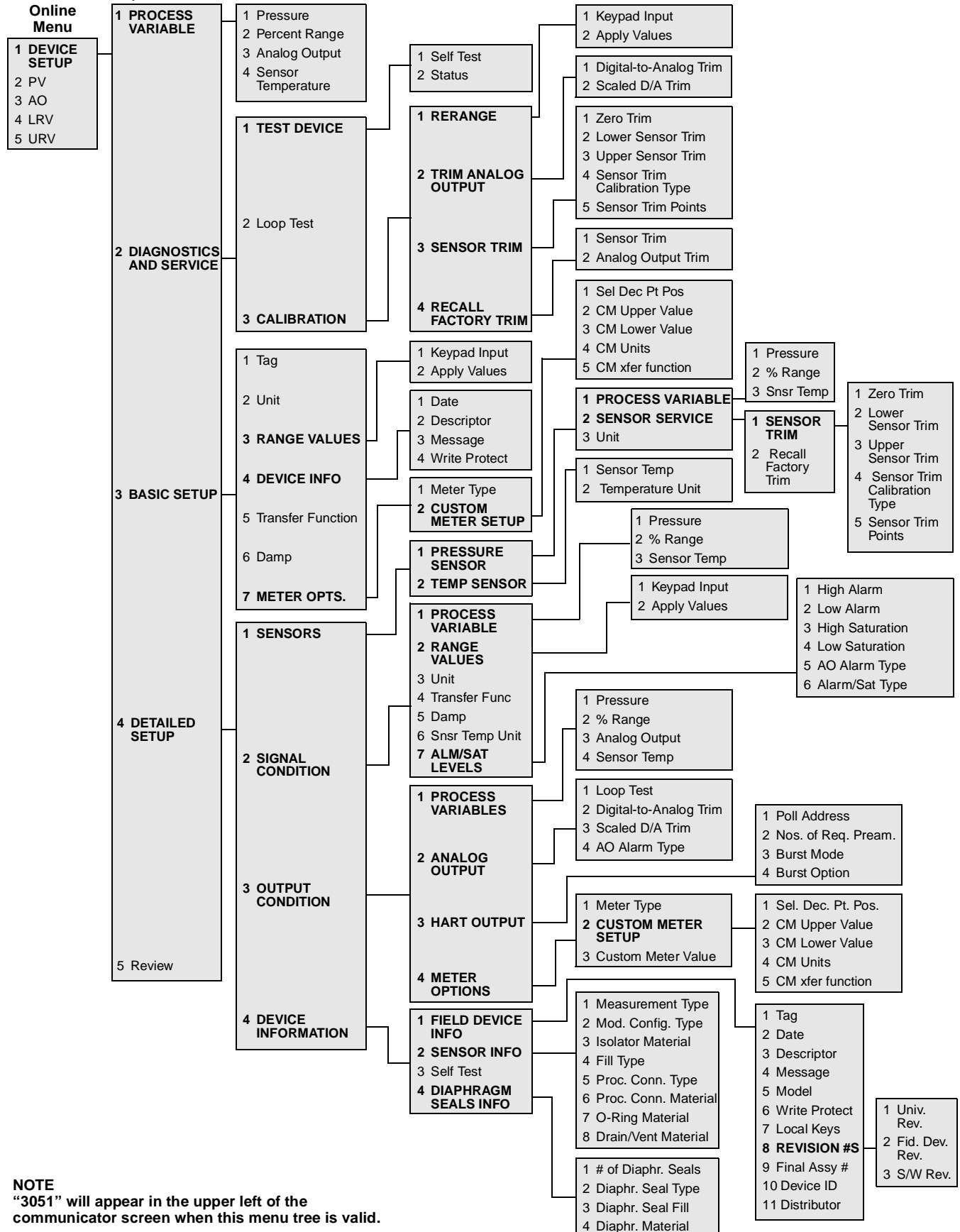
### Warnings ()

#### **WARNING**

**Explosions can result in death or serious injury.**

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed according to intrinsically safe or nonincendive field wiring practices.

FIGURE A-1. HART Communicator Menu Tree for Improved Model 3051.

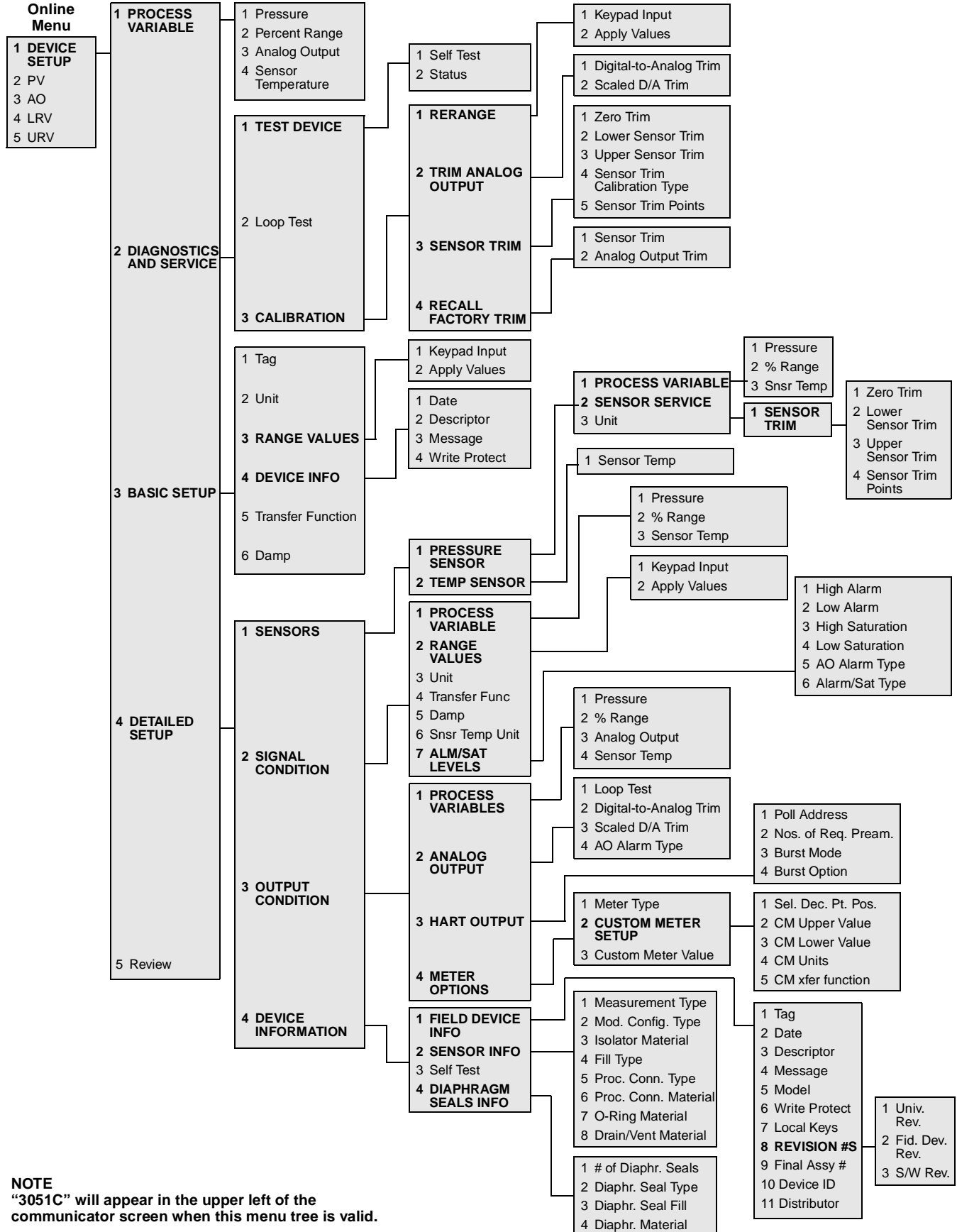


**NOTE**  
 "3051" will appear in the upper left of the communicator screen when this menu tree is valid.

TABLE A-1. HART Fast Key Sequences for the *Improved* Model 3051.

Function	HART Fast Key Sequence
Alarm and Saturation Levels	1, 4, 2, 7
Analog Output Alarm Type	1, 4, 3, 2, 4
Burst Mode Control	1, 4, 3, 3, 3
Burst Operation	1, 4, 3, 3, 3
Clone Data	See page 2-29
Custom Meter Configuration	1, 3, 7, 2
Custom Meter Value	1, 4, 3, 4, 3
✓ Damping	1, 3, 6
Date	1, 3, 4, 1
Descriptor	1, 3, 4, 2
Digital To Analog Trim (4–20 mA Output)	1, 2, 3, 2, 1
Disable Local Span/Zero Adjustment	1, 4, 4, 1, 7
Field Device Info	1, 4, 4, 1
Full Trim	1, 2, 3, 3
Keypad Input – Rerange	1, 2, 3, 1, 1
Local Zero and Span Control	1, 4, 4, 1, 7
Loop Test	1, 2, 2
Lower Sensor Trim	1, 2, 3, 3, 2
Message	1, 3, 4, 3
Meter Options	1, 4, 3, 4
Number Of Requested Preambles	1, 4, 3, 3, 2
Poll Address	1, 4, 3, 3, 1
Poll a Multidropped Transmitter	Left Arrow, 4, 1, 1
✓ Range Values	1, 3, 3
Rerange	1, 2, 3, 1
Scaled D/A Trim (4–20 mA Output)	1, 2, 3, 2, 2
Self Test (Transmitter)	1, 2, 1, 1
Sensor Info	1, 4, 4, 2
Sensor Temperature	1, 1, 4
Sensor Trim Points	1, 2, 3, 3, 5
Status	1, 2, 1, 2
✓ Tag	1, 3, 1
✓ Transfer Function (Setting Output Type)	1, 3, 5
Transmitter Security (Write Protect)	1, 3, 4, 4
Trim Analog Output	1, 2, 3, 2
✓ Units (Process Variable)	1, 3, 2
Upper Sensor Trim	1, 2, 3, 3, 3
Zero Trim	1, 2, 3, 3, 1
NOTE: A check (✓) indicates the basic configuration parameters. At minimum, these parameters should be verified as part of the configuration and startup procedure.	

FIGURE A-2. HART Communicator Menu Tree for Previous Model 3051.




**NOTE**  
 "3051C" will appear in the upper left of the communicator screen when this menu tree is valid.

TABLE A-2. HART Fast Key Sequences for the *Previous* Model 3051.

Function	HART Fast Key Sequence
Analog Output Alarm	1, 4, 3, 3
Burst Mode Control	1, 4, 3, 4, 3
Burst Operation	1, 4, 3, 4, 4
Clone Data	See page 2-29
✓ Damping	1, 3, 6
Date	1, 3, 4, 1
Descriptor	1, 3, 4, 2
Digital To Analog Trim (4–20 mA Output)	1, 2, 3, 2, 1
Disable Local Span/Zero Adjustment	1, 4, 4, 1, 7
Field Device Info	1, 4, 4, 1
Full Trim	1, 2, 3, 3
Keypad Input	1, 2, 3, 1, 1
Loop Test	1, 2, 2
Lower Sensor Trim	1, 2, 3, 3, 2
Message	1, 3, 4, 3
Meter Type	1, 4, 3, 5
Number Of Requested Preambles	1, 4, 3, 4, 2
Poll Address	Left Arrow, 5, 1
✓ Range Values	1, 3, 3
Rerange	1, 2, 3, 1
Scaled D/A Trim (4–20 mA Output)	1, 2, 3, 2, 2
Self Test (Transmitter)	1, 2, 1, 1
Sensor Info	1, 4, 4, 2
Sensor Temperature	1, 1, 4
Sensor Trim Points	1, 2, 3, 3, 4
Status	1, 2, 1, 2
✓ Tag	1, 3, 1
✓ Transfer Function (Setting Output Type)	1, 3, 5
Transmitter Security (Write Protect)	1, 3, 4, 4
Trim Analog Output	1, 2, 3, 2
✓ Units (Process Variable)	1, 3, 2
Upper Sensor Trim	1, 2, 3, 3, 3
Zero Trim	1, 2, 3, 3, 1
Analog Output Alarm	1, 4, 3, 3
Burst Mode Control	1, 4, 3, 4, 3
Burst Operation	1, 4, 3, 4, 4
Clone Data	See page 2-29.
✓ Damping	1, 3, 6
NOTE: A check (✓) indicates the basic configuration parameters. At minimum, these parameters should be verified as part of the configuration and startup procedure.	

## CONNECTIONS AND HARDWARE

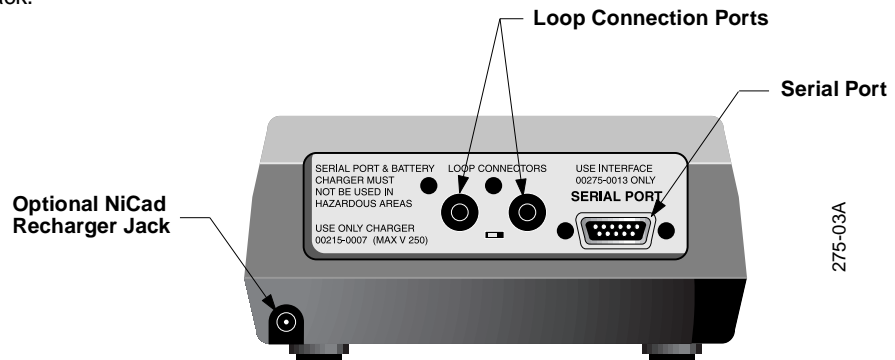
 The HART Communicator Model 275 can interface with a transmitter from the control room, the instrument site, or any wiring termination point in the loop through the rear connection panel as shown in Figure A-3. Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere. To communicate, connect the HART Communicator in parallel with the instrument or load resistor. The connections are non-polarized. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

### NOTE

The HART Communicator needs a minimum of 250 ohms resistance in the loop to function properly.

The HART Communicator is not a measurement device and does not need to be calibrated; it is a communications device through which you can read and adjust the transmitter configuration information. All variable outputs displayed by the communicator are functions of the transmitter.

FIGURE A-3. Rear Connection Panel with Optional NiCad Recharger Pack.



 See "Safety Messages" on page A-1 for complete warning information.

FIGURE A-4. Bench Hook-up  
(4–20 mA Transmitters).

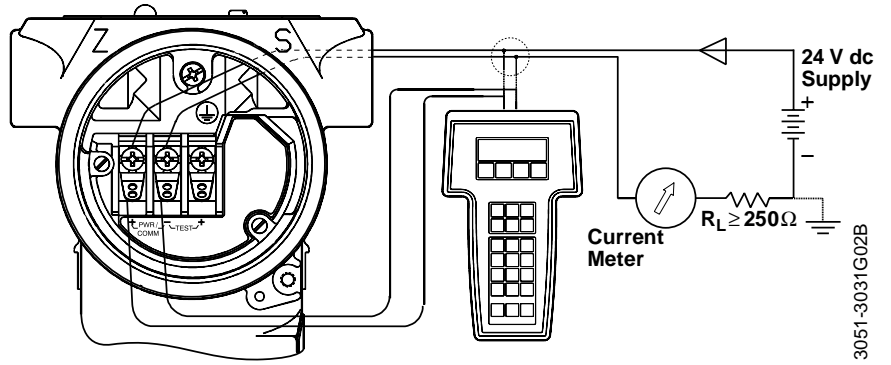


FIGURE A-5. Bench Hook-up  
(Low Power Transmitters).

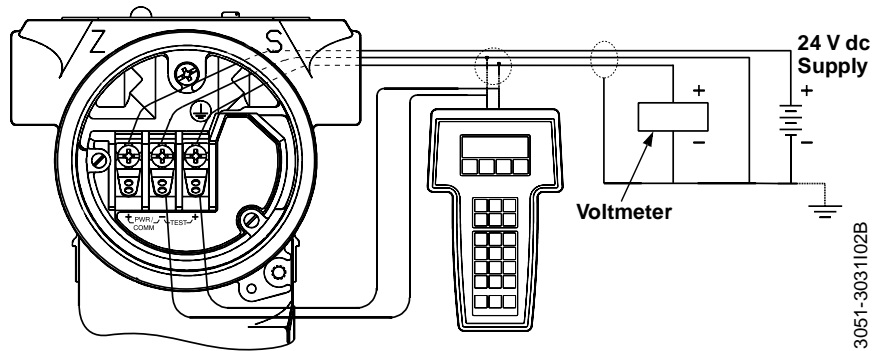


FIGURE A-6. Field Hook-up  
(4–20 mA Transmitters).

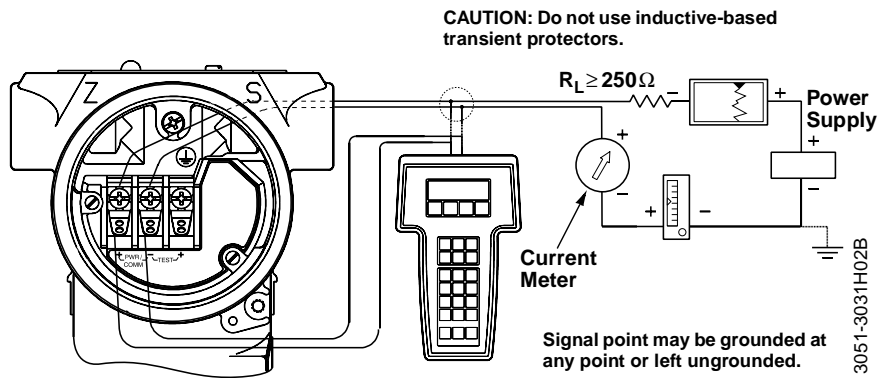
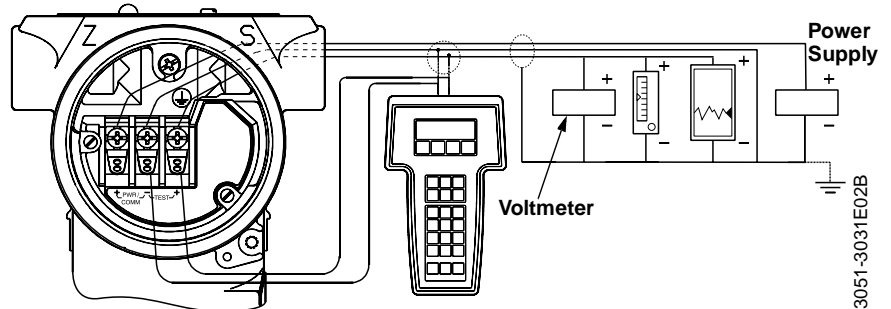


FIGURE A-7. Field Hook-up  
(Low Power Transmitters).

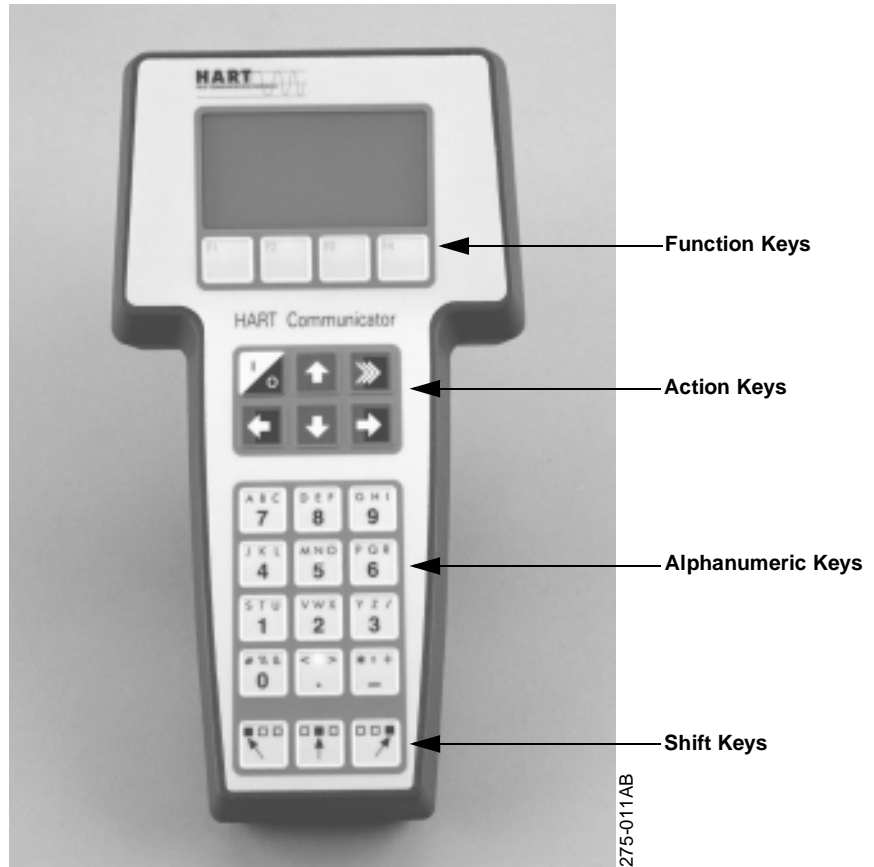




## COMMUNICATOR KEYS

The keys of the HART Communicator include action, function, alphanumeric, and shift keys.

FIGURE A-8. Model 275 HART Communicator.



### Action Keys

As shown in Figure A-8, the action keys are the six blue, white, and black keys located above the alphanumeric keys. The function of each key is described as follows:

#### ON/OFF Key

Use this key to power the HART Communicator. When the communicator is turned on, it searches for a transmitter on the 4–20 mA loop. If a device is not found, the communicator displays the message “No Device Found. Press OK.”

If a HART-compatible device is found, the communicator displays the **ONLINE MENU** with device ID and tag.

#### Directional Keys

Use these keys to move the cursor up, down, left, or right. The **RIGHT ARROW** key also selects menu options, and the **LEFT ARROW** key returns to the previous menu.

**Hot Key** 

Use this key to quickly access important, user-selectable options when connected to a HART-compatible device. Pressing the **HOT KEY** turns the HART Communicator on and displays the Hot Key Menu. See “Customizing the Hot Key Menu” in the HART Communicator manual for more information.

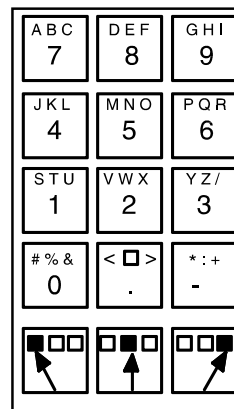
**Function Keys**



Use the four software-defined function keys, located below the LCD, to perform software functions. On any given menu, the label appearing above a function key indicates the function of that key for the current menu. As you move among menus, different function key labels appear over the four keys. For example, in menus providing access to on-line help, the **HELP** label may appear above the **F1** key. In menus providing access to the **ONLINE MENU**, the **HOME** label may appear above the **F3** key. Simply press the key to activate the function. See your HART Communicator manual for details on specific function key definitions.

**Alphanumeric and Shift Keys**

FIGURE A-9. HART Communicator Alphanumeric and Shift Keys.



275-0383A

**Data Entry**

Some menus require data entry. Use the alphanumeric and shift keys to enter all alphanumeric information into the HART Communicator. If you press an alphanumeric key alone from within an edit menu, the bold character in the center of the key appears. These large characters include the numbers zero through nine, the decimal point (.), and the dash symbol (-).

To enter an alphabetic character, first press the shift key that corresponds to the position of the letter you want on the alphanumeric key. Then press the alphanumeric key. For example, to enter the letter “R”, first press the right shift key, then the “6” key (see Figure A-10). Do not press these keys simultaneously, but one after the other.

FIGURE A-10. Data Entry Key Sequence.



275-0632A,  
0343A

## Fast Key Sequences

HART fast key sequences provide quick on-line access to transmitter variables and functions. Instead of stepping your way through the menu structure using the action keys, you can press a HART fast key sequence to move from the **ONLINE MENU** to the desired variable or function. On-screen instructions guide you through the rest of the screens.

### Fast Key Sequence Conventions

The fast key sequences for the Model 275 use the following conventions for their identification:

**1 through 9**—Refer to the keys located directly below the dedicated keypad.

**Left Arrow**—Refers to the **LEFT ARROW** directional key.

### Fast Key Sequence Example

HART fast key sequences are made up of the series of numbers corresponding to the individual options in each step of the menu structure. For example, from the **ONLINE MENU** you can change the date. Following the menu structure, press 1 to reach *Device Setup*, press 3 for *Basic Setup*, press 4 for *Device Info*, press 1 for *Date*. The corresponding HART fast key sequence is 1, 3, 4, 1.

HART fast keys are operational only from the **ONLINE MENU**. If you use them consistently, you will need to return to the **ONLINE MENU** by pressing **HOME (F3)** when it is available. If you do not start at the **ONLINE MENU**, the HART fast key sequences will not function properly.

Use Table A-1, an alphabetical listing of every on-line function, to find the corresponding HART fast key sequences. These codes are applicable only to Model 3051 transmitters and the HART Communicator.

## MENUS AND FUNCTIONS

The HART Communicator is a menu driven system. Each screen provides a menu of options that can be selected as outlined above, or provides direction for input of data, warnings, messages, or other instructions.

### Main Menu

When the HART Communicator is turned on, one of two menus will appear. If the HART Communicator is connected to an operating loop, the communicator will find the device and display the **ONLINE MENU** (see below). If it is not connected to a loop, the communicator will indicate that no device was found. When you press **OK (F4)**, it will display the **MAIN** menu.

The **MAIN** menu provides the following options:

- *Offline*—The Offline option provides access to offline configuration data and simulation functions.
- *Online*—The Online option checks for a device and if it finds one, brings up the **ONLINE MENU**.
- *Transfer*—The Transfer option provides access to options for transferring data either from the HART Communicator (memory) to the transmitter (device) or vice versa. Transfer is used to move off-line data from the HART Communicator to the transmitter, or to retrieve data from a transmitter for off-line revision.

**NOTE**

Online communication with the transmitter automatically loads the current transmitter data to the HART Communicator. Changes in on-line data are made active by pressing **SEND (F2)**. The transfer function is used only for off-line data retrieval and sending.

- *Frequency Device*—The Frequency Device option displays the frequency output and corresponding pressure output of current-to-pressure transmitters.
- *Utility*—The Utility option provides access to the contrast control for the HART Communicator LCD screen and to the autopoll setting used in multidrop applications.

Once selecting a **MAIN** menu option, the HART Communicator provides the information you need to complete the operation. If further details are required, consult the HART Communicator manual.

**Online Menu**

The **ONLINE MENU** can be selected from the **MAIN** menu as outlined above, or it may appear automatically if the HART Communicator is connected to an active loop and can detect an operating transmitter.

**NOTE**

The **MAIN** menu can be accessed from the **ONLINE MENU**. Press the left arrow action key to deactivate the on-line communication with the transmitter and to activate the **MAIN** menu options.

When configuration variables are reset in the on-line mode, the new settings are not activated until the data is sent to the transmitter. Press **SEND (F2)** when it is activated to update the process variables of the transmitter.

On-line mode is used for direct evaluation of a particular meter, re-configuration, changing parameters, maintenance, and other functions.

**Diagnostic Messages**

The following pages contain a list of messages used by the HART Communicator (HC) and their corresponding descriptions.

Variable parameters within the text of a message are indicated with *<variable parameter>*.

Reference to the name of another message is identified by *[another message]*.

Message	Description
1k snsr EEPROM error-factory ON	Replace the sensor module
1k snsr EEPROM error-user-no out ON	Use the HART communicator to reset the following parameters: remote seal isolator, remote seal fill fluid, flange material, o-ring material, transmitter type, remote seal type, flange type, meter type, number of remote seals.
1k snsr EEPROM error-user ON	Perform a full trim to recalibrate the transmitter.
4k micro EEPROM error-factory ON	Replace the electronics board.
4k micro EEPROM error-user-no out ON	Use the hart communicator to reset the message field.

Message	Description
<b>4k micro EEPROM error-user ON</b>	Use the HART communicator to reset the following parameters: units, range values, damping, analog output, transfer function, tag, scaled meter values. Perform a d/a trim to ensure that the error is corrected.
<b>4k snsr EEPROM error-factory ON</b>	Replace the sensor module.
<b>4k snsr EEPROM error-user ON</b>	Use the HART communicator to reset the temperature units and the calibration type.
<b>Add item for ALL device types or only for this ONE device type.</b>	Asks the user whether the hot key item being added should be added for all device types or only for the type of device that is connected.
<b>Command Not Implemented</b>	The connected device does not support this function.
<b>Communication Error</b>	The communicator and the device are not communicating correctly. Check all connections between the communicator and the device and resend the information.
<b>Configuration memory not compatible with connected device</b>	The configuration stored in memory is incompatible with the device to which a transfer has been requested.
<b>CPU board not initialized ON</b>	The electronics board is not initialized. Replace the electronics board.
<b>CPU EEPROM write failure ON</b>	Message sent to electronics board from HART signal failed. Replace the electronics board.
<b>Device Busy</b>	The connected device is busy performing another task.
<b>Device Disconnected</b>	The device failed to respond to a command. Check all connections between the communicator and the device and resend the command.
<b>Device write protected</b>	Device is in write-protect mode. Data can not be written.
<b>Device write protected. Do you still want to shut off?</b>	Device is in write-protect mode. Press YES to turn the HART communicator off and lose the unsent data.
<b>Display value of variable on hotkey menu?</b>	Asks whether the value of the variable should be displayed adjacent to its label on the hotkey menu if the item being added to the hotkey menu is a variable.
<b>Download data from configuration memory to device</b>	Press the SEND softkey to transfer information from the communicator memory to the device.
<b>Exceed field width</b>	Indicates that the field width for the current arithmetic variable exceeds the device-specified description edit format.
<b>Exceed precision</b>	Indicates that the precision for the current arithmetic variable exceeds the device-specified description edit format.
<b>Ignore next 50 occurrences of status?</b>	Select YES to ignore the next 50 occurrences of device status, or select no to display every occurrence.
<b>Illegal character</b>	An invalid character for the variable type was entered.
<b>Illegal date</b>	The day portion of the date is invalid.

Message	Description
<b>Illegal month</b>	The month portion of the date is invalid.
<b>Illegal year</b>	The year portion of the date is invalid.
<b>Incompatible CPU board and module ON</b>	Upgrade the electronics board or the sensor module to the current revision.
<b>Incomplete exponent</b>	The exponent of a scientific notation floating point variable is incomplete.
<b>Incomplete field</b>	The value entered is not complete for the variable type.
<b>Looking for a device</b>	Polling for multidropped devices at addresses 1–15.
<b>Local buttons operator error ON</b>	Illegal pressure applied during zero or span operation. Repeat the process after verifying the correct pressures.
<b>Mark as read only variable on hotkey menu?</b>	Asks whether the user should be allowed to edit the variable from the hotkey menu if the item being added to the hotkey menu is a variable.
<b>Module EEPROM write failure ON</b>	Message sent to the module from the HART signal failed. Replace the sensor module.
<b>No device configuration in configuration memory</b>	There is no configuration saved in memory available to re-configure off-line or transfer to a device.
<b>No Device Found</b>	Poll of address zero fails to find a device, or poll of all addresses fails to find a device if auto-poll is enabled.
<b>No hotkey menu available for this device.</b>	There is no menu named “hotkey” defined in the device description for this device.
<b>No pressure updates ON</b>	No pressure updates being received from the sensor module. Verify that the sensor module ribbon cable is attached correctly. Or replace the sensor module.
<b>No offline devices available.</b>	There are no device descriptions available to be used to configure a device offline.
<b>No simulation devices available.</b>	There are no device descriptions available to simulate a device.
<b>No temperature updates ON</b>	No temperature updates being received from the sensor module. Verify that the sensor module ribbon cable is attached correctly. Or replace the sensor module.
<b>No UPLOAD_VARIABLES in ddl for this device</b>	There is no menu named “upload_variables” defined in the device description for this device. This menu is required for offline configuration.
<b>No Valid Items</b>	The selected menu or edit display contains no valid items.
<b>OFF KEY DISABLED</b>	Appears when the user attempts to turn the HC off before sending modified data or before completing a method.
<b>Online device disconnected with unsent data. RETRY or OK to lose data.</b>	There is unsent data for a previously connected device. Press RETRY to send data, or press OK to disconnect and lose unsent data.

Message	Description
<b>Out of memory for hotkey configuration. Delete unnecessary items.</b>	There is no more memory available to store additional hotkey items. Unnecessary items should be deleted to make space available.
<b>Overwrite existing configuration memory</b>	Requests permission to overwrite existing configuration either by a device-to-memory transfer or by an offline configuration. User answers using the softkeys.
<b>Press OK...</b>	Press the OK softkey. This message usually appears after an error message from the application or as a result of HART communications.
<b>Restore device value?</b>	The edited value that was sent to a device was not properly implemented. Restoring the device value returns the variable to its original value.
<b>ROM checksum error ON</b>	Checksum of transmitter software has detected a fault. Replace the electronics board.
<b>Save data from device to configuration memory</b>	Prompts user to press SAVE softkey to initiate a device-to-memory transfer.
<b>Saving data to configuration memory.</b>	Data is being transferred from a device to configuration memory.
<b>Sending data to device.</b>	Data is being transferred from configuration memory to a device.
<b>Sensor board not initialized ON</b>	The sensor module electronics board is not initialized. Replace the sensor module.
<b>There are write only variables which have not been edited. Please edit them.</b>	There are write-only variables which have not been set by the user. These variables should be set or invalid values may be sent to the device.
<b>There is unsent data. Send it before shutting off?</b>	Press YES to send unsent data and turn the HC off. Press NO to turn the HC off and lose the unsent data.
<b>Too few data bytes received</b>	Command returns fewer data bytes than expected as determined by the device description.
<b>Transmitter Fault</b>	Device returns a command response indicating a fault with the connected device.
<b>Units for &lt;variable label&gt; has changed. Unit must be sent before editing, or invalid data will be sent.</b>	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
<b>Unsent data to online device. SEND or LOSE data</b>	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.

Message	Description
<b>Upgrade 275 software to access XMTR function. Continue with old description?</b>	The communicator does not contain the most recent Model 3051 Device Descriptors (DDs). Select YES to communicate using the existing DDs. Select NO to abort communication.
<b>Use up/down arrows to change contrast. Press DONE when done.</b>	Gives direction to change the contrast of the HC display.
<b>Value out of range</b>	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<b>&lt;message&gt; occurred reading/writing &lt;variable label&gt;</b>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<b>&lt;variable label&gt; has an unknown value. Unit must be sent before editing, or invalid data will be sent.</b>	A variable related to this variable has been edited. Send related variable to the device before editing this variable.





# Model 268 Communicator

## INTRODUCTION

This appendix provides basic communicator information on the Rosemount Model 268 SMART FAMILY Interface when used with a Model 3051 Smart Pressure Transmitter.

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### NOTE

All additional features of the Model 3051 are only accessible by using a HART Communicator Model 275. The Model 268 SMART FAMILY Interface will only provide features accessible with the existing Model 3051 Device Descriptors (DD) present in the Model 268. For full functionality, use a Model 275 Communicator. Contact your nearest Rosemount Service Center or Sales Representative for details.

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## SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

### Warnings (⚠)

**⚠ WARNING**

**Explosions can result in death or serious injury.**

- Do not remove the transmitter covers in explosive environments when the circuit is alive.
- Both transmitter covers must be fully engaged to meet explosionproof requirements.
- Before connecting a communicator in an explosive atmosphere, make sure the instruments in the loop are installed according to intrinsically safe or nonincendive field wiring practices.

Figure B-1. Model 268 Menu Tree.

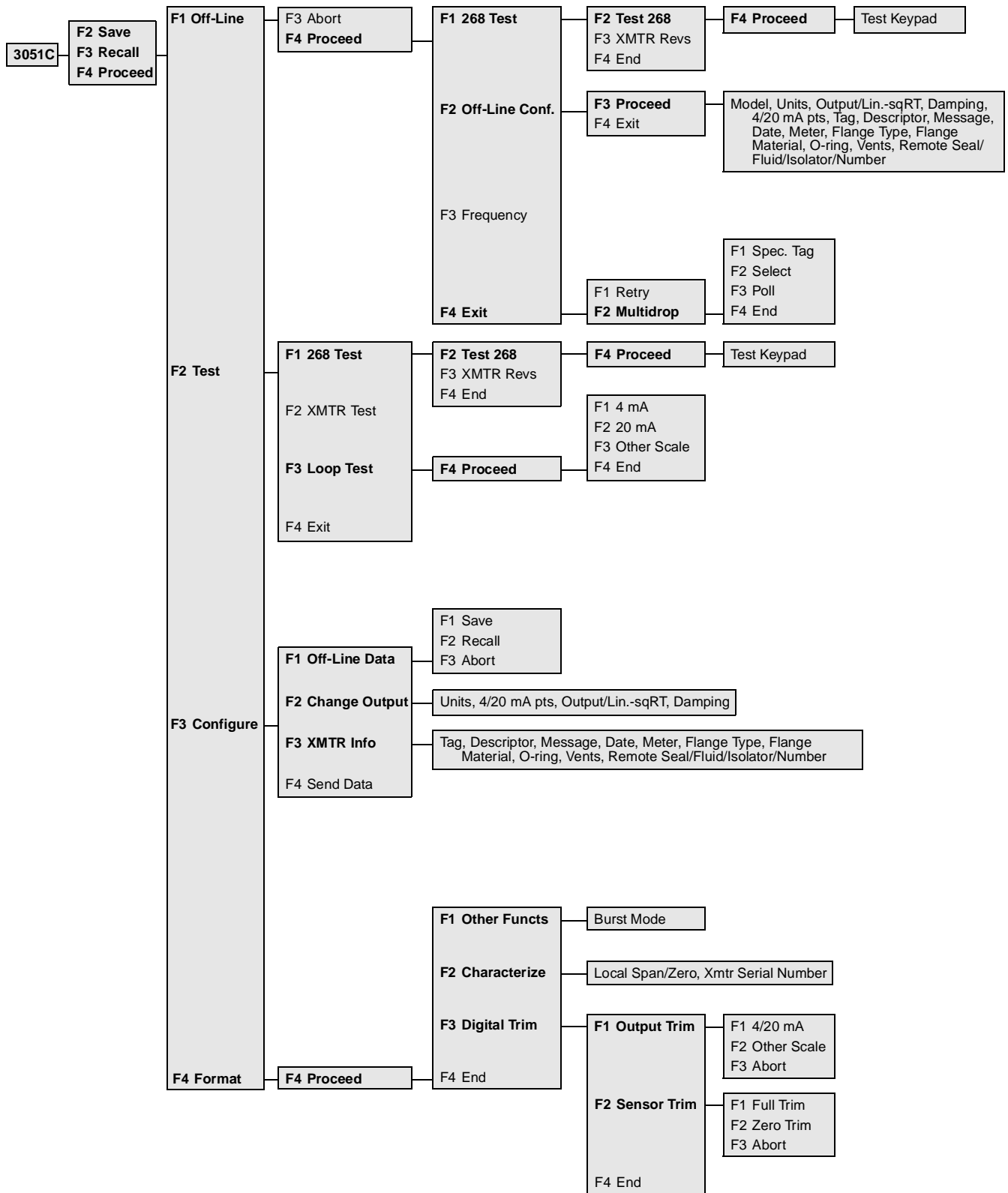


TABLE B-1. Model 268 Fast Key Equivalents.

Function	Model 268 Fast Key Sequence
Analog Output	F3, F2
Analog Output Alarm	Not Applicable
Burst Mode Control	F4, F4, F1
Burst Operation	Not Applicable
Calibration	Not Applicable
Clone Data	F4, F4, F1
Damping	F3, F2, (F1 x 3)
Date	F3, F3, (F1 x 3)
Descriptor	F3, F3, F1
Digital To Analog Trim (4–20 mA Output)	F4, F4, F3
Disable Local Span/Zero Adjustment	F4, F4, F2
Field Device Info	F3, F3
Full Trim	F4, F4, F3, F2, F1
Keypad Input (Trim Points)	F3, F2, F1
Loop Test	F2, F3
Lower Range Value	Process Variable Key, F2
Lower Sensor Trim	F4, F4, F3, F2, F1, F2
Message	F3, F3, F1, F1
Meter Type	F3, F3, (F1 x 4)
Number Of Requested Preambles	Not Applicable
Percent Range	Not Applicable
Poll Address	F1, F4, F4, F2, F3
Pressure	Process Variable Key
Range Values	F3, F2, F1
Rerange	F4, F4, F3, F1, F1
Scaled D/A Trim (4–20 mA Output)	F4, F4, F3, F1, F2
Self Test (Transmitter)	F2, F2
Sensor Info	F3, F3
Sensor Temperature	Process Variable Key, F3
Sensor Trim Points	F3, F2, F1
Status	Not Applicable
Tag	F3, F3
Transfer Function (Setting Output Type)	F3, F2, F1, F1
Transmitter Security (Write Protect)	Not Applicable
Trim Analog Output	F4, F4, F3, F1
Units (Process Variable)	F3, F2
Upper Range Value	Process Variable Key, F2
Upper Sensor Trim	F4, F4, F3, F2, F1, F3
Zero Trim	F4, F4, F3, F2, F2

## CONNECTIONS AND HARDWARE

The Model 268 can communicate with a transmitter from the control room, the transmitter site, or any other wiring termination point in the loop. To communicate, it must be connected in parallel with the transmitter; the connections are non-polarized.

Figure B-2. Bench Hook-up (4–20 mA Transmitters).

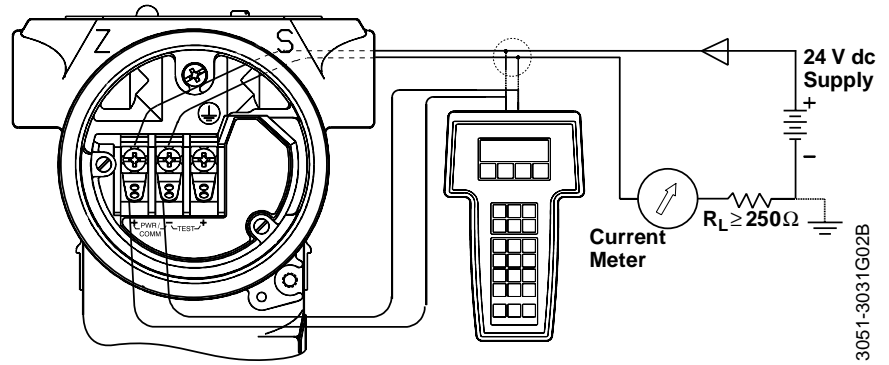


Figure B-3. Bench Hook-up (Low Power Transmitters).

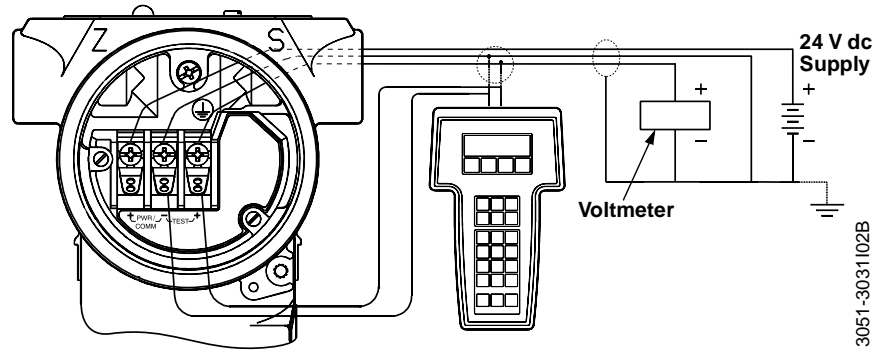


Figure B-4. Field Hook-up  
(4–20 mA Transmitters).

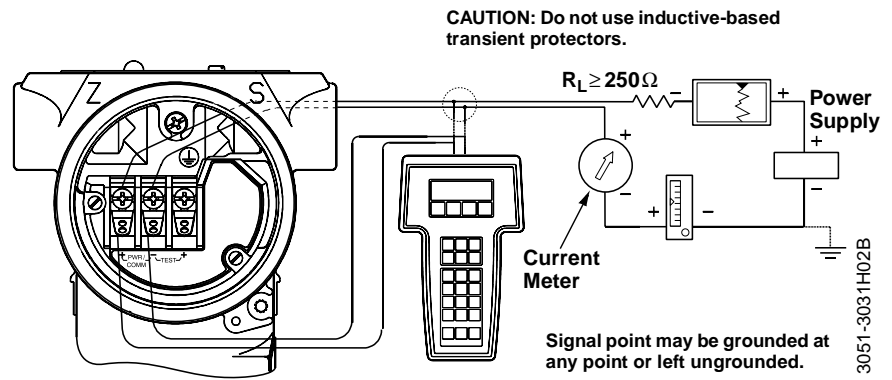
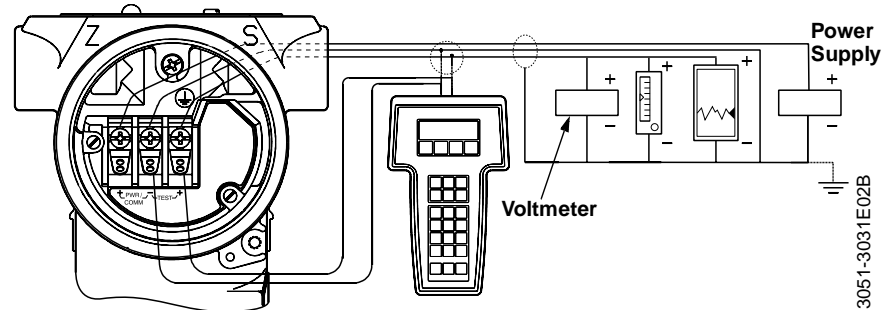


Figure B-5. Field Hook-up  
(Low Power Transmitters).



## COMMUNICATOR KEYS

The keys of the Model 268 include the alphanumeric, dedicated, and function keys that vary depending on the task being performed. The dedicated key functions are always the same.

### Dedicated Keys

#### On/Off

Use this key to turn the unit on and off. When the Model 268 is turned **ON**, it searches for a transmitter in the 4–20 mA loop. If no transmitter is found, the Model 268 offers the opportunity to try again, select **MULTI DROP** or **OFF-LINE**.

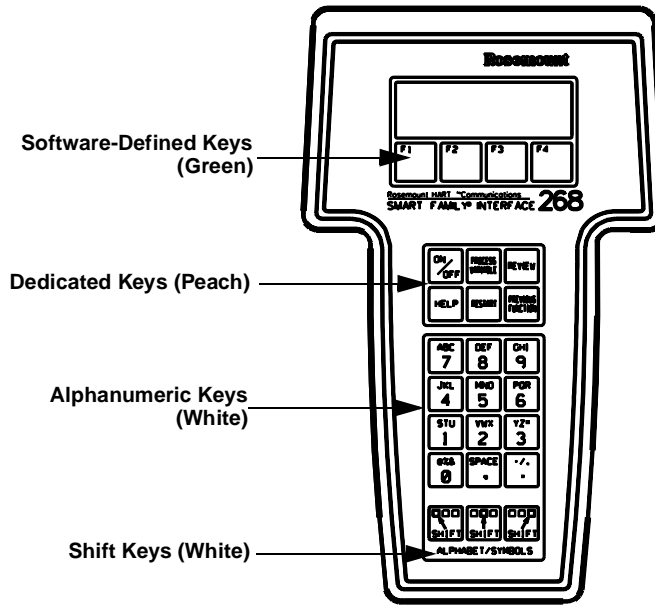
#### Process Variable

Use the **PROCESS VARIABLE** key to display up-to-date process variable readings from the transmitter in engineering units, milliamps, pulse rate, and shedding rate. It also displays totalized flow.

#### Review

The **REVIEW** key allows you to step through all the information currently held in the four memory locations of the transmitter and Model 268—SAFE MEM, OFLN MEM, WORK REG, and XMTR MEM.

Figure B-6. Model 268 Communicator.



268-2681A01C

### Help

Use the Help key to explain the software-defined key functions (F1-F4) in detail.

### Restart

Use the Restart key to initiate communication with a transmitter while the Model 268 is still turned on. Upon connection to a new transmitter, pressing this key loads information from the new transmitter into the Model 268 working register.

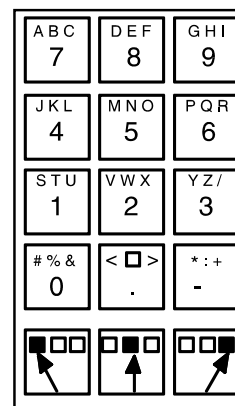
### Previous Function

The Previous Function key returns you to the previous decision level and allows you to select a different software-defined key function.

## Alphanumeric and Shift Keys

Some menus require data entry. Use the alphanumeric and shift keys to enter all alphanumeric information into the Model 268.

Figure B-7. Model 268 Communicator Alphanumeric and Shift Keys.



275-0383A

If you press an alphanumeric key alone from within an edit menu, the bold character in the center of the key appears. These characters include the numbers zero through nine, the decimal point (.), and the dash symbol (-).

To enter an alphabetic character, first press the shift key that corresponds to the position of the letter you want on the alphanumeric key. Then press the alphanumeric key. For example, to enter the letter “R,” first press the right shift key, then the “6” key (see Figure B-8). Do not press these keys simultaneously, but one after the other.

Figure B-8. Data Entry Key Sequence.



275-0532A,  
0343A

## Function Keys

Use the four software-defined function keys, located below the LCD, to perform software functions. On any given menu, the label appearing above a function key indicates the function of that key for the current menu. As you move among menus, different function key labels appear over the four keys.

## Fast Key Sequences

The Model 268 fast key sequences provide quick on-line access to transmitter variables and functions. Instead of stepping your way through the menu structure, you can press a fast key sequence to move from the Home Menu to the desired variable or function. On-screen instructions guide you through the rest of the screens.

## Fast Key Sequence Conventions

The fast key sequences for the Model 268 use the following conventions for their identification:

**F1, F2, F3, F4**—Refer to each function key located directly below the LCD on the Model 268.

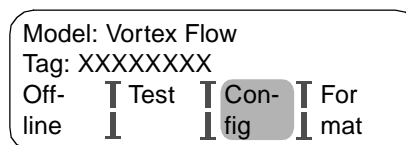
**(F2 x 7)**—Means to push the **F2** key seven consecutive times.

**Process Variable**—Refers to the dedicated key located below the function keys on the Model 268.

To return to the **HOME MENU**, use the function keys to exit the current task and press the **PREVIOUS FUNCTION** key as many times as necessary.

The fast key sequences are applicable only from the **HOME MENU**. The **HOME MENU** lists the model and tag, and labels the four function keys **OFFLINE**, **TEST**, **CONFIGURE** and **FORMAT** (see Figure B-9). After completing a task, return to the Home Menu if you intend to use the fast key sequences. Fast key sequences will not work from any other Model 268 screen.

Figure B-9. Model 268 Home Screen





To return to the **HOME MENU**, use the function keys to exit the current task and press the **PREVIOUS FUNCTION** key as many times as necessary. When the **HOME MENU** appears, you can use another fast key sequence to reach a desired task.

**NOTE**

In order to complete certain tasks, you must first set the loop to manual control. Fast key sequence steps often include the warning to return the loop to manual. If the loop is not in manual control, be sure to watch for this screen. If it comes up during the fast key sequence, set the loop to manual before continuing with the task.

**Fast Key Sequence Example**

**Date**

To change the Date following the menu structure, you would start at the **HOME MENU** and press F3 for *Configure*, F3 for *Xmtr Info*, and F1 three times in a row to reach the *Date* function. The fast key sequence is F3, F3, (F1 x 3).

**Diagnostic Messages**

The following table provides a guide to Model 268 diagnostic messages.

Message	Description
<b>CAUTION– Progressing will clear OfIn Mem</b>	OFLN Memory is cleared for new information.
<b>Data saved in OFLN Mem for downloading</b>	Off-line configuration data are saved in the Off-line Memory and can be downloaded or sent to the flowmeter at an appropriate time.
<b>Different XMTR type connected–XMTR Mem not changed</b>	Flowmeter did not accept data sent because the data is meant for a different type of transmitter.
<b>ERR–Filter Auto Adj</b>	The low pass filter auto-adjust sequence error occurs under the following conditions: <ul style="list-style-type: none"> <li>• no flow in pipe</li> <li>• filter tracking disabled</li> </ul> Remedy conditions and repeat function.
<b>ERR–Not xmtr command</b>	Flowmeter does not understand the command sent by the Model 268. Press F4, RESTART to restart the flowmeter, or press F3 to suppress the error message and REVIEW the software revision level. You may need to contact the Rosemount Service Center.
<b>ERR–Xmtr will not support command</b>	The flowmeter does not understand the Model 268 command. Press F4, RESTART or press F3, REVIEW to review the software revision level of the flowmeter. Check compatibility.
<b>Errors Detected– XMTR Mem not changed</b>	Flowmeter did not accept data because it contained nonpermissible values. Data errors must be corrected and the data sent again.
<b>Making changes permanent– PLEASE WAIT</b>	Data is being sent to flowmeter and flowmeter is accepting the data.
<b>No data modified to send</b>	Data with no changes is being sent. Press F4 to continue.
<b>No data saved in OFLN Mem</b>	There are no data in the Off-line Memory to review.

Message	Description
<b>No data saved in SAFE Mem</b>	There are no data in the Safe Memory to review.
<b>OfIn Mem not compatible with WORK REGS—Data not transferred</b>	The data stored in Off-line Memory and WORKing Register are from different kinds of transmitters, or the Off-line Memory is empty. Press F4, REVIEW, F2 to see the data in Off-line Memory and connect the Model 268 to similar transmitter.
<b>SAFE Mem from diff Xmtr than WORK REGS—Data not transferred</b>	Data in the Safe Memory and Working Register are from different transmitters. Press F4, REVIEW, F1 and find the flowmeter serial number. Connect the Model 268 to the flowmeter with that serial number and press RESTART.
<b>SAFE Mem not compatible with WORK REGS—Data not transferred</b>	The unique identifier in the Safe Memory and the transmitter are different. Press F4, REVIEW, F1 to see the data in the Safe Memory. Connect the Model 268 to the matching transmitter and press RESTART.
<b>WARN—Used nearest legal table value</b>	The value entered has too many decimal places. The Model 8800 defaults to the closest value available.
<b>WARN—Value entered is illegal, re-enter</b>	The Model 268 will not accept the entered value. Enter an acceptable value (see relevant section in manual).
<b>WARN—Value out of limits, altered by 268, re-check data</b>	The Model 268 could not store the entered value so it changed to the maximum allowable value. Check the new value.
<b>WARNING—Control loop should be in manual</b>	Before sending the data that could affect the 4–20 mA output signal, set the loop to manual control. After it is set, press F4.
<b>WARNING—Data transmission error</b>	Previous communication between Model 268 and the flowmeter was not successful. If this message appears repeatedly, check the loop for a source of noise that could corrupt the signal.
<b>WARNING—Loop may be returned to auto</b>	After completing a communication that required the loop to be set in manual, you may return the loop to automatic control.
<b>WARNING—Match xmtr S/N to nameplate S/N</b>	Check to be sure that the entered flowmeter serial number is the same as that on the flowmeter nameplate.
<b>WARNING—Not on line</b>	The key you have pressed is not applicable for off-line configuration tasks.
<b>WARNING—Process has been aborted</b>	Indicates that the self-test has been aborted by pressing any key.
<b>WARNING—Some of the changes were not saved in the xmtr mem</b>	Flowmeter did not receive all configuration changes. Note differences in configuration data and reconfigure the flowmeter accordingly.
<b>WARNING—This address already being used</b>	Another transmitter is already using the entered multi-drop address. Enter a new address.
<b>WARNING—This will erase work reg</b>	Data in the Working Register will be replaced with data from a another location.

Message	Description
<b>WARNING–Xmtr/268 not in communication</b>	Model 268 did not get answer from flowmeter: <ul style="list-style-type: none"> <li>• Check connections</li> <li>• Check that power is reaching flowmeter</li> <li>• Check for minimum 250 ohms resistance in loop</li> </ul>
<b>WARNING–Xmtr in output mode</b>	During start-up and restart, the transmitter milliamp output does not reflect the process variable. Press F4.
<b>WARNING–Xmtr is not communicating</b>	Model 268 did not get answer from flowmeter: <ul style="list-style-type: none"> <li>• Check connections</li> <li>• Check that power is reaching flowmeter</li> <li>• Check for minimum 250 ohms resistance in loop</li> </ul>
<b>WARNING–268 does not know this Xmtr</b>	Model 268 recognizes a Rosemount transmitter in the loop but cannot communicate with it. The message usually indicates a software revision level incompatibility between the Model 268 and the transmitter.
<b>XMTR Mem diff than WORK Regs–XMTR not changed</b>	Data in the Working Register and in the flowmeter have different unique identifiers. The Model 268 was probably connected to different flowmeter without RESTART or power-off/power-on sequence. Press RESTART to erase the Working Register or save the Working Register to the Off-line Memory and download to the proper flowmeter at a later time.
<b>Xmtr still busy</b>	Flowmeter is running a computational or diagnostic routine and cannot respond to the Model 268 instructions. Press the PREVIOUS FUNCTION key to cancel.

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## Approval Drawings

### OVERVIEW

Index of intrinsically safe Factory Mutual barrier systems and entity parameters for Models 3051C/L/P/H/T and 3001C/S (Drawing Number 03031-1019, Rev AA), pages C-2 through C-10.

Index of intrinsically safe C.S.A. barrier systems for Models 3051C/L/P/H/T and 3001C/S (Drawing Number 03031-1024, Rev AA), pages C-11 through C-14.

Index of SAA Entity Concept approvals, which are intrinsically safe when used in the circuit with SAA approved barriers that meet the listed entity parameters for Models 3051C/L/P/H/T and 3001C/S (Drawing Number 03031-1026, Rev AA), pages C-15 and C-16.

Index of intrinsically safe barrier systems and entity parameters for the Model 268 SMART FAMILY Interface (Drawing Number 00268-0031, Rev M), pages C-17 through C-23.

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY	REVISIONS				
	REV	DESCRIPTION	CHG. NO.	APP'D	DATE
	AA	ADD FIELDBUS	RTC1004088	M.L.M.	5/28/98

ENTITY APPROVALS FOR

3051C	3001C
3051L	3001CL
3051P	3001CH
3051H	3001S
3051CA	3001SL
3051T	3001SH

OUTPUT CODE A (4-20 MA HART) SEE SHEETS 2-4  
 OUTPUT CODE M (LOW POWER) SEE SHEETS 5-6  
 OUTPUT CODE F (FIELDBUS) SEE SHEETS 7-9

THE ROSEMOUNT TRANSMITTERS LISTED ABOVE ARE F.M. APPROVED AS INTRINSICALLY SAFE WHEN USED IN CIRCUIT WITH F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED IN THE CLASS I, II, AND III, DIVISION 1 GROUPS INDICATED. TEMP CODE T4. ADDITIONALLY, THE ROSEMOUNT 751 FIELD SIGNAL INDICATOR IS F.M. APPROVED AS INTRINSICALLY SAFE WHEN CONNECTED IN CIRCUIT WITH ROSEMOUNT TRANSMITTERS (FROM ABOVE) AND F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED FOR CLASS I, II, AND III, DIVISION 1, GROUPS INDICATED, TEMP CODE T4.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM, THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURER'S FIELD WIRING INSTRUCTIONS AND THE APPLICABLE CIRCUIT DIAGRAM.

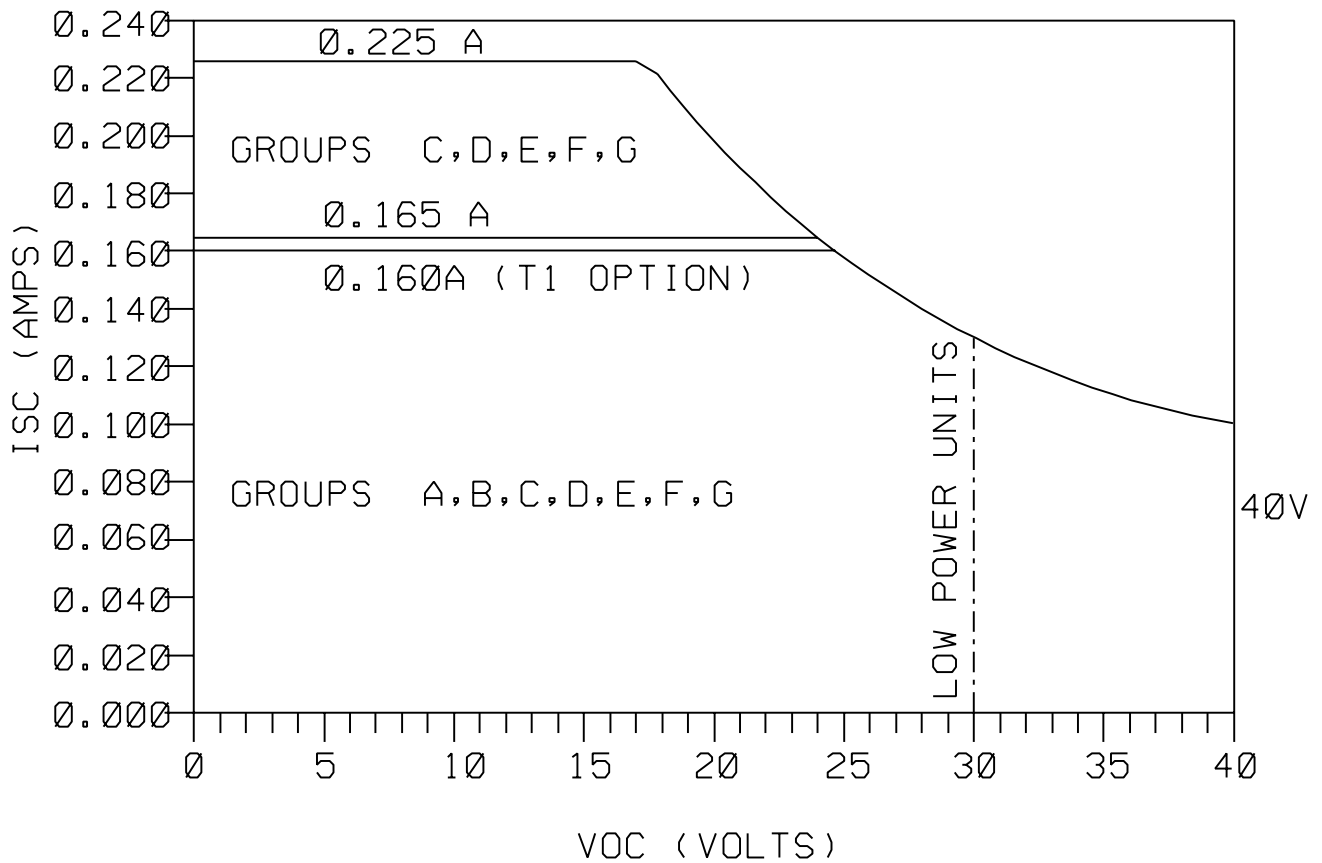
CAD Maintained, (MICROSTATION).

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES (mm). REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125  -TOLERANCE- .X * .1 [2.5] .XX * .02 [0.5] .XXX * .010 [0.25]  FRACTIONS    ANGLES * 1/32       * 2°  DO NOT SCALE PRINT	CONTRACT NO.	<b>ROSEMOUNT MEASUREMENT</b>		ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA
	DR. <b>MIKE DOBE</b> 03/21/89	FISHER-ROSEMOUNT		
	CHK'D	TITLE		
	APP'D. <b>KELLY ORTH</b> 03/22/89	INDEX OF I.S. F.M. FOR 3051C/L/P/H/T & 3001C/S		
APP'D. GOVT.	SIZE A	FSCM NO	DWG NO.	03031-1019
	SCALE	N/A	WT.	SHEET 1 OF 9

1019A01A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

BARRIER PARAMETERS (APPLICABLE TO OUTPUT CODES A & M)  
 P<sub>MAX</sub> = 1WATT



ROSEMOUNT INC.  
 12001 TECHNOLOGY DRIVE  
 EDEN PRAIRIE, MN 55344 USA

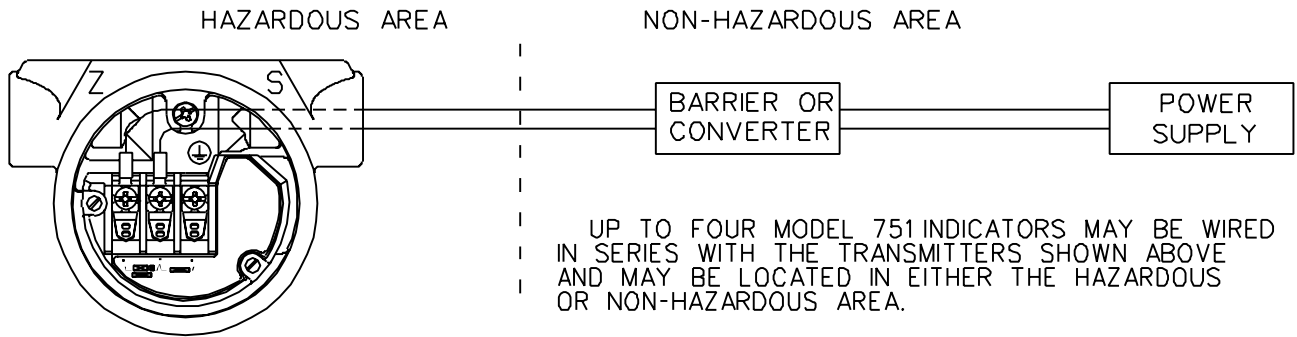
CAD Maintained, (MICROSTATION).

DR.	<b>MIKE DOBE</b>	SIZE	A	FSCM NO		DWG NO.	03031-1019
ISSUED		SCALE	N/A	WT.		SHEET	2 OF 9

1019A02A

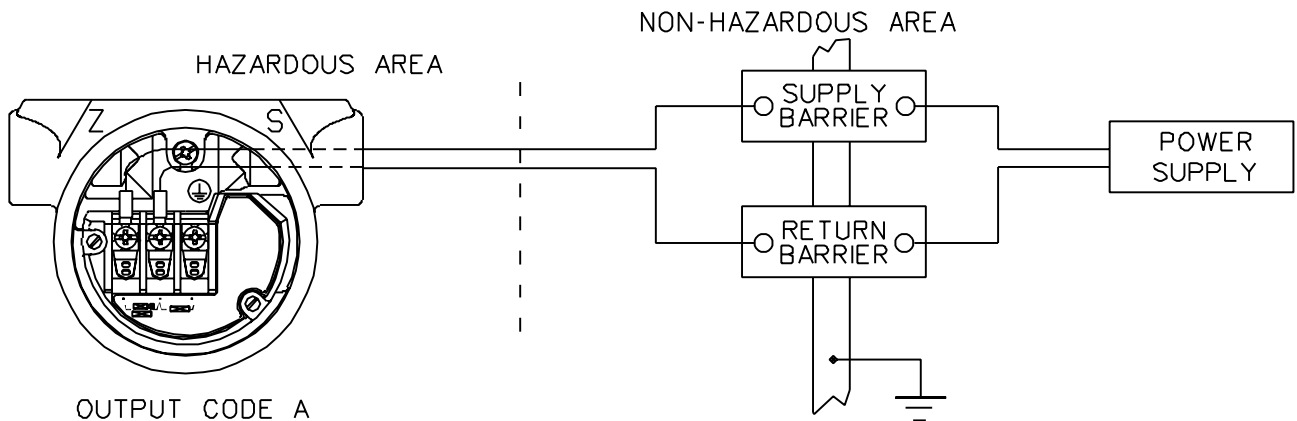
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

CIRCUIT DIAGRAM 1  
ONE BARRIER OR CONVERTER:  
SINGLE OR DUAL CHANNEL



OUTPUT CODE A  
MODELS INCLUDED  
3051C, L, P, H, T, CA  
3001C, CL, CH, S, SL, SH

CIRCUIT DIAGRAM 2  
SUPPLY AND RETURN BARRIERS  
(ONLY FOR USE WITH BARRIERS APPROVED IN THIS CONFIGURATION)



OUTPUT CODE A  
MODELS INCLUDED  
3051C, L, P, H, T, CA  
3001C, CL, CH, S, SL, SH

ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR.	<b>MIKE DOBE</b>	SIZE	FSCM NO	DWG NO.
ISSUED		A		03031-1019
		SCALE	N/A	WT.
				SHEET 3 OF 9

1019A03A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (VOC OR VT) AND MAX. SHORT CIRCUIT CURRENT (ISC OR IT) AND MAX. POWER (VOC X ISC/4) OR (VT X IT/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (VMAX), MAXIMUM SAFE INPUT CURRENT (IMAX), AND MAXIMUM SAFE INPUT POWER (PMAX) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (CA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (CI) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (LA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (LI) OF THE INTRINSICALLY SAFE APPARATUS.

FOR OUTPUT CODE A NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

CLASS I, DIV. 1, GROUPS A AND B

$V_{MAX} = 40V$	$V_T$ OR $V_{OC}$ IS LESS THAN OR EQUAL TO 40V
$I_{MAX} = 165MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 165MA
$P_{MAX} = 1 \text{ WATT}$	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
$C_I = .01\mu F$	$C_A$ IS GREATER THAN $.01\mu F$
$L_I = 10\mu H$	$L_A$ IS GREATER THAN $10\mu H$

\* FOR T1 OPTION:

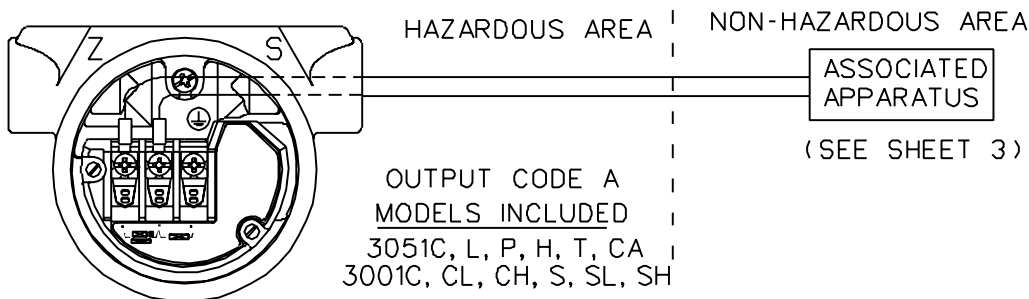
$I_{MAX} = 160MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 160MA
$L_I = 1.05MH$	$L_A$ IS GREATER THAN $1.05MH$

CLASS I, DIV. 1, GROUPS C AND D

$V_{MAX} = 40V$	$V_T$ OR $V_{OC}$ IS LESS THAN OR EQUAL TO 40V
$I_{MAX} = 225MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 225MA
$P_{MAX} = 1 \text{ WATT}$	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
$C_I = .01\mu F$	$C_A$ IS GREATER THAN $.01\mu F$
$L_I = 10\mu H$	$L_A$ IS GREATER THAN $10\mu H$

\* FOR T1 OPTION:

$L_I = 1.05MH$	$L_A$ IS GREATER THAN $1.05MH$
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ROSEMOUNT INC.  
12001 TECHNOLOGY DRIVE  
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION).

DR. <b>MIKE DOBE</b>	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT.	SHEET 4 OF 9

1019A04A



REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

FOR OUTPUT CODE M

CLASS I, DIV. 1, GROUPS A AND B

$V_{MAX} = 30V$	$V_T$ OR $V_{OC}$ IS LESS THAN OR EQUAL TO 30V
$I_{MAX} = 165MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 165MA
$P_{MAX} = 1 \text{ WATT}$	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
$C_T = .042\mu F$	$C_A$ IS GREATER THAN $.042\mu F$
$L_T = 10\mu H$	$L_A$ IS GREATER THAN $10\mu H$

\* FOR T1 OPTION:

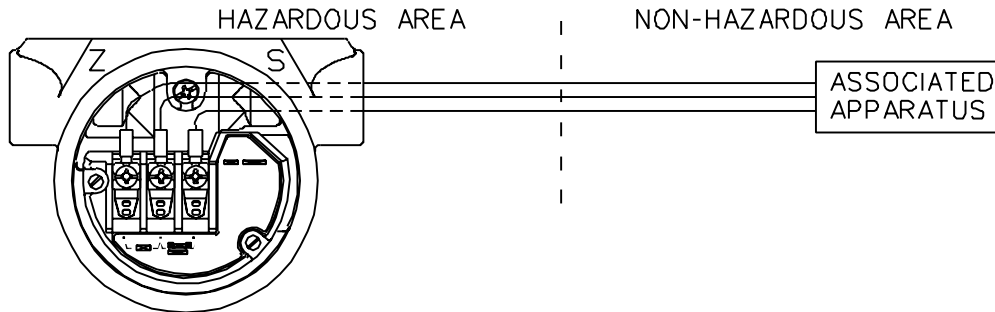
$L_T = 0.75MH$	$L_A$ IS GREATER THAN $0.75MH$
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CLASS I, DIV. 1, GROUPS C AND D

$V_{MAX} = 30V$	$V_T$ OR $V_{OC}$ IS LESS THAN OR EQUAL TO 30V
$I_{MAX} = 225MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 225MA
$P_{MAX} = 1 \text{ WATT}$	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
$C_T = .042\mu F$	$C_A$ IS GREATER THAN $.042\mu F$
$L_T = 10\mu H$	$L_A$ IS GREATER THAN $10\mu H$

\* FOR T1 OPTION:

$L_T = 0.75MH$	$L_A$ IS GREATER THAN $0.75MH$
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OUTPUT CODE M  
AVAILABLE FOR THE MODELS LISTED

3051C      3051H  
3051L      3051CA  
3051P      3051T

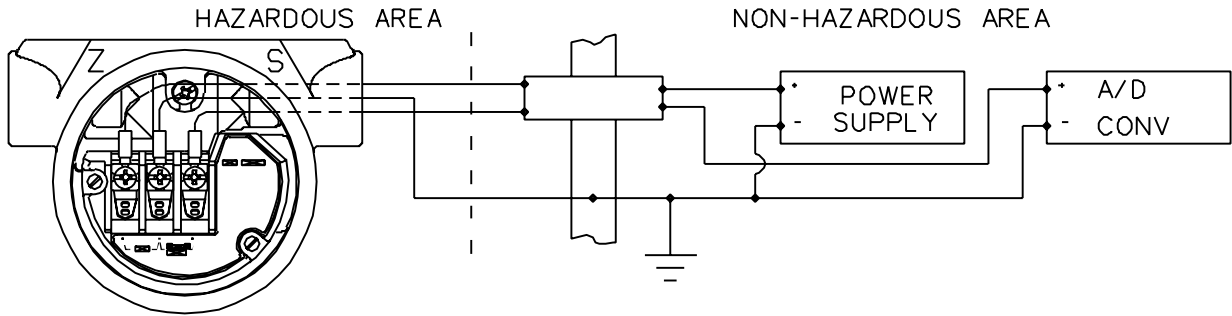
ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA	
DR.	<b>MIKE DOBE</b>
ISSUED	

CAD Maintained, (MICROSTATION).		
SIZE A	FSCM NO	DWG NO. 03031-1019
SCALE N/A	WT.	SHEET 5 OF 9

1019A05A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

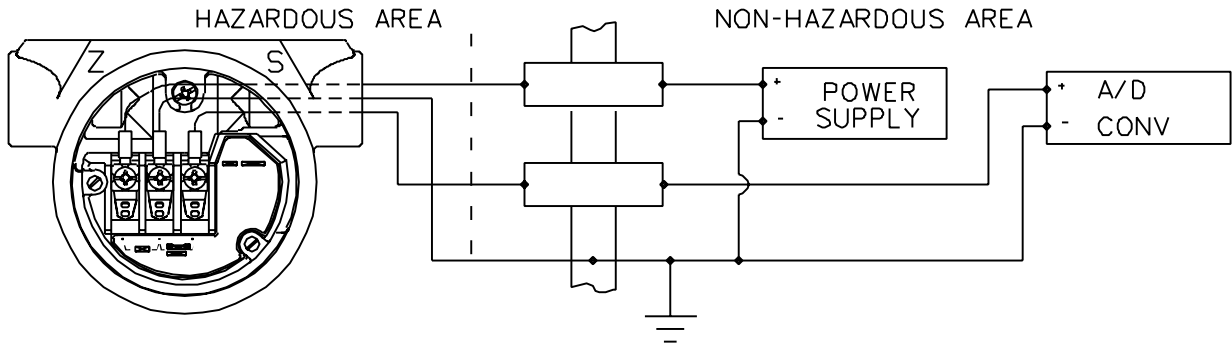
CIRCUIT DIAGRAM 3  
ONE DUAL CHANNEL BARRIER



OUTPUT CODE M  
AVAILABLE FOR THE MODELS LISTED

3051C	3051H
3051L	3051CA
3051P	3051T

CIRCUIT DIAGRAM 4  
TWO SINGLE CHANNEL BARRIERS  
(ONLY FOR USE WITH BARRIERS APPROVED  
IN THIS CONFIGURATION)



OUTPUT CODE M  
AVAILABLE FOR THE MODELS LISTED

3051C	3051H
3051L	3051CA
3051P	3051T

ROSEMOUNT INC.  
12001 TECHNOLOGY DRIVE  
EDEN PRAIRIE, MN 55344 USA

CAD Maintained, (MICROSTATION).

DR. **SANDI MANSON**

SIZE	FSCM NO
A	

DWG NO.	03031-1019
---------	------------

ISSUED

SCALE	N/A	WT.	
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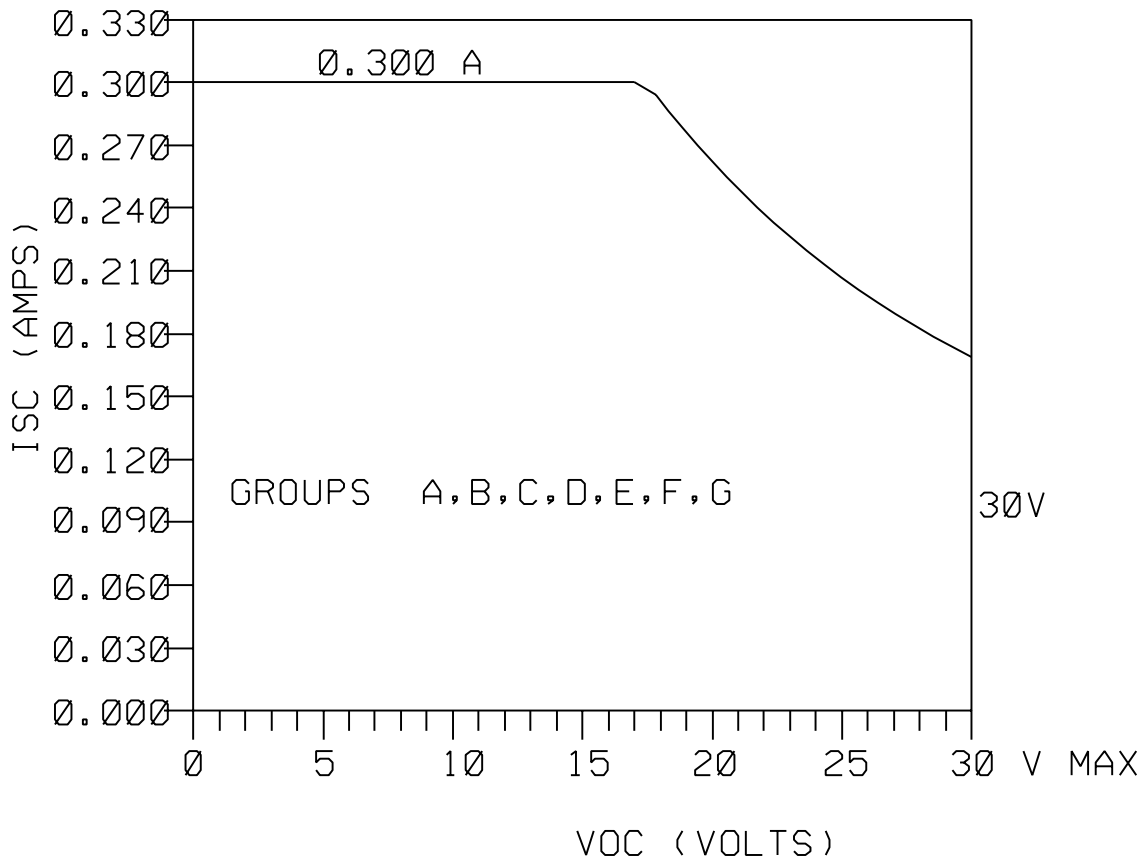
SHEET	6 OF 9
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1019A06A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

3051 WITH FOUNDATION FIELDBUS.  
(OUTPUT CODE F)

BARRIER PARAMETERS (APPLICABLE TO OUTPUT CODE F)  
P<sub>MAX</sub> = 1.3 WATT



ROSEMOUNT INC.  
12001 TECHNOLOGY DRIVE  
EDEN PRAIRIE, MN 55344 USA

DR. **Myles Lee Miller**

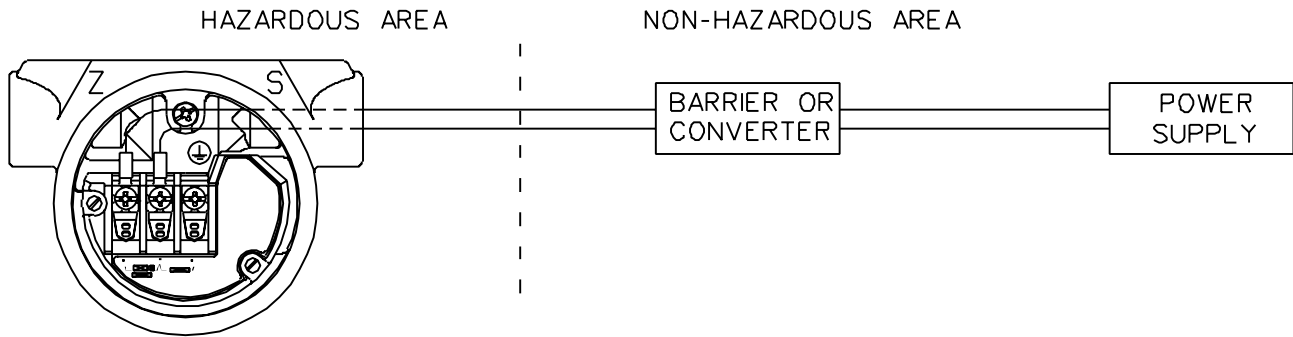
ISSUED

SIZE A	FSCM NO	CAD Maintained, (MICROSTATION).		
SCALE N/A	WT.	DWG NO. 03031-1019	SHEET 7 OF 9	

1019A07A

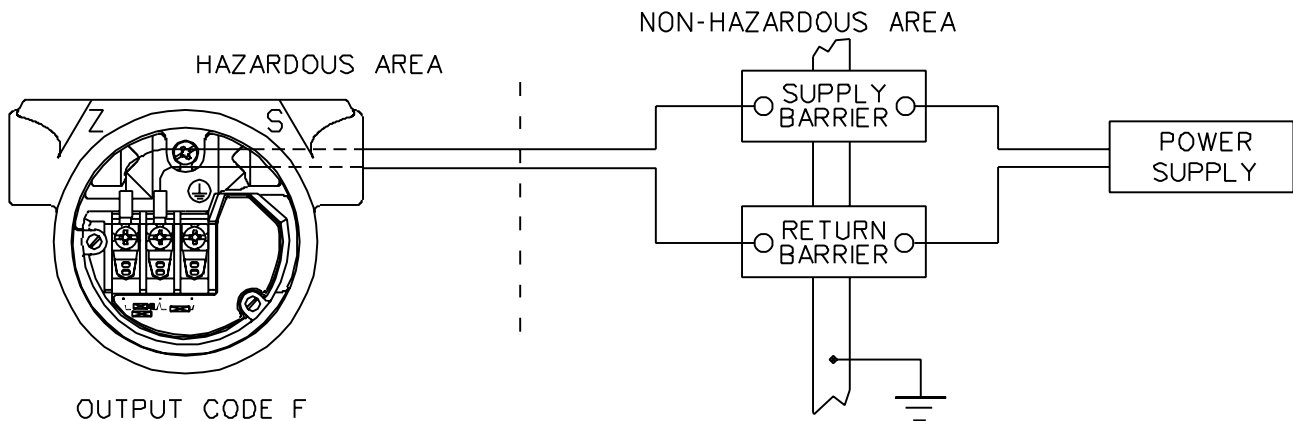
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

CIRCUIT DIAGRAM 1  
ONE BARRIER OR CONVERTER:  
SINGLE OR DUAL CHANNEL



OUTPUT CODE F  
MODELS INCLUDED  
3051C, L, P, H, T, CA  
3001C, CL, CH

CIRCUIT DIAGRAM 2  
SUPPLY AND RETURN BARRIERS  
(ONLY FOR USE WITH BARRIERS APPROVED IN THIS CONFIGURATION)



OUTPUT CODE F  
MODELS INCLUDED  
3051C, L, P, H, T, CA  
3001C, CL, CH

ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA	
DR.	<b>Myles Lee Miller</b>
ISSUED	

SIZE	FSCM NO	DWG NO.	CAD Maintained, (MICROSTATION).	
A		03031-1019		
SCALE	N/A	WT.	SHEET	8 OF 9

1019A08A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004088		

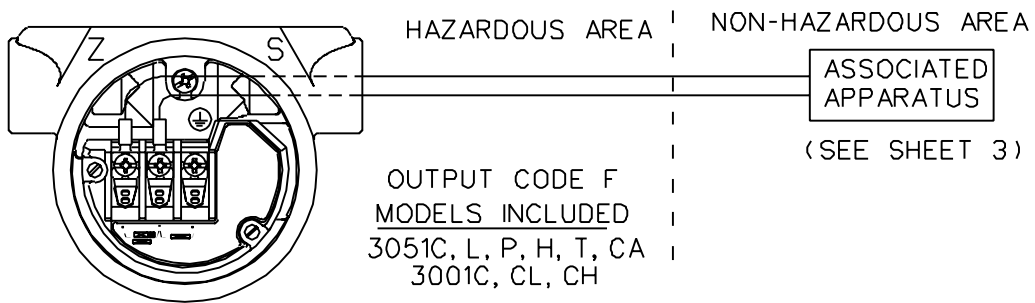
ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (VOC OR VT) AND MAX. SHORT CIRCUIT CURRENT (ISC OR IT) AND MAX. POWER (VOC X ISC/4) OR (VT X IT/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (VMAX), MAXIMUM SAFE INPUT CURRENT (IMAX), AND MAXIMUM SAFE INPUT POWER (PMAX) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (CA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (CI) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (LA) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (LI) OF THE INTRINSICALLY SAFE APPARATUS.

FOR OUTPUT CODE F NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

CLASS I, DIV. 1, GROUPS A, B, C AND D

$V_{MAX} = 30V$	$V_T$ OR $V_{OC}$ IS LESS THAN OR EQUAL TO 30V
$I_{MAX} = 300MA$	$I_T$ OR $I_{SC}$ IS LESS THAN OR EQUAL TO 300MA
$P_{MAX} = 1.3 WATT$	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1.3 WATT
$C_I = 0\mu F$	$C_A$ IS GREATER THAN $0\mu F$
$L_I = 0\mu H$	$L_A$ IS GREATER THAN $0\mu H$



ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR. <b>Myles Lee Miller</b>	SIZE A	FSCM NO	DWG NO. <b>03031-1019</b>	
ISSUED	SCALE N/A	WT.	SHEET 9 OF 9	



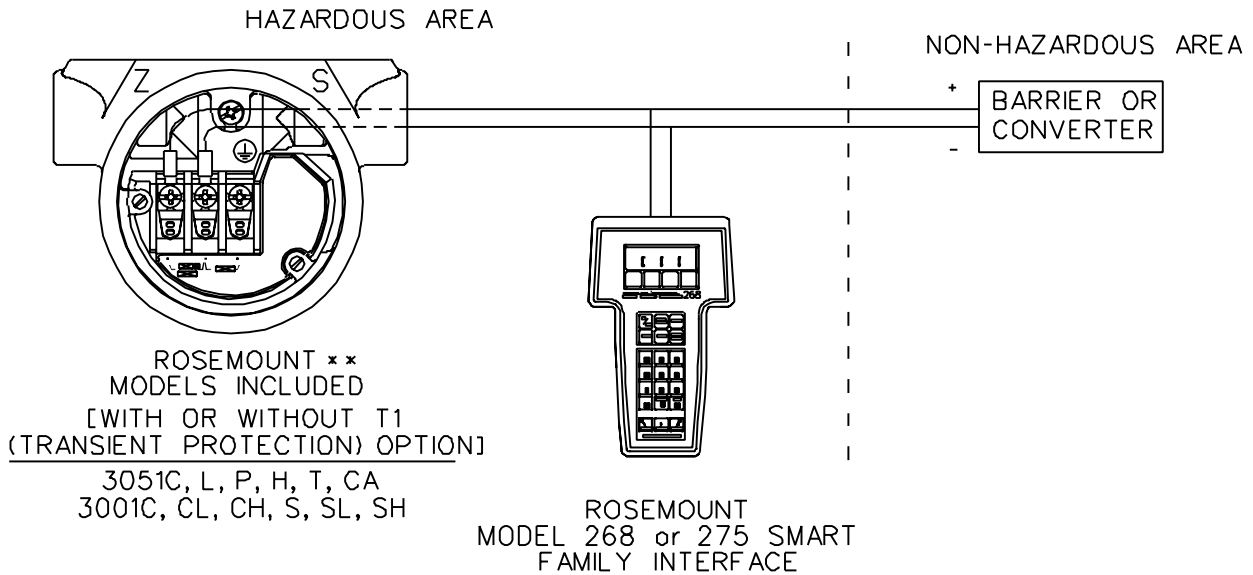
1019A09A

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA	ADD FIELDBUS	RTC1004232	<b>M.L.M.</b>	5/28/98

CSA INTRINSIC SAFETY APPROVALS  
CIRCUIT CONNECTION WITH BARRIER OR CONVERTER

Ex ia  
INTRINSICALLY SAFE/SECURITE INTRINSEQUE  
4-20 mA, ("A" OUTPUT CODE)



WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMBLEMES DE CLASSE I, DIVISION 2.

\*\* FOR THE LOW POWER OPTION, SEE PAGE 3 FOR THE CIRCUIT CONNECTION WITH BARRIER OR CONVERTER. FOR FIELDBUS ("F" OUTPUT CODE), SEE PAGE 4 FOR PARAMETERS AND CIRCUIT CONNECTION TO BARRIER.

CAD Maintained, (MICROSTATION).

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm] REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125

-TOLERANCE-  
.X = .1 [2.5]  
.XX = .02 [0.5]  
.XXX = .010 [0.25]

FRACTIONS ANGLES  
= 1/32 = 2°

DO NOT SCALE PRINT

CONTRACT NO.	
DR.	<b>Mike Dobe</b> 08/27/90
CHK'D	
APP'D.	<b>GLEN MONZO</b> 8/31/90
APP'D. GOVT.	

<b>ROSEMOUNT MEASUREMENT</b>		ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA	
FISHER ROSEMOUNT			
TITLE INDEX OF I.S. CSA FOR 3051C/L/P/H/T & 3001C/S			
SIZE A	FSCM NO	DWG NO. 03031-1024	
SCALE N/A	WT.	SHEET 1 OF	4

1024A01A

**Rosemount Model 3051 Smart Pressure Transmitters**

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004232		

4-20 MA, ("A" OUTPUT CODE)

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.1
CSA APPROVED SAFETY BARRIER	30 V OR LESS * 330 OHMS OR MORE * 28 V OR LESS * 300 OHMS OR MORE 25 V OR LESS 200 OHMS OR MORE * 22 V OR LESS 180 OHMS OR MORE	GROUPS A, B, C, D
FOXBORO CONVERTER 2A1-12V-CGB, 2A1-13V-CGB, 2AS-131-CGB, 3A2-12D-CGB, 3A2-13D-CGB, 3AD-131-CGB, 3A4-12D-CGB, 2AS-121-CGB, 3F4-12DA		GROUPS B, C, D
CSA APPROVED SAFETY BARRIER	30 V OR LESS 150 OHMS OR MORE	GROUPS C, D

LOW POWER, ("M" OUTPUT CODE)

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.1
CSA APPROVED SAFETY BARRIER	SUPPLY $\leq 28V_{\geq}$ 300 \\ RETURN $\leq 10V_{\geq}$ 47 \	GROUPS A, B, C, D
CSA APPROVED SAFETY BARRIER	SUPPLY $\leq 30V_{\geq}$ 150 \\ RETURN $\leq 10V_{\geq}$ 47 \	GROUPS C, D

\* MAY BE USED WITH ROSEMOUNT MODEL 268 or 275 SMART FAMILY INTERFACE.

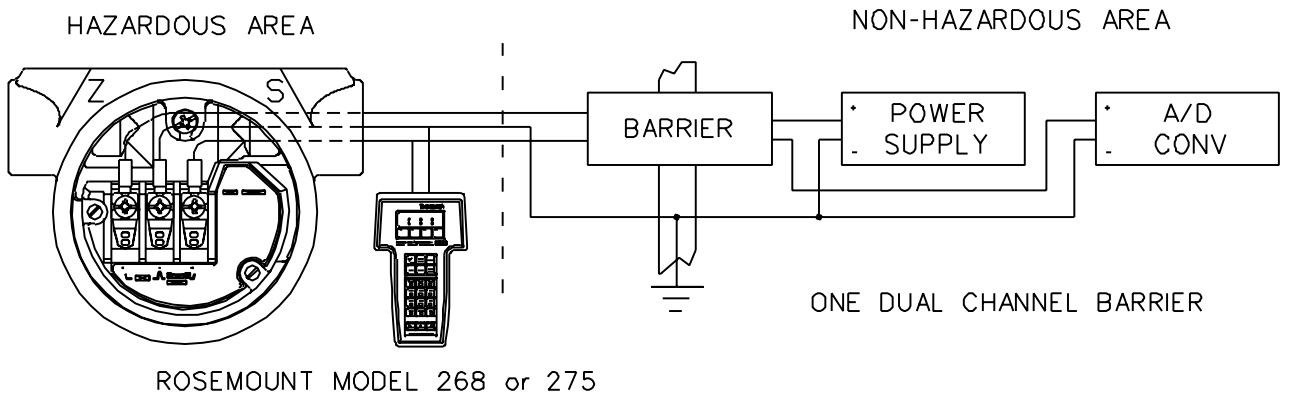
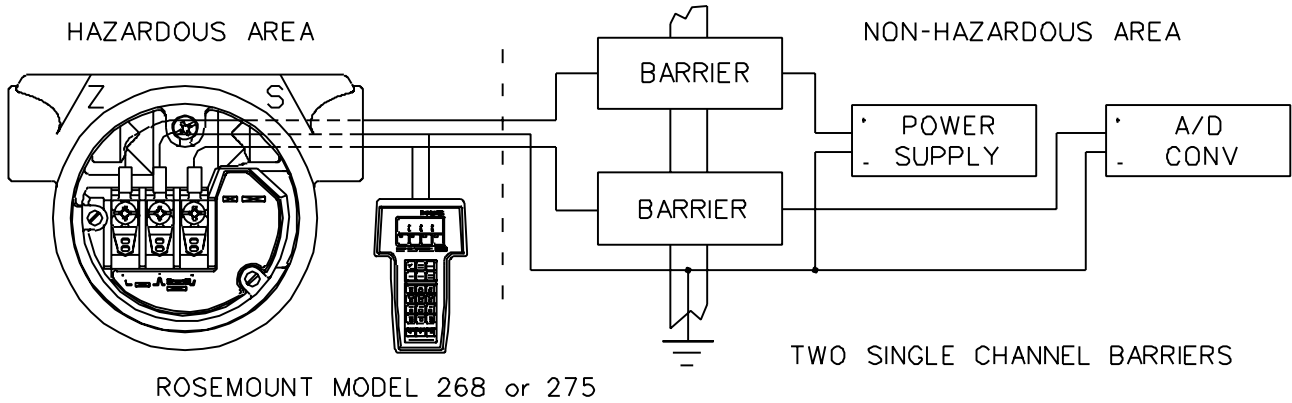
ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR. <b>Mike Dobe</b>	SIZE A	FSCM NO	DWG NO. 03031-1024	
ISSUED	SCALE N/A	WT.	SHEET 2 OF 4	

1024A02A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004232		

CSA INTRINSIC SAFETY APPROVALS  
3051C LOW POWER CIRCUIT CONNECTION WITH INTRINSIC SAFETY BARRIERS

Ex ia  
INTRINSICALLY SAFE/SECURITE INTRINSEQUE  
LOWPOWER, ("M" OUTPUT CODE)



APPROVED FOR CLASS 1, DIVISION 1, GROUPS A,B,C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 28 VOLTS OR LESS AND 300 OHMS OR MORE IN +PWR LINE, AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE, OR ONE CSA APPROVED DUAL CHANNEL SAFETY BARRIER WITH IDENTICAL APPROVED SAFETY PARAMETERS CONNECTED IN LIKE MANNER, AS ABOVE.

APPROVED FOR CLASS 1, DIVISION 1, GROUPS C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 30 VOLTS OR LESS AND 150 OHMS OR MORE IN +PWR LINE AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE.

ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR. <b>SANDI MANSON</b>	SIZE A	FSCM NO	DWG NO.	03031-1024
ISSUED	SCALE N/A	WT.	SHEET 3	OF 4

1024A03A

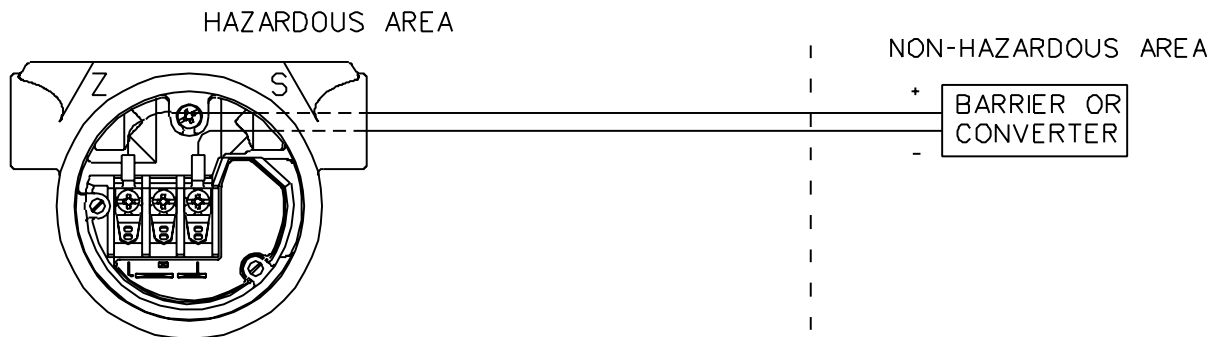


REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1004232		

FIELDBUS, ("F" OUTPUT CODE)

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.1
CSA APPROVED SAFETY BARRIER	30 V OR LESS	GROUPS A, B, C, D
	300 OHMS OR MORE	
	28 V OR LESS	
	235 OHMS OR MORE	
	25 V OR LESS	
	160 OHMS OR MORE	
	22 V OR LESS	
	100 OHMS OR MORE	

CSA INTRINSIC SAFETY APPROVALS  
 CIRCUIT CONNECTION WITH BARRIER OR CONVERTER  
 Ex ia  
 INTRINSICALLY SAFE/SECURITE INTRINSEQUE  
 FIELDBUS, ("F" OUTPUT CODE)



ROSEMOUNT \*\*  
 MODELS INCLUDED  
 [WITH OR WITHOUT T1  
 (TRANSIENT PROTECTION) OPTION]  
 3051C, L, P, H, T, CA  
 3001C, CL, CH, S, SL, SH

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS  
 MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS  
 PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS  
 DE CLASSE I, DIVISION 2.

ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).	
DR. <b>Mylee Lee Miller</b>	SIZE A	FSCM NO	DWG NO. 03031-1024
ISSUED	SCALE N/A	WT. _____	SHEET 4 OF 4



1024A04A

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA	UPDATE ENTITY PARAMETERS	RTC1002910	J.D.J.	12/2/97

### SAA ENTITY CONCEPT APPROVALS

THE ROSEMOUNT PRESSURE TRANSMITTERS LISTED BELOW ARE INTRINSICALLY SAFE WHEN USED IN THE CIRCUIT WITH SAA APPROVED BARRIERS WHICH MEET THE LISTED ENTITY PARAMETERS.

**APPROVED TRANSMITTERS \***

3051C 3051H 3001C 3001S  
 3051L 3051T 3001CL3001SL  
 3051P 3051CA 3001CH3001SH

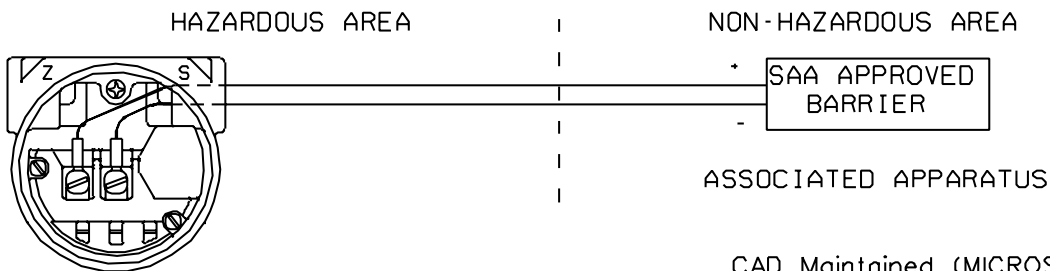
\* SEE SHEET 2 FOR LOW POWER CONFIGURATION.

ENTITY PARAMETER FOR EX IA IIC T6 CLASS I, ZONE 0 PROTECTION:

APPARATUS PARAMETER	BARRIER PARAMETER
VMAX = 30V	VOC IS LESS THAN OR EQUAL TO 30V
IMAX = 200MA	ISC IS LESS THAN OR EQUAL TO 200MA
PMAX = 0.9W	$\frac{VOC * ISC}{4}$ IS LESS THAN OR EQUAL TO 0.9W
CI = 0.01μ F	CA IS GREATER THAN 0.01 MICROFARADS
LI = 10μH	LA IS GREATER THAN 10 MICROHENRIES
FOR T1 OPTION ONLY	
IMAX = 160MA	ISC IS LESS THAN OR EQUAL TO 160MA
LI = 1.05MH	LA IS GREATER THAN 1.05 MILLIHENRIES

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURERS FIELD WIRING INSTRUCTIONS AND THE CIRCUIT DIAGRAM SHOWN BELOW.



CAD Maintained, (MICROSTATION).

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES (mm). REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125  -TOLERANCE- .X * .1 [2.5] .XX * .02 [0.5] .XXX * .010 [0.25]  FRACTIONS ANGLES * 1/32 * 2°  DO NOT SCALE PRINT	CONTRACT NO.	<b>ROSEMOUNT MEASUREMENT</b>		ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA
	DR. <b>Mike Dobe</b> 12/30/91	FISHER-ROSEMOUNT		
	CHK'D	TITLE		
	APP'D. <b>GLEN MONZO</b> 5/8/92	SAA I.S. INDEX FOR 3051 & 3001		
APP'D. GOVT.	SIZE A	FSCM NO	DWG NO.	03031-1026
	SCALE	N/A	WT.	SHEET 1 OF 2

1026A01A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA		RTC1002910		

### SAA ENTITY CONCEPT APPROVALS

THE ROSEMOUNT LOW POWER CONFIGURED PRESSURE TRANSMITTERS LISTED BELOW ARE SAA APPROVED AS INTRINSICALLY SAFE WHEN USED IN THE CIRCUIT WITH SAA APPROVED BARRIERS WHICH MEET THE LISTED ENTITY PARAMETERS.

APPROVED TRANSMITTERS WITH LOW POWER CONFIGURATION

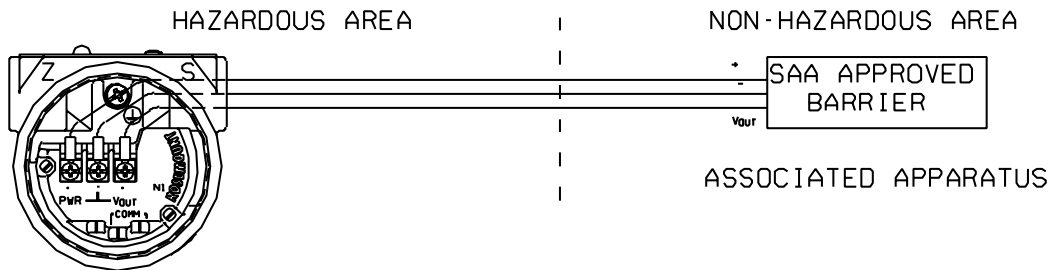
3051C      3051T  
 3051L      3051CA  
 3051P  
 3051H

ENTITY PARAMETER FOR EX IA IIC T6 CLASS I, ZONE 0 PROTECTION:

APPARATUS PARAMETER	BARRIER PARAMETER
VMAX = 30V IMAX = 200MA PMAX = 0.9W	VOC IS LESS THAN OR EQUAL TO 30V ISC IS LESS THAN OR EQUAL TO 200MA $\frac{VOC \times ISC}{4}$ IS LESS THAN OR EQUAL TO 0.9W
CI = 0.042 F LI = 10μH	CA IS GREATER THAN 0.042 MICROFARADS LA IS GREATER THAN 10 MICROHENRIES
FOR T1 OPTION ONLY LI = 0.75MH	LA IS GREATER THAN 0.75 MILLIHENRIES

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURERS FIELD WIRING INSTRUCTIONS AND THE CIRCUIT DIAGRAM SHOWN BELOW.



ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR. <b>Mike Dobe</b>	SIZE A	FSCM NO	DWG NO. 03031-1026	
ISSUED	SCALE N/A	WT.	SHEET 2 OF	2

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY	REVISIONS				
	REV	DESCRIPTION	CHG. NO.	APP'D	DATE
	G	ADD SHT 4&5, DELETE CLASS II & III	I. 636328	<b>B.S.J.</b>	08/01/90
	H	ADD 3051 P/L/H, 3001C CL /CH	636904	<b>K.D.V.</b>	09/06/90
	J	ADD SHT. 6, FIX TBL. 1.	638723	<b>B.S.J.</b>	01/02/91
	K	ADD 3044C	641710	<b>W.R.K.</b>	06/13/91
	L	ADD 3001S & SHT 7 FOR 3051C-LP	642380	<b>G.E.M.</b>	8/13/91
	M	ADD 3095	653145	<b>K.D.V.</b>	4/8/93

THE ROSEMOUNT MODEL 268 SMART FAMILY INTERFACE IS APPROVED BY FACTORY MUTUAL AS INTRINSICALLY SAFE FOR THE CLASS I, DIVISION 1 GROUPS INDICATED WHEN USED IN CIRCUIT WITH THE BARRIERS AND CONVERTERS LISTED BELOW AND THE ROSEMOUNT SMART FAMILY TRANSMITTERS DEPICTED IN THE ACCOMPANYING CIRCUIT DIAGRAMS.

BARRIER MANUFACTURER	MODEL	APPROVED FOR CLASS I DIVISION 1, GROUPS
FOXBORO	2AI-12V-FGB	A, B, C, D
	2AI-13V-FGB	
	2AS-13I-FGB	
	3A2-12D-CS-E/FGB-A	
	3A2-13D-CS-E/FGB-A	
HONEYWELL	38545-000-0110-113-F5B5	C, D
	38545-000-0110-111/112-F5B5	
MTL	115	A, B, C, D
	122	
	322	
	715	
	722	
R. STAHL	8901/31-199/100/7	C, D
	8901/30-199/100/7	
	8901/31-280/165/7	C, D
	8901/30-280/165/7	
	[ 8903/51-200/050/7	A, B, C, D
	[ 8901/31-086/150/7	A, B, C, D
	[ 8901/31-280/165/7	C, D
	[ 8901/31-086/150/7	C, D
	9005/01-245/060	A, B, C, D
	9005/01-252/100	A, B, C, D
TAYLOR	5850FL81200	C, D
	5851FL81200	
	1130FF21000	
	1130FF22000	
	1135FF21000	
	1135FF22000	

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UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES (mm). REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125	CONTRACT NO.	<b>ROSEMOUNT MEASUREMENT</b>		ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA
	DR. <b>MIKE DOBE</b> 2/7/90	FISHEROSEMOUNT		
	CHK'D	TITLE		
	APP'D. <b>K. CARLSON</b> 03/13/90	INDEX OF I.S. BARRIER SYSTEMS FOR MOD. 268 SMART FAMILY INTERFACE		
-TOLERANCE- .X * .1 [2.5] .XX * .02 [0.5] .XXX * .010 [0.25]		SIZE A	FSCM NO	DWG NO. <b>00268-0031</b>
FRACTIONS * 1/32	ANGLES * 2°	SCALE	WT. _____	SHEET 1 OF 7
DO NOT SCALE PRINT	APP'D. GOV'T.			

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M		653145		

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAXIMUM OPEN CIRCUIT VOLTAGE ( $V_T$  OR  $V_{OC}$ ) AND MAXIMUM SHORT CIRCUIT CURRENT ( $I_T$  OR  $I_{SC}$ ) AND MAXIMUM OUTPUT POWER ( $\frac{V_{OC} \times I_{SC}}{4}$  OR  $\frac{V_T \times I_T}{4}$ ), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE ( $V_{MAX}$ ), MAXIMUM SAFE INPUT CURRENT ( $I_{MAX}$ ) AND MAXIMUM SAFE INPUT POWER ( $P_{MAX}$ ) OF THE INTRINSICALLY SAFE APPARATUS, IN ADDITION, THE APPROVED MAXIMUM ALLOWABLE CONNECTED CAPACITANCE ( $C_A$ ) AND INDUCTANCE ( $L_A$ ) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE MAXIMUM UNPROTECTED INTERNAL CAPACITANCE ( $C_I$ ) AND INDUCTANCE ( $L$ ) OF THE INTRINSICALLY SAFE APPARATUS. THE APPROVED ENTITY CONCEPT PARAMETERS ARE AS FOLLOWS:  
ARE AS FOLLOWS:

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

INPUT PARAMETERS (CLASS I, DIV. 1, GROUPS A, B, C, D)

VMAX = 32 VDC		$V_T$ or $V_{OC}$ of barrier must be $\leq 32$ Vdc		
IMAX = 186 MA		$I_T$ or $I_{SC}$ of barrier must be $\leq 186$ mA		
CI = 0.01 UF		$C_A$ of barrier must be $\geq 0.01 \mu F$		
LI = 1.1 MH		$L_A$ of barrier must be $\geq 1.1$ mH		
PMAX:	1.1W	0.8W	0.6W	$\frac{V_{OC} \times I_{SC}}{4}$ of barrier must be $\leq$ specified value.
TEMP CODE	T4A	T5	T6	

OUTPUT PARAMETERS

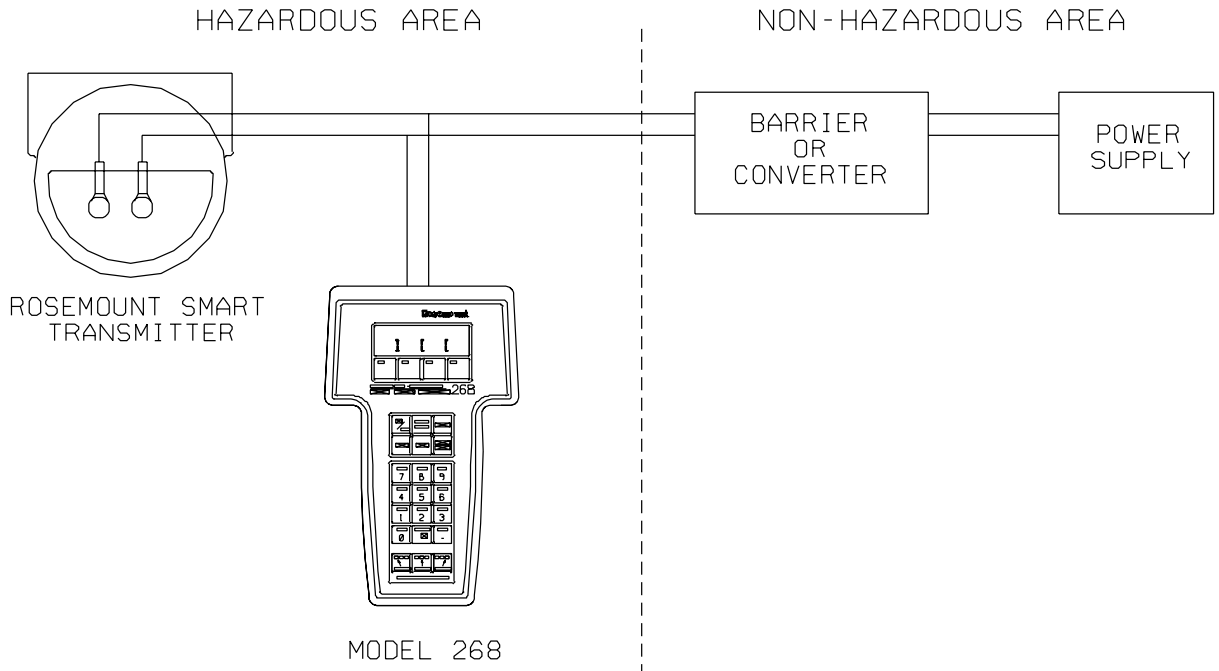
VOC = 1.5 VD.C.
ISC = 27 MA
$C_A = 10,000 \mu F$
$L_A = 46$ MH

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SIZE A	FSCM NO	DWG NO. 00268-0031
SCALE N/A	WT. _____	SHEET 2 OF 7

0031A02A

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ROSEMOUNT SMART TRANSMITTERS

- MODEL 1151 SMART
- MODEL 3051
- MODEL 3051C, 3051P, 3051L, 3051H, 3051CA
- MODEL 3044
- MODEL 3044C
- MODEL 3001C, 3001CL, 3001CH
- MODEL 3311
- MODEL 3001S, 3001SL, 3001SH
- MODEL 3095

UP TO FOUR MODEL 751 INDICATORS MAY BE WIRED IN SERIES WITH THE TRANSMITTERS SHOWN ABOVE AND MAY BE LOCATED IN EITHER THE HAZARDOUS OR NON-HAZARDOUS AREA

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DR. **D.PEARSON**

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SIZE  
A

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DWG NO. 00268-0031

SCALE N/A

WT. \_\_\_\_\_

SHEET 3 OF 7

0031A03A

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M		653145		

THE MAXIMUM ALLOWABLE CONNECTED INDUCTANCE ( $L_a$ ) OF THE ASSOCIATED APPARATUS IS DETERMINED BY ADDING 27 mA TO THE  $I_{sc}$  OF THE BARRIER ( $I_m = I_{sc} + 27mA$ ) AND ENTERING TABLE 1 (SHT 5) AT THE RESULTING VALUE,  $I_m$ , OR THE NEXT HIGHER VALUE OF  $I_m$ , TO DETERMINE THE  $L_a$ , (THE  $L_a$  MUST INCLUDE THE  $L_1$  OF THE MODEL 268, WHICH IS 1.1mH).

EXAMPLE #1:  $I_{sc}$  OF BARRIER = 100mA.

$$I_m = 100mA + 27mA = 127mA$$

ENTER TABLE AT  $I_m = 130mA$ ;  $L_a = 2.0mH$

--WARNING-- BEFORE CONNECTING THE MODEL 268 INTO THE LOOP, DETERMINE THE CONNECTED INDUCTANCE OF THE SYSTEM BY ADDING THE  $L_1$  OF THE TRANSMITTER, CABLE, AND MODEL 268. THE SUM MUST BE LESS THAN THE  $L_a$  DETERMINED FROM THE TABLE IN ORDER FOR THE MODEL 268 TO BE CONNECTED INTO THE LOOP. IF THE CONNECTED INDUCTANCE IS GREATER THAN THE VALUE DETERMINED FROM THE TABLE, A BARRIER WITH A LOWER  $I_{sc}$  MUST BE CHOSEN.

EXAMPLE #2: BARRIER  $I_{sc}$  = 41.8mA; BARRIER  $L_a$  = 20.0mH

$$I_m = 41.8mA + 27mA = 68.8mA;$$

ENTER TABLE AT 70mA AND READ  $L_a = 7.5mH$

ADD CONNECTED INDUCTANCE OF SYSTEM:

MODEL 268	$L_1 = 1.1mH$
MODEL 3051 TRANSMITTER	$L_1 = 0.48mH$
INDUCTANCE OF LOOP WIRING	1.0mH

-----

$$\text{TOTAL CONNECTED INDUCTANCE} = 2.58mH$$

TOTAL CONNECTED INDUCTANCE IS LESS THAN  $L_a = 7.5$  mH AS DETERMINED ABOVE AND IS ALSO LESS THAN THE BARRIER  $L_a$ . THE MODEL 268 MAY SAFELY BE CONNECTED INTO THE LOOP. IF THE MODEL 751 INDICATORS ARE USED, THEIR TOTAL INDUCTANCE (LABEL VALUE \* NUMBER OF INDICATORS) MUST ALSO BE INCLUDED.

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DR. <b>S.BARDUSON</b>	30JUL90	SIZE A	FSCM NO	DWG NO. <b>00268-0031</b>
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0031A04A

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M		653145		

Im (mA)	L <sub>a</sub> (mH)
150	1.3
145	1.5
140	1.6
130	2.0
120	2.5
110	3.0
100	4.0
90	5.0
85	5.5
80	6.0
75	6.7
70	7.5
65	8.8
62	9.5
60	10.0
57	11.0
55	12.0
50	15.0
45	19.0
40	23.0
35	31.0

TABLE 1

ROSEMOUNT INC.  
 12001 TECHNOLOGY DRIVE  
 EDEN PRAIRIE, MN 55344 USA

DR. **S.BARDUSON** 30JUL90

ISSUED

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SIZE A	FSCM NO	DWG NO. 00268-0031
SCALE N/A	WT. _____	SHEET 5 OF 7

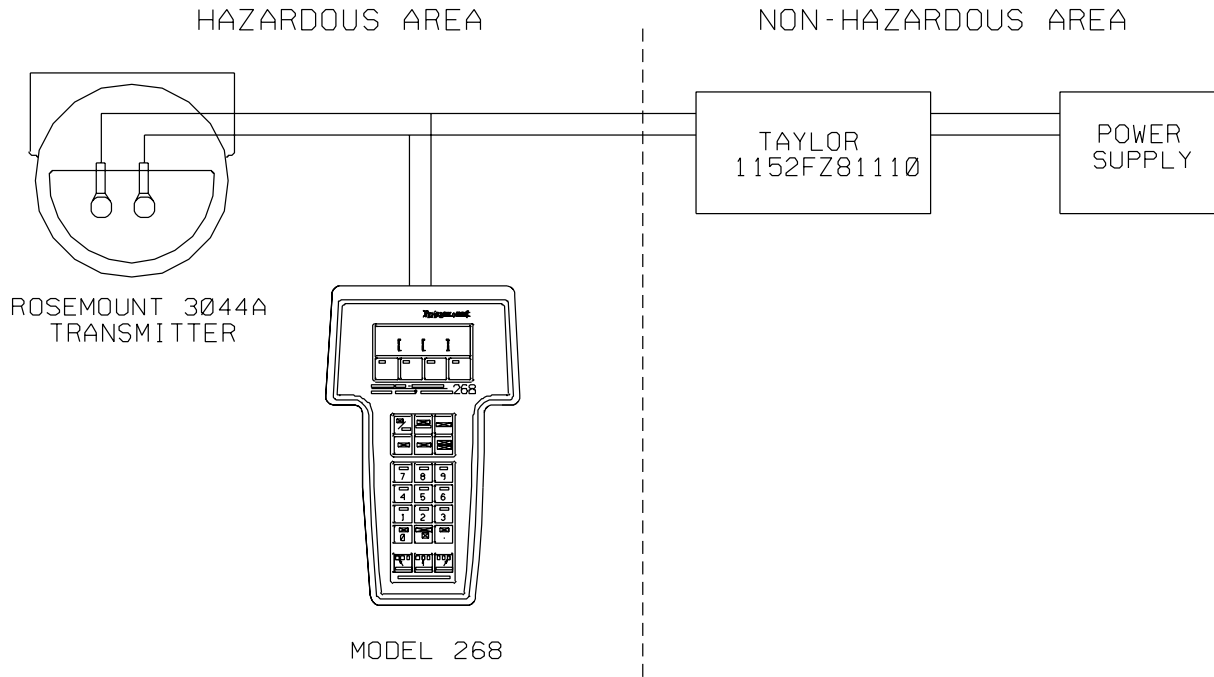
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REV	DESCRIPTION	CHG. NO.	APP'D	DATE

TAYLOR 1152FZ81110 SYSTEM



ROSEMOUNT 3044A SMART TRANSMITTERS MAY BE PLACED IN A CLASS I, DIVISION I, GROUP A, B, C, D HAZARDOUS LOCATION AS SHOWN ABOVE. THE LOOP POWER IS LIMITED BY A TAYLOR 1152FZ81110 INTRINSIC SAFETY BARRIER. THE ROSEMOUNT 268 MAY ALSO BE CONNECTED IN THE LOOP AS SHOWN. FOR CABLE WITH CAPACITANCE OF 60 PF/FT OR LESS AND INDUCTANCE OF .2 UH/FT OR LESS; CABLE LENGTHS OF UP TO 1600 FEET ARE ALLOWED .

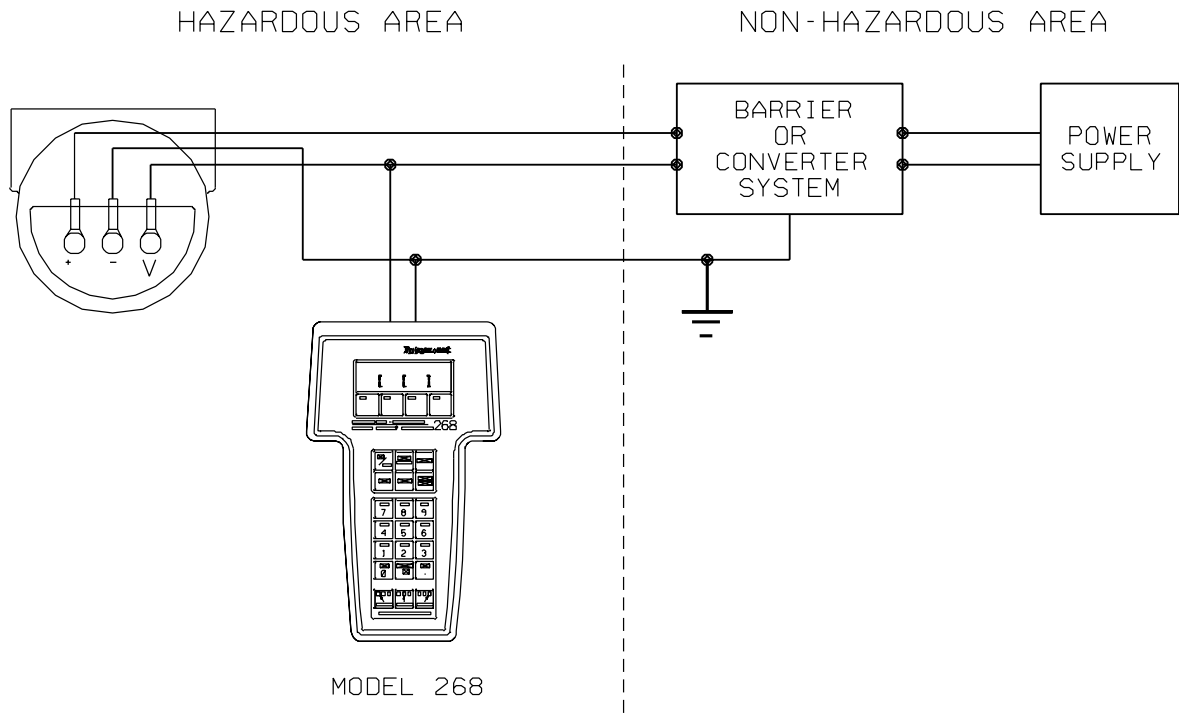
- TRANSMITTER: ROSEMOUNT 3044A
- BARRIER: TAYLOR 1152FZ81110
- COMMUNICATOR: ROSEMOUNT 268
- CABLE: CMAX = 60 PF/FT
- LMAX = .2 UH/FT
- MAX. LENGTH = 1600 FT

ROSEMOUNT INC. 12001 TECHNOLOGY DRIVE EDEN PRAIRIE, MN 55344 USA		CAD Maintained, (MICROSTATION).		
DR. <b>C. SCRIBNER</b> 12/21/90	SIZE <b>A</b>	FSCM NO	DWG NO. <b>00268-0031</b>	
ISSUED	SCALE <b>N/A</b>	WT. _____	SHEET <b>6</b> OF <b>7</b>	



0031A06A

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
M		653145		



CONNECTION FOR LOW POWER VERSIONS  
OF THE FOLLOWING  
ROSEMOUNT SMART TRANSMITTERS

- MODEL      3051C, 3051P, 3051L, 3051H, 3051CA
- MODEL      3001C, 3001CL, 3001CH
- MODEL      3001S, 3001SL, 3001SH

ROSEMOUNT INC.  
12001 TECHNOLOGY DRIVE  
EDEN PRAIRIE, MN 55344 USA

DR. **SANDI MANSON** 8/8/91

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SIZE A	FSCM NO	DWG NO. 00268-0031
SCALE N/A	WT. _____	SHEET 7 OF 7

0031A07A

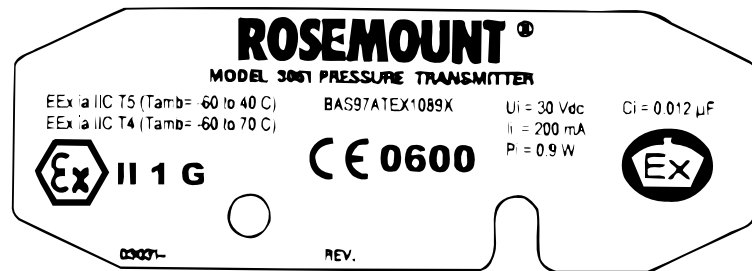


# European ATEX Directive Information

## OVERVIEW

### CENELEC/BASEEFA Intrinsic Safety

Rosemount Model 3051 Pressure Transmitters that have the following label attached, have been certified to comply with Directive 94/9/EC of the European Parliament and the Council as published in the Official Journal of the European Communities No. L 100/1 on 19–April–1994.



3051LAB

The following information is provided as part of the labeling of the transmitter:

- Name and address of the manufacturer (may be any of the following):
  - Rosemount USA
  - Rosemount England
  - Rosemount Germany
  - Rosemount Singapore

CE 0600

- Complete model number (see Section 5 Specifications and Reference Data).
- The serial number of the device
- Year of construction
- Marking for explosion protection:
  - EEx ia IIC T5 ( $T_{amb} = -60$  to  $40$  °C)
  - EEx ia IIC T4 ( $T_{amb} = -60$  to  $70$  °C)
  - $U_i = 30$  Vdc,  $I_i = 200$  mA,  $P_i = 0.9$  W,  $C_i = 0.012$  mF

Ex II 1 G

### Special conditions for safe use (X):

Model 3051 transmitters fitted with the transient protection terminal block are not capable of withstanding the 500 V insulation test required by Clause 6.4.12 of EN 50 020 (1994), and this must be taken into account when installing the apparatus.



---



# Glossary

<b>Analog Output Trim</b>	Digital Trim operation that allows adjustment of the output electronics to conform to the plant standard. Three types of analog output trim are available: 4–20 mA Trim, 4–20 mA Other Scale, and Low Power. See “Analog Output Trim” on page 2-27.
<b>Cloning</b>	Off-line operation that uses the Model 268 to copy configuration data from one transmitter to one or more other transmitters that require the same data. See “Saving, Recalling, and Cloning Configuration Data” on page 2-29.
<b>Commissioning</b>	Functions performed with a HART-based communicator and the transmitter which test the transmitter, test the loop, and verify transmitter configuration data. See “Commissioning the Model 3051 on the bench with a HART-Based Communicator” on page 2-9.
<b>Configuration</b>	Process of setting parameters that determine how the transmitter operates. See page 2-1.
<b>Damping</b>	Output function that increases the response time of the transmitter to smooth the output when there are rapid input variations. See “Damping” on page 2-17.
<b>Descriptor</b>	Sixteen-character field for additional identification of the transmitter, its use, or location. The descriptor is stored in the transmitter and can be changed using the HART-based communicator.
<b>Digital Trim</b>	Format function that allows you to adjust the transmitter characterization for purposes of digital calibration to plant standards. Digital Trim includes two separate operations: Sensor Trim and Analog Output Trim. See pages 2-24 and 2-27.
<b>Failure Mode Alarm</b>	Transmitter function that drives the analog output to a jumper-selectable high or low value in the event of an electronics failure. See “Failure Mode Alarm” on page 2-2.
<b>Factory Characterization</b>	Factory process during which each sensor module is subjected to pressures and temperatures covering the full operating range. The sensor module memory stores data generated from this process for use by the microprocessor in correcting the transmitter output during operation.
<b>Full Trim</b>	Sensor Trim function in which two accurate, end-point pressures are applied, and all output is linearized between them. The selected end points should always be equal to or outside the LRV and URV. See “Full Trim” on page 2-25.
<b>HART (Highway Addressable Remote Transducer) Protocol</b>	Communications standard that provides simultaneous analog and digital signal transmission between control rooms and field devices such as transmitters. All Rosemount SMART FAMILY products communicate using the HART protocol.

<b>Lower Range Limit (LRL)</b>	Lowest value of the measured variable that the transmitter can be configured to measure.
<b>Lower Range Value (LRV)</b>	Lowest value of the measured variable that the analog output of the transmitter is currently configured to measure.
<b>Multidropping</b>	The connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated. See “Multidrop Communication” on page 2-31.
<b>Reranging</b>	Configuration function that changes the transmitter 4 and 20 mA settings. See “Rerange” on page 2-14.
<b>Send Data</b>	HART-based communicator command that transfers configuration data from the hand-held communicator’s memory to the transmitter memory.
<b>Sensor Trim</b>	Digital Trim function that allows you to adjust the digital process variable reading to a precise pressure input. Zero Trim and Full Trim are the two Sensor Trim functions. See page 2-24.
<b>Smart</b>	Term used to describe instruments that are microprocessor-based and feature advanced communications capabilities. See <b>Section 1: Introduction</b> .
<b>SMART FAMILY</b>	Rosemount pressure, temperature, level, and flow instruments with microprocessor-based digital electronics.
<b>Span</b>	Algebraic difference between the upper and lower range values.
<b>Tag</b>	Eight-character field for identifying the transmitter. The tag is stored in the transmitter and can be changed using the Model 268 and the Transmitter Information function.
<b>Transmitter Address</b>	Unique number (1-15) used to identify a multidropped transmitter. Transmitters that are not multidropped have 0 as an address. See page 2-31.
<b>Transmitter Security</b>	Jumper-selectable feature that prevents accidental or deliberate changes to configuration data. See “Transmitter Security” on page 2-4.
<b>Upper Range Limit (URL)</b>	Highest value of the measured variable that the transmitter can be configured to measure.
<b>Upper Range Value (URV)</b>	Highest value of the measured variable that the analog output of the transmitter is currently configured to measure.
<b>Zero Trim</b>	A zero-based, one-point adjustment used in differential pressure applications to compensate for mounting position effects or zero shifts caused by static pressure. See “Zero Trim” on page 2-25.

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PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DIFFERENTIAL PRESSURE INSTRUMENTS				SHEET 1 OF 1									
								SPEC NO		FILE 14.11.P							
CUSTOMER : PROPAK				NO	BY	DATE	REVISION	JOB # 054468									
PLANT : STOCK REFRIG. 8B				0	RDD	03/11/05	ISSUE FOR PURCHASE	DATE 03/11/2005									
SERVICE : RECORDER								REQ.									
								BY	CHK'D	APPR.							
1	TAG NO.	FR/PR/TR-690	FUEL GAS OUTLET														
2	FUNCTIONS	RECORD	X	INDICATE		CONTROL		BLIND		TRANS.							
3	CASE	MFR STD	X	NOM SIZE		COLOR : MFR STD	X	OTHER									
4	MOUNTING	FLUSH		SURFACE		YOKE		OTHER	60MM PIPE MOUNT								
5	ENCLOSURE CLASS	GENERAL PURPOSE		WEATHER PROOF		EXPLOSION PROOF		CLASS									
6	POWER SUPPLY	FOR USE IN INTRINSICALLY SAFE SYSTEM				OTHER											
7	CHART	117 V 60Hz		OTHER AC		DC		VOLTS									
8	CHART DRIVE	STRIP		ROLL		FOLD		CIRCULAR	X	TIME MARKS	24h, 7 day						
9	SCALES	SPEED				POWER											
		TYPE															
		RANGE	1	0-1400 kPag	2	0 to 65°C	3	0-100" WC	4								
10	TRANSMITTER OUTPUT	4 - 20 mA		10 - 50 mA		21 - 103 kPa(g)		42 - 206 kPa (g)		OTHER							
		FOR RECEIVER SEE SPEC. SHEET															
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST															
		P		PI		PD		PID		IF		DF		IS		DS	
12	ACTION	OTHER															
13	AUTO - MAN SWITCH	ON MEAS. INCREASE OUTPUT :	INCREASES				DECREASES										
14	SET POINT ADJ.	NONE		MFR STD		OTHER											
15	MANUAL REG.	MANUAL		EXTERNAL		REMOTE		OTHER									
16	OUTPUT	NONE		MFR STD		OTHER											
17	SERVICE	4 - 20 mA		10 - 50 mA		21 - 103 kPa(g)		42 - 206 kPa (g)		OTHER							
18	ELEMENT TYPE	FLOW	X	LEVEL		DIFF. PRESS.		OTHER									
19	MATERIAL	DIAPHRAGM		BELLOWS	X	MERCURY		OTHER									
20	RATING	BODY		ELEMENT SS													
21	DIFF. RANGE	OVERRANGE		BODY RATING	17000	kPa (g)											
22		FIXED	0-100"WC	ADJ. RANGE		SET AT	60" WC	kPa (g)									
23	PROCESS DATA	ELEVATION		SUPPRESSION													
24	PROCESS CONN.	FLUID	H.C.GAS	MAX TEMP.	30	° C	MAX. PRESS.	689	kPa (g)								
25	ALARM SWITCHES	21 mm NPT	X	OTHER													
26	FUNCTION	QUANTITY		FORM		RATING											
27	OPTIONS	MEAS. VAR.		DEVIATION		CONTACTS TO		ON INC. MEAS.									
		PRESSURE ELEMENT	X	RANGE	0-1400 kPag	MATL.	SS										
		TEMP. ELEMENT	X	RANGE	0 to 65°C	TYPE	CAPILLARY 27mm NPT, 64mm"U"										
		FILT REG.		SUP. GAGE		OUTPUT GAGE		CHARTS									
		VALVE MANIFOLD		ADJ. DAMP		INTEGRAL SQ. RT. EXT.											
		COND. POTS		INTEGRATOR													
		OTHER															
28	MFR. & MODEL NO.	BARTON															
29	MODEL NO.	202E - 3 PEN RECORDER															
30	P. O. NUMBER																

NOTES:

AREA. UNIT # :

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				CONTROL VALVES				SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : EMERGENCY SHUT DOWN VALVE				NO	BY	DATE	REVISION	JOB #	054468
				0	RDD	03/11/05	ISSUE FOR PURCHASE	DATE	03/11/2005
								REQ.	
								BY	CHK'D
G 1	TAG NO.	ESDV-600							
E 2	SERVICE	BLOWDOWN							
N 3	LINE NO. / VESSEL NO.	E-600							
E 4	LINE SIZE / SCHED. NO.	33 / S80							
5	TYPE OF BODY	GLOBE (FLOW UP)							
6	BODY SIZE	PORT SIZE	33 mm	12.5 mm	mm	mm	mm	mm	
7	GUIDING	NO. OF PORTS	STD	ONE(1)					
B 8	END CONN. & RATING	33 NPT							
O 9	BODY MATERIAL	CS							
D 10	PACKING MATERIAL	STD							
Y 11	LUBRICATOR	ISOLAT. VALVE							
12	BONNET TYPE	STD BONNET							
13	TRIM FORM	TAPER							
14	TRIM MATERIAL	SEAT / PLUG	STD						
		SHAFT / MAT'L	STD						
15	REQUIRED SEAT TIGHTNESS								
16	MAX. ALLOW SOUND LEV. dBA								
A 17	MODEL NO. & SIZE	40							
C 18	TYPE OF ACTUATOR	DIAPHRAGM							
T 19	CLOSE AT	OPEN AT	20 kPa	100 kPa	kPa	kPa	kPa	kPa	
U 20	FLOW ACTION TO	OPEN							
A 21	FAIL POSITION	OPEN							
T 22	HANDWHEEL & LOCATION								
P 23	MFR. & MODEL NO.								
O 24	FILT REG   GAGES   BYPASS								
S 25	INPUT SIGNAL								
I 26	OUTPUT SIGNAL								
T 27	AIR SUPPLY PRESS		kPa	kPa	kPa	kPa	kPa	kPa	
T 28	MFR. & MODEL NO.								
R 29	INPUT SIGNAL								
N 30	OUTPUT SIGNAL								
O 31									
P 32									
T 33									
34	FLOW UNITS	STD M <sup>3</sup> /D							
35	FLUID	NATURAL GAS							
36	QUANT. MAX.	MAX. Cg	152,917	192					
S 37	QUANT. OPER.	OPER Cg							
E 38	VALVE Cg	VALVE FL	192						
R 39	NORM IN PRES	NORM DELTA P	6780 kPa(g)	6780 kPa	kPa(g)	kPa	kPa(g)	kPa	
V 40	MAX. INLET PRESS.		8963 kPa	kPa	kPa	kPa	kPa	kPa	
I 41	MAX. SHUT OFF	MAX. DELTA P	8963 kPa(g)	8963 kPa	kPa(g)	kPa	kPa(g)	kPa	
C 42	TEMP. MAX.	OPER. TEMP	66 ° C	38 ° C	° C	° C	° C	° C	
E 43	OPER. SP. GR.	MOL. WT.		19.5					
44	OPER. VISC.	% FLASH							
45	% SUPERHEAT	% SOLIDS							
46	VAPOR PRESS	CRIT PRESS	kPa(g)	3830 kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	
47	PREDICTED SOUND LEVEL dBA								
48	MANUFACTURER	FISHER							
49	MODEL NO.	357-40							
50	P. O. NUMBER								

NOTES:

AREA. UNIT # :

# 357 Series Control Valves

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## Introduction

### Scope of Manual

This instruction manual provides installation, maintenance, and parts information for 357 Series control valves. Refer to separate manuals for instruction covering accessories used with the control valve.

### Description

The 357 Series control valves (figure 1) are designed for high-pressure on-off and throttling applications and are used as dump valves on oil and gas separators, scrubbers, and other field process equipment. They are also used for well-head applications where rugged



W58101L

Figure 1. 357 Series Control Valve

steel construction and easy maintenance are necessary. (The bonnet/body connection is covered by patent.)

Only personnel qualified through training or experience should install, operate, and maintain this control valve. If you have any questions concerning these instructions, contact your Fisher sales office before proceeding.

### Specifications

Table 1 lists specifications for the 357 Series control valves. Some of the specifications for the control valve, as it originally comes from the factory, are stamped on nameplates.



# 357 Series

Table 1. Specifications

<p><b>Available Configurations</b> See table 2</p> <p><b>Valve Body Sizes and End Connection Styles</b> See table 3</p> <p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b> 276 bar from –29 to 93°C (4000 psig from –20 to 200°F), 276 bar at –45°C (4000 psig at –50°F), and 268 bar at 149°C (3880 psig at 300°F) unless limited by end connection rating</p> <p><b>Maximum Pressure Drops<sup>(1)</sup></b> <b>Metal Seats:</b> See tables 4 and 5</p> <p><b>Input Signal to Actuator</b> See tables 4 and 5</p> <p><b>Actuator Maximum Casing Pressure</b> Size 20: 3.4 bar (50 psig) Size 40: 3.4 bar (50 psig)</p> <p><b>Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4</b> <b>Metal Seats:</b> ANSI Class IV <b>Soft Seats:</b> ANSI Class VI</p> <p><b>Material Temperature Capabilities<sup>(1)(2)</sup></b> <b>With Nitrile O-Rings, Nylon Bushings, and WCC Valve Bodies:</b> –29 to 93°C (–20 to 200°F) <b>With Fluoroelastomer O-Rings, Ryton Bushings, and WCC Valve Bodies:</b> –23 to 149°C (–10 to 300°F)</p>	<p><b>With Nitrile<sup>(3)</sup> O-Rings, Nylon Bushings, and LCC Valve Bodies:</b> –45 to 82°C (–50 to 180°F)</p> <p><b>Flow Characteristic</b> <b>Metal or Ceramic Seats:</b> Equal percentage <b>Soft Seats:</b> Quick opening</p> <p><b>Flow Direction</b> May be in either direction as suits the application</p> <p><b>Port Diameters</b> ■ 6.4, ■ 9.5, ■ 12.7, ■ 19.1, ■ 25.4, or ■ 38.1 mm (1/4, 3/8, 1/2, 3/4, 1, or 1-1/2 inch) port diameters for both 1-inch and 2-inch valve bodies. See tables 4 and 5 for more information.</p> <p><b>Maximum Rated Valve Plug Travel</b> 19 mm (3/4 inch)</p> <p><b>Valve Plug Style</b> Micro-Form™ valve plug<sup>(4)</sup></p> <p><b>Actuator Diaphragm Effective Area</b> Size 20: 213 cm<sup>2</sup> (33 inches<sup>2</sup>) Size 40: 452 cm<sup>2</sup> (70 inches<sup>2</sup>)</p> <p><b>Actuator Spring Information</b> See table 6</p> <p><b>Actuator Pressure Connection Size</b> 1/4 inch NPT female</p> <p><b>Approximate Weight</b> See table 7</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ANSI code limitations should not be exceeded.  
 2. Process temperature should not go below –29°C (–20°F).  
 3. Low temperature material.  
 4. Contact your Fisher sales office for other valve plug requirements.

Table 2. Available Configurations

VALVE TYPE NUMBER AND FAIL ACTION	357, FAIL DOWN (SPRING CLOSES—AIR OPENS)				357, FAIL UP (SPRING OPENS—AIR CLOSES)			
	20		40		20		40	
Actuator Sizes	20		40		20		40	
Valve Configurations	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Valve Size, Inches	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2



# 357 Series

Table 3. Valve Sizes and Connection Styles

VALVE SIZE, INCHES	SCREWED <sup>(1)</sup>	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		Class 150	Class 300	Class 600	Class 1500	Class 600	Class 1500
1	X	X	X	X	---	X	---
2	X	X	X	X	X	X	X

X = Available construction.  
 1. The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

Table 4. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Down, Spring Closes—Air Opens Configuration)

ACTUATOR SIZE	FLOW DIRECTION	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR, SPRING PART NUMBER											
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
		mm	Inches	16A9594X012		16A9595X012		16A9656X012		16A9929X012		16A9656X012		16A9656X012	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open	6.4	1/4	117	1700	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	42	610	166	2400	104	1510	104	1510	276	4000	276	4000
		12.7	1/2	18	260	88	1270	53	770	53	770	157	2280	169	2450
		19.1	3/4	3	40	34	490	19	270	19	270	65	940	70	1010
		25.4	1	---	---	17	240	8	110	8	110	34	490	37	530
		38.1	1-1/2	---	---	5	70	1	10	1	10	12	180	14	200
	Down to Close	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	16A9929X012		16A9656X012		16A9656X012		16A9929X012		16A9656X012		16A9656X012	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				66	960	111	1620	111	1620	111	1620	186	2700	232	3360
				76	1100	178	2590	178	2590	178	2590	276	4000	276	4000
				87	1270	236	3420	247	3580	121	1760	276	4000	276	4000
				31	450	76	1100	103	1490	76	1100	141	2050	195	2830
				12	180	32	460	43	620	32	460	54	850	81	1180
				---	---	12	170	16	230	12	170	22	320	30	440
40	Up to Open	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
				1F176827092		1E792427082		1E795627082		1F176827092		1E792427082		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
				201	2920	276	4000	276	4000	276	4000	276	4000	276	4000
				108	1560	157	2270	157	2270	181	2630	276	4000	276	4000
	43	620	65	940	65	940	76	1100	30	1890	174	2520			
	21	310	34	490	34	490	39	570	70	1020	95	1380			
	7	100	12	180	12	180	15	220	29	420	39	570			
	Down to Close	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	1J258127092		1E793327082		1E795627082		1J258127092		1E793327082		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
				159	2300	276	4000	257	3720	257	3720	276	4000	276	4000
				259	3750	276	4000	276	4000	276	4000	276	4000	276	4000
				276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
83				1210	182	2640	248	3860	182	2640	276	4000	276	4000	
34				500	76	1100	117	1690	76	1100	141	2050	190	2760	
13				190	28	410	44	630	28	410	52	760	71	1030	

1. For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.

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Table 5. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Up, Spring Opens—Air Closes Configuration)

ACTUATOR SIZE	FLOW DIRECTION <sup>(3)</sup>	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR <sup>(2)</sup> , SPRING PART NUMBER					
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
		mm	Inches	16A9594X012		16A9929X012		16A9595X012	
				Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open <sup>(2)</sup>	6.4	1/4	276	4000	276	4000	276	4000
		9.5	3/8	152	2210	276	4000	276	4000
		12.7	1/2	80	1160	173	2510	273	3960
		19.1	3/4	30	440	72	1040	117	1690
		25.4	1	14	210	37	540	63	910
		38.1	1-1/2	3	50	14	200	26	370
40	Up to Open <sup>(2)</sup>	6.4 9.5 12.7 19.1 25.4 38.1	1/4 3/8 1/2 3/4 1 1-1/2	0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
				1F176727032		1F714327092		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi
				276	4000	276	4000	276	4000
				276	4000	276	4000	276	4000
				194	2810	276	4000	276	4000
86	1250	175	2540	119	1730				
48	700	96	1390	64	930				
21	300	40	580	26	380				

- For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.
- Actual operating pressure includes an additional 0.2 bar (3 psig) input supply to the controller.
- Consult your Fisher sales office for maximum allowable shutoff pressure drops of flow down to close valve configuration.

Table 6. Spring Part Number, Color Code, Spring Rate and Free Length

ACTUATOR SIZE	SPRING PART NUMBER	COLOR CODE	SPRING RATE		FREE LENGTH	
			N/mm	Lb/in	mm	Inch
20	16A9594X012	Aluminum	36	205	140	5.5
	16A9595X012	Light Green	100	571		
	16A9656X012	Yellow	160	912		
	16A9929X012	Black	67	380		
40	1E792427082	Light Green	257	1470	165	6.5
	1E793327082	Yellow	367	2100		
	1E795627082	White	441	2520		
	1F176727032	Dark Green	64	368		
	1F176827092	Aluminum	86	490		
	1F714327092	Aluminum/Dark Blue	145	830		
	1J258127092	Aluminum/Brown	175	1000		

Table 7. 357 Series Approximate Weights

Actuator Size	20				40				
	1		2		1		2		
Valve Size, Inches	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle	
Valve Configuration	kg	21 <sup>(1)</sup>	21 <sup>(1)</sup>	28	23	29 <sup>(1)</sup>	29 <sup>(1)</sup>	35	31
	Pounds	47 <sup>(1)</sup>	47 <sup>(1)</sup>	61	51	64 <sup>(1)</sup>	64 <sup>(1)</sup>	78	68
Screwed	kg	23	22	27	27	30	29	35	35
	Pounds	50	48	60	60	67	65	77	77
Class 150	kg	26	26	37	35	34	34	45	43
	Pounds	57	57	82	77	74	74	99	94
Class 300 & 600	kg	---	---	55	57	---	---	63	65
	Pounds	---	---	122	126	---	---	139	143

- The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

## Installation

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.



### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**



### WARNING

**To avoid personal injury or property damage caused by bursting of pressure-retaining parts or by uncontrolled process fluid, be certain the service conditions do not exceed the limits shown on the valve nameplate and in tables 1, 4, and 5.**

1. Before installing the control valve assembly, inspect it for any damage and for any foreign material that may have collected in the valve body.
2. Remove any pipe scale, welding slag, and other foreign material from the pipeline.
3. The control valve can be installed in any position, but normally the actuator is vertical above the valve. Install the valve so the flow direction arrow on the side of the valve indicates the direction of the process flow.
4. Install the valve following local and national piping codes when they apply to the application. For screwed connections, treat the male pipe threads with a good grade pipe compound. For flanged valves, use suitable gaskets between valve and pipeline flanges.
5. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the valve.
6. Connect loading pressure for the fail-up configuration to the 1/4-18 NPT connection in the spring case. The fail-down configuration loading pressure connection is in the lower casing assembly as shown in figure 3.

## CAUTION

**If a fail-up configuration is used, do not plug the 1/4-18 NPT connection in the lower casing. It acts as a vent for the lower casing, permitting air to move in and out of the lower casing cavity as the diaphragm moves up and down. If the vent is plugged, the actuator will not respond properly to loading pressure changes and may be incapable of completely opening or shutting off the valve.**

## Spring Adjustment

The spring supplied with the actuator has been selected to meet the requirements of the application as specified on the order. This pressure condition is stamped on the actuator nameplate.

The spring has a fixed pressure span over which loading pressure will stroke the valve. Adjustment of the spring compression shifts the span so that more or less loading pressure is required to start travel. Since the span does not change, there will be a corresponding increase or decrease in the pressure requirements at the end of the valve stroke.

If the actuator has been disassembled or pressure conditions have changed, the spring may need adjustment to make the valve travel coincide with the diaphragm pressure range. Make the adjustment in the following manner.

1. Loosen the adjusting screw nut (key 35, figure 3) on the fail-down configuration, or unscrew the spring case assembly (key 46, figure 2) on the fail-up configuration.
2. Turn the fail-down adjusting screw (key 34, figure 3) or the fail-up adjusting stem nut (key 35, figure 2) clockwise to compress the spring or counterclockwise to decrease spring compression.

Increased spring compression results in increased loading pressure necessary to start travel. Decreased spring compression results in less loading pressure required to start travel. With the fail-down configuration flow-to-open, increased spring compression will balance a higher line pressure or provide additional seating load. With the fail-up configuration flow-to-open, decreased spring compression may be necessary if the line pressure is increased or if more valve plug seating load is required from the input signal.

3. After adjustment, tighten the adjusting screw nut (fail-down configuration), or replace the spring case assembly (fail-up configuration).

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The maximum pressure drop conditions are shown in tables 4 and 5. Note that the springs can be identified by the color code. Depending on how much conditions are changed, it may be necessary to change the actuator spring. If so, check the *Parts List* section to see if a different adjusting screw or adjusting stem assembly (key 34) is required.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

Due to the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher.

### WARNING

**Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.
- Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.
- Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.
- Vent the power actuator loading pressure and relieve any actuator spring precompression.
- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
- The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or

### **when loosening the packing box pipe plug.**

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

The following describes the procedure for complete disassembly and assembly of the actuator-valve combination. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. Key numbers refer to figure 2 for the fail-up configuration and figure 3 for the fail-down configuration.

## Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Unscrew the hammer nut (key 3). If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 58) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

If the bonnet is stuck on the valve, insert a large screwdriver or steel rod into the pry hole in the bonnet. Push down on the screwdriver or rod to loosen the bonnet.

### Note

**The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.**

3. Remove the cage (key 60) and seat ring (key 61). Inspect the cage and bonnet O-rings (keys 6 and 11) for wear or damage.

If the seat ring cannot be easily removed, perform one of the following procedures.

- If the end connections are accessible, reach in through one of the end connections and pry out the seat ring.
  - If the end connections are not accessible or if the valve is installed in a pipeline, use a blind-hole puller similar to CG 2545AB, which is made by Snap-On Tools.
4. To remove the valve plug (key 7), drive out the roll pin (key 9) and unscrew the valve plug from the stem (key 8).

If the valve plug cannot be easily unscrewed from the stem, disassemble the actuator in accordance with steps 7 through 9. Hold a wrench on the hex nut (key 29) to prevent the stem and diaphragm from rotating.

## CAUTION

**Be careful to avoid damaging the seating surface on the valve plug or the cage as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.**

5. If packing parts (keys 12, 13, 14, 15 for PTFE V-ring and nitrile/cotton; keys 12, 13, 14, and 16 for PTFE/composition) are to be replaced with new parts, remove the washer (key 10) and pull out the old parts using a formed wire hook.

### Note

**Save three flat washers (key 13) when removing packing.**

6. No further disassembly is necessary if only the trim and/or packing is being serviced. To reassemble the unit, proceed to the *Assembly* section step 1 and steps 7 through 15.



## WARNING

**To avoid personal injury caused by sudden release of spring force, relieve all spring compression before continuing disassembly. Use step 7 to relieve spring compression.**

7. To relieve all spring compression,

**For fail-down configuration**, loosen the adjusting screw nut (key 35, figure 3) and turn the adjusting screw (key 34, figure 3) counterclockwise to remove all spring compression.

**For fail-up configuration**, unscrew the spring case assembly (key 46, figure 2) and turn the adjusting stem nut (key 35, figure 2) counterclockwise to remove all spring compression. Remove the adjusting stem nut, spring seat, and spring.

8. Unscrew the casing cap screws and hex nuts (keys 36 and 37), and remove the upper casing assembly (key 23) from the lower casing (key 22).
9. For fail-up configuration, remove the cotter pin (key 50, figure 2) and unscrew the adjusting stem (key 34, figure 2) from the stem.
10. Lift out the diaphragm, diaphragm plate, and stem assembly.
11. To replace the diaphragm (key 26), separate the diaphragm assembly by using a wrench on the hex nuts (key 29) to unscrew the assembly.
12. Separate the parts—diaphragm washer, actuator O-ring (keys 27 and 28), diaphragm, and diaphragm plate, (keys 26 and 24).
13. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.
14. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 21) and lift off the lower casing (key 22). Replace the O-ring if necessary.

### Note

**The stem O-ring and bonnet bushing (keys 19 and 20), when used in fail-down, seal against loading pressure. The stem O-ring and bonnet bushing in fail-up have atmospheric pressure on the actuator side.**

15. If the hammer nut needs to be removed from the bonnet, the spring pins (key 58) can be removed with locking pliers.
16. The travel indicator assembly on the fail-up configuration has an O-ring (key 44, figure 2) that may become worn and leak loading pressure. If this happens, replace with a new assembly (key 43).
17. The fail-up configuration has an adjusting stem bushing and actuator stem O-ring (keys 48 and 49, figure 2) that seals against loading pressure around the adjusting stem.

## Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might

# 357 Series

cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant, lubricate all O-rings and bushings and the threads of parts that have to pass through the O-rings and bushings.

## CAUTION

**The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.**

2. If the actuator being reassembled is a fail-up configuration, replace the O-ring and bushing (keys 49 and 48, figure 2).
3. Assemble the diaphragm and diaphragm plate assembly. Place the patterned side of the diaphragm (key 26) (size 40 only) against the diaphragm plate (key 24). Be sure to turn the diaphragm washer (key 27) so that the side that is beveled on the inside diameter is against the O-ring (key 28). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 30) and lower spring seat (key 31), if used, are on the spring side.
4. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20); then bolt the lower casing to the bonnet.

### Note

**Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.**

5. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 29). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet.

6. For a fail-up configuration, screw the adjusting stem (key 34) onto the stem (key 8) and secure with a cotter pin (key 50). Make sure the bushing (key 48) and O-ring (key 49) are in place in the upper casing.
7. Install packing parts (keys 12, 13, 14, 15, or 16). Install the washer (key 10). Screw the valve plug onto the stem. Drive in the roll pin.
8. Make sure the O-ring (key 6) is in the seat ring. Install the seat ring and cage into the valve.
9. Make sure the bonnet O-ring (key 11) is on the bonnet.
10. Lubricate the threads on the valve body and hammer nut and on the contact surfaces of the bonnet and hammer nut flange. Install the bonnet with the attached diaphragm and valve plug onto the valve body. Tighten the hammer nut using a hammer until the nut stops turning. A few extra hammer blows will be required to ensure that the assembly is tight. To avoid overloading of the cage, do not use excessive force, which can be seen by deformation of the nut.

## CAUTION

**Over-tightening the diaphragm casing cap screws and nuts (keys 36 and 37) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.**

11. If the valve is a fail-up, position the upper casing (key 23) on the lower casing (key 22). Insert the cap screws (key 36) and tighten the hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern. Replace the spring, spring seat, (keys 32 and 33) and adjusting stem nut (key 35) over the adjusting stem (key 34). Replace the spring case assembly (key 46).
12. If the valve is fail-down, replace the spring (key 32) on the diaphragm plate (key 24). Replace the upper spring seat (key 33). Position the upper casing (key 23) on the lower casing (key 22). Insert the cap screws (key 36) and tighten the hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
13. Install the travel indicator assembly.
14. Refer to the *Spring Adjustment* section.
15. Adjust the travel indicator nut (key 42).

## Parts Ordering

Each 357 Series control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting your Fisher representative for assistance or when ordering replacement parts. When ordering replacement parts, also be sure to include the complete 11-character part number from the following parts list.

## Parts Kits

### Repair kits for the valve portion only.

PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, and 15) Nitrile seal Fluoroelastomer seal	R357XPTFE12 R357XPTFE22
Nitrile/Cotton Packing Repair Kit (includes keys 6, 11, 12, and 15) Nitrile seal Fluoroelastomer seal	R357X00NC12 R357X00NC22
Ceramic Trim Package (includes keys 7, 9, 60, and 61) 6.4 mm (1/4-inch) port diameter 9.5 mm (3/8-inch) port diameter 12.7 mm (1/2-inch) port diameter 19.1 mm (3/4-inch) port diameter 25.4 mm (1-inch) port diameter 38.1 mm (1-1/2 inch) port diameter	R357XVTC012 R357XVTC022 R357XVTC032 R357XVTC042 R357XVTC052 R357XVTC062

### Repair kits for the valve and actuator assembly.

Diaphragm is not included and must be ordered separately by appropriate part number. PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49) Nitrile seal Fluoroelastomer seal	R357X000012 R357X000032
Nitrile/Cotton Packing Repair Kit (includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49) Nitrile seal Fluoroelastomer seal	R357X000022 R357X000042

## Parts List

### Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Fisher sales office.

Key	Description	Part Number
2	Bonnet	
3	Hammer Nut	
4	Pipe Plug	
6*	Cage O-Ring	See following table
7*	Valve Plug	
	Taper Plug (all port diameters)	
	416 stainless steel	22B3498X012
	17-4PH stainless steel DH1150 (NACE)	22B3498X022
	Micro-Form Plug	
	416 stainless steel	
	6.4 mm (1/4-inch) port diameter	22B3492X012
	9.5 mm (3/8-inch) port diameter	22B3493X012
	12.7 mm (1/2-inch) port diameter	22B3494X012
	19.1 mm (3/4-inch) port diameter	22B3495X012
	25.4 mm (1-inch) port diameter	22B3496X012
	38.1 mm (1-1/2 inch) port diameter	22B3497X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	22B3492X022
	9.5 mm (3/8-inch) port diameter	22B3493X022
	12.7 mm (1/2-inch) port diameter	22B3494X022
	19.1 mm (3/4-inch) port diameter	22B3495X022
	25.4 mm (1-inch) port diameter	22B3496X022
	38.1 mm (1-1/2 inch) port diameter	22B3497X022
	VTC (ceramic) (standard or NACE)	
	6.4 mm (1/4-inch) port diameter	22B8922X012
	9.5 mm (3/8-inch) port diameter	22B8923X012
	12.7 mm (1/2-inch) port diameter	22B8924X012
	19.1 mm (3/4-inch) port diameter	22B8925X012
	25.4 mm (1-inch) port diameter	22B8926X012
	38.1 mm (1-1/2 inch) port diameter	22B8927X012
8*	Valve Stem	
	S31600 (316 stainless steel)	22B3516X012
	S20910 (Nitronic 50) (NACE)	22B3516X032
9*	Roll Pin, 18-8 stainless steel	1U5972X0012
9*	Pin, 17-4PH SST (DH1150) (NACE)	12B3507X022
10	Cage/Packing Washer	
11*	Bonnet O-Ring	See following table
12*	Packing Wiper, PTFE	15A9637X012
13	Packing Washer	
14	Packing Spring	

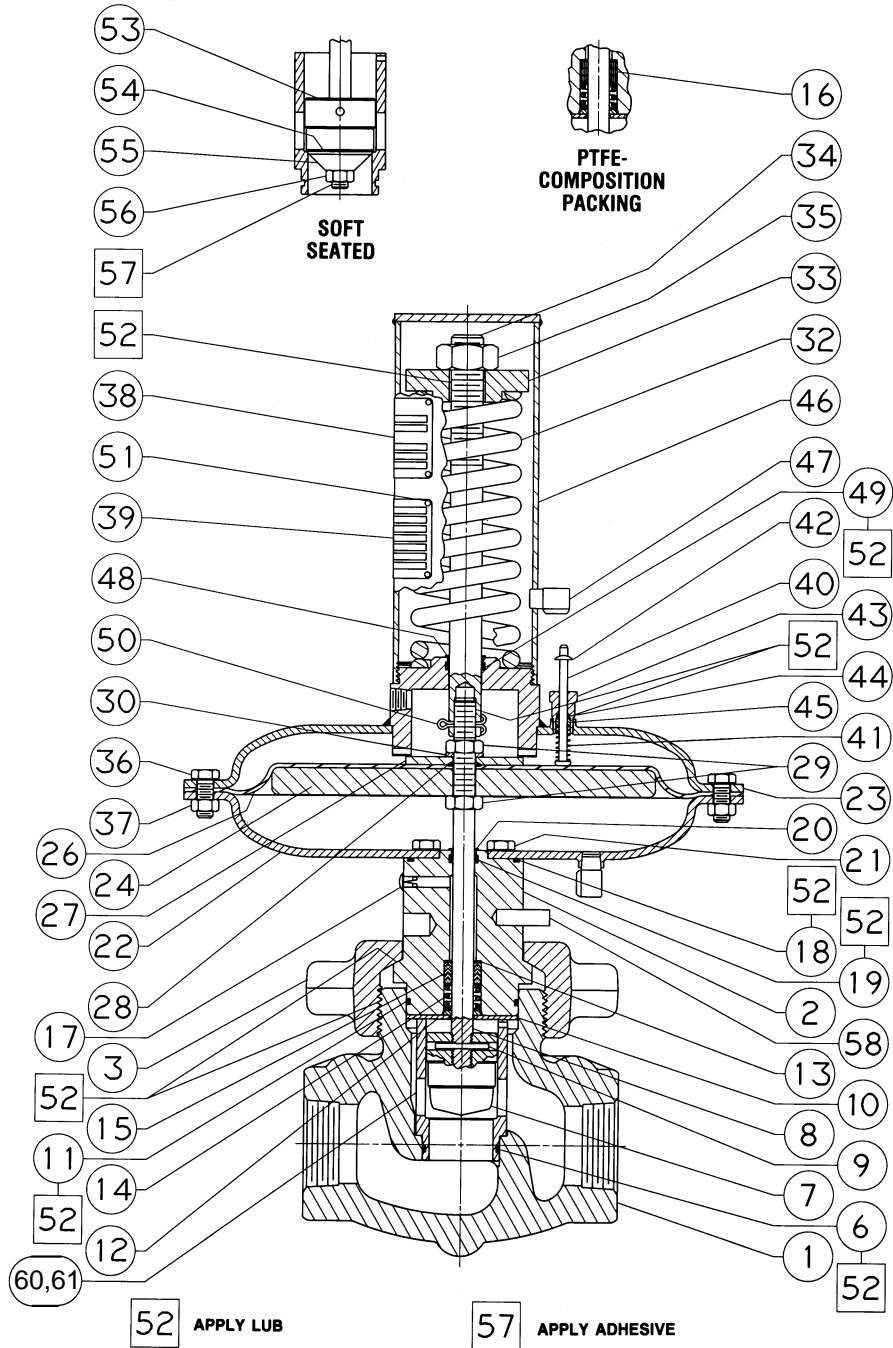
# 357 Series

Key	Description	Part Number	Key	Description	Part Number
15*	Packing Set		48*	Adjusting Stem Bushing, nylon (for fail up)	17A4059X012
	PTFE V-ring	12A9016X012	49*	Actuator Stem O-Ring (for fail up)	See following table
	Nitrile/cotton	19A5772X012	50*	Cotter Pin, S30200 (302 stainless steel) (for fail up)	1C608035022
16*	Packing Ring, PTFE comp (3 req'd)	1P390501042	51	Drive Screw	
17	Leak-off Plug		52	Lubricant, Lubriplate Mag-1	- - -
18*	Casing O-Ring	See following table		Not included with control valve	
19*	Stem O-Ring	See following table	53*	Plug, Disk Holder, S17400 D1150	
20*	Bonnet Bearing	See following table		12.7 mm (1/2-inch) port diameter	22B3533X012
21	Cap Screw			19.1 mm (3/4-inch) port diameter	22B3532X012
22	Lower Casing			25.4 mm (1-inch) port diameter	22B3531X012
23	Upper Casing Assy			38.1 mm (1-1/2 inch) port diameter	22B3530X012
24	Diaphragm Plate		54*	Disk, Plug Seat, UHMWPE <sup>(1)</sup>	
26*	Diaphragm (O-Ring, key 28 should be ordered with diaphragm)			12.7 mm (1/2-inch) port diameter	15A3584X012
	Size 20			19.1 mm (3/4-inch) port diameter	13A7446X012
	Nitrile/nylon	32B3520X012		25.4 mm (1-inch) port diameter	13A7450X012
	Fluoroelastomer	32B3520X022		38.1 mm (1-1/2 inch) port diameter	13A7463X012
	Size 40		55*	Disk Retainer, S31600	
	Neoprene/nylon	22B3521X012		12.7 mm (1/2-inch) port diameter	15A3583X022
	Fluoroelastomer	22B3521X032		19.1 mm (3/4-inch) port diameter	13A7447X012
27	Diaphragm Washer			25.4 mm (1-inch) port diameter	13A7451X012
28*	Actuator O-Ring	See following table		38.1 mm (1-1/2 inch) port diameter	12B3529X012
29	Hex Nut		56	Hex Nut	
30	Lockwasher		57	Adhesive, Loctite No. 262	
31	Lower Spring Seat		58	Spring Pin	
32	Actuator Spring	See tables 4, 5, and 6	60*	Cage for Metal Seats, Soft Seats, and Ceramic Trim	
33	Upper Spring Seat			S17400 D1150 (std or NACE) all port dia	22B8912X012
34	Adjusting Screw		61*	Seat Ring, 17-4PH stainless steel DH1150 (NACE)	
34	Adjusting Stem			Metal Seat Only,	
35	Adjusting screw nut			6.4 mm (1/4-inch) port diameter	39B2046X012
35	Adjusting stem nut			9.5 mm (3/8-inch) port diameter	39B2846X012
36	Cap Screw			Metal Seat and Soft Seat	
37	Hex Nut			12.7 mm (1/2-inch) port diameter	39B2047X012
38	Actuator Nameplate			19.1 mm (3/4-inch) port diameter	39B2048X012
40	Indicator Rod (included in key 43 assembly)			25.4 mm (1-inch) port diameter	39B2843X012
41	Indicator Spring (included in key 43 assembly)			38.1 mm (1-1/2 inch) port diameter	39B2844X012
42	Indicator Nut (included in key 43 assembly)		61*	Seat Ring for Ceramic Trim	
43	Indicator Assembly			S17400/Ceramic D1150 (std or NACE)	
	Fail up (includes keys 40, 41, 42, 43, 44, and 45)			6.4 mm (1/4 inch) port diameter	17B1949X012
	Fail down (includes keys 40, 41, 42, and 43)			9.5 mm (3/8 inch) port diameter	17B1950X012
44	Indicator O-Ring (included in key 43 assembly)			12.7 mm (1/2 inch) port diameter	17B1951X012
45	Indicator Bushing (included in key 43 assembly)			19.1 mm (3/4 inch) port diameter	17B9680X012
46	Spring Case Assembly			25.4 mm (1-inch) port diameter	17B9681X012
47	Vent Assy			Ceramic (std or NACE)	
				38.1 mm (1-1/2 inch) port diameter	32B8918X012

\*Recommended spare parts

1. Ultra High Molecular Weight Polyethylene

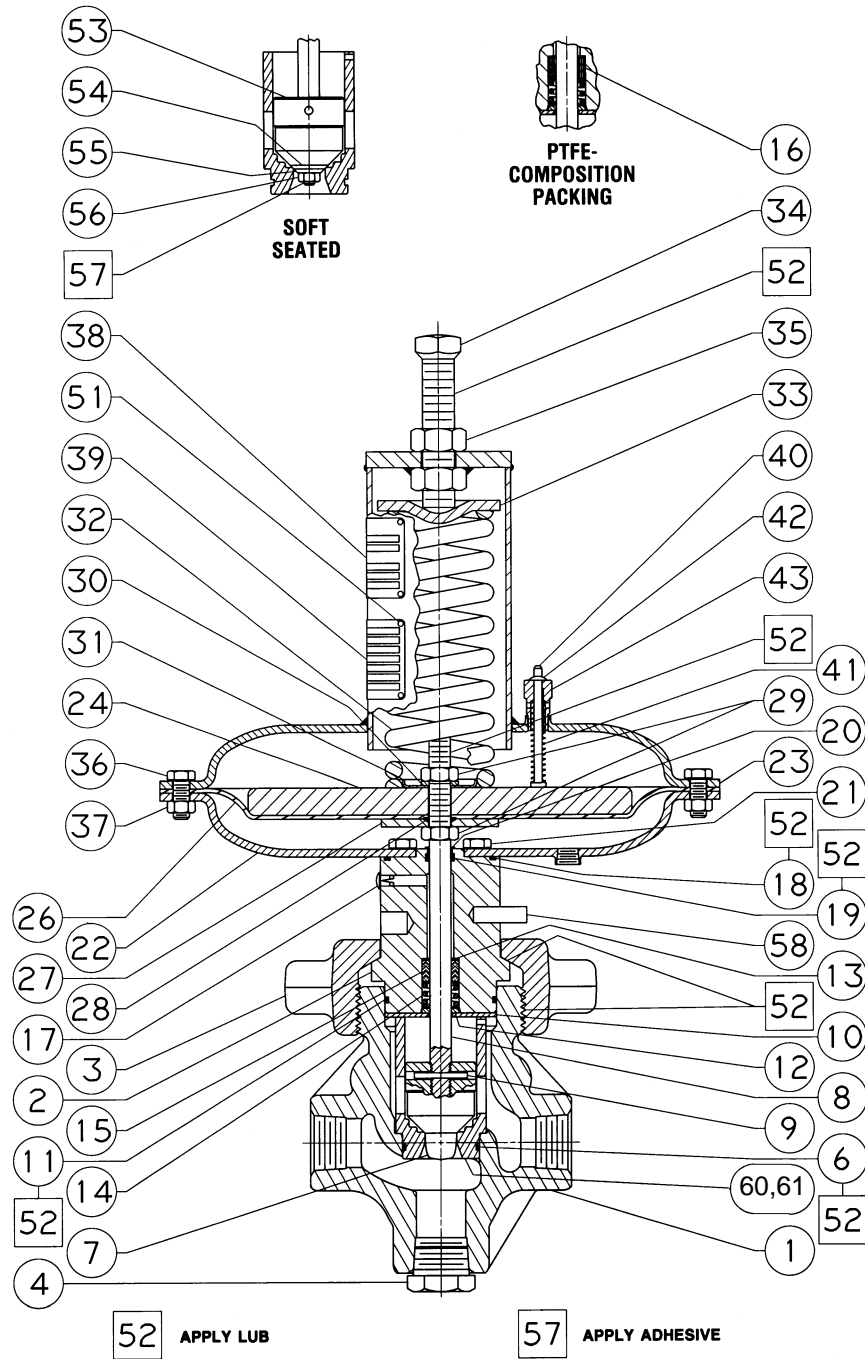




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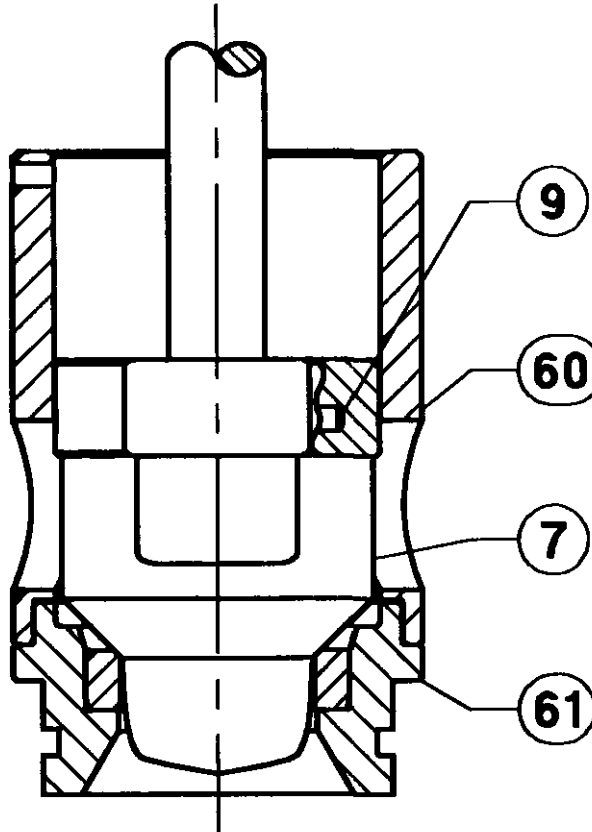
Figure 2. 2-Inch 357 Series Valve—Fail-Up

# 357 Series



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Figure 3. 1-Inch 357 Series Valve—Fail-Down



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Figure 4. Ceramic Trim Assembly

Keys 6\*, 11\*, 18\*, 19\*, 28\*, and 49\* O-Rings and Key 20\* Bushing

KEY NUMBER	PART NAME	WCC VALVE BODY MATERIAL		LCC VALVE BODY MATERIAL
		Temperature Capabilities		
		-29 to 93°C (-20 to 200°F)	-23 to 149°C (-10 to 300°F)	-45 to 82°C (-50 to 180°F)
		O-Ring Materials		
		Nitrile	Fluoroelastomer	Nitrile <sup>(1)</sup>
6*	Cage O-Ring	12B3522X012	12B3522X022	12B3522X042
11*	Bonnet O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
18*	Casing O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
19*	Stem O-Ring	1K7561X0012	1K756106382	1K7561X0022
28*	Actuator O-Ring	1K7561X0012	1K756106382	1K7561X0022
49* <sup>(2)</sup>	Actuator Stem O-Ring	1C7812X0012	1C7821X0012	1C782106992
		Bushing Materials		
		Nylon	Ryton	Nylon
20*	Bonnet Bushing	17A7112X012	17A7112X032	17A7112X012

1. Low-temperature material.  
2. For fail-up configuration.





# 357 Series

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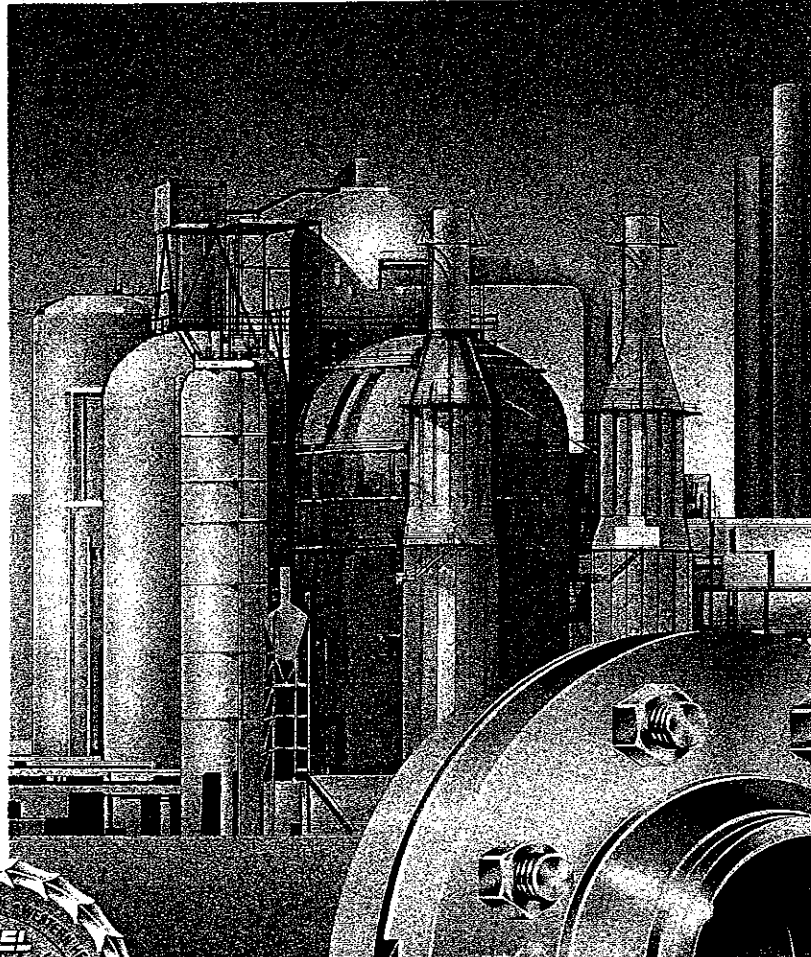
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Marshalltown, Iowa 50158 USA  
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Sao Paulo 05424 Brazil  
Singapore 128461



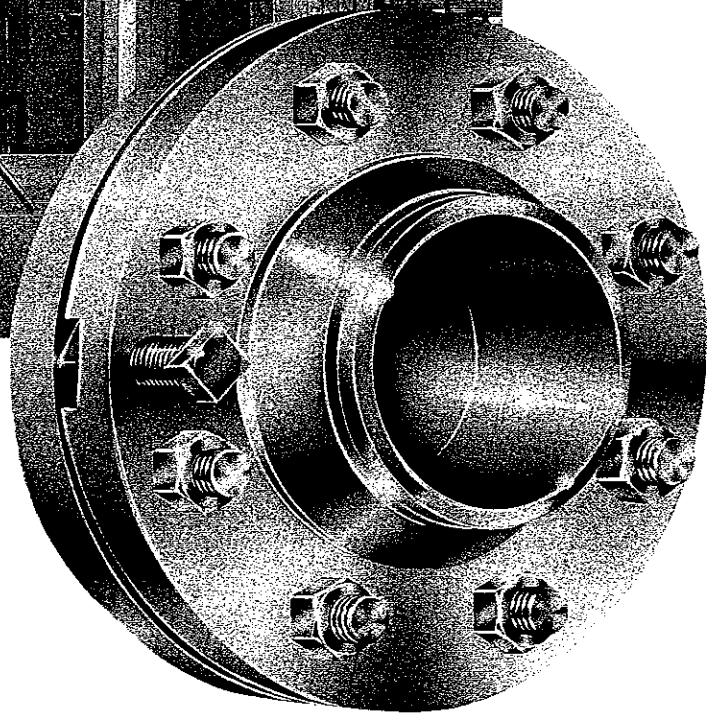


# Orifice Flanges

CATALOG SECTION P



CERTIFICATE QSR-16  
9720 Old Katy Road  
Houston, TX 77055 USA

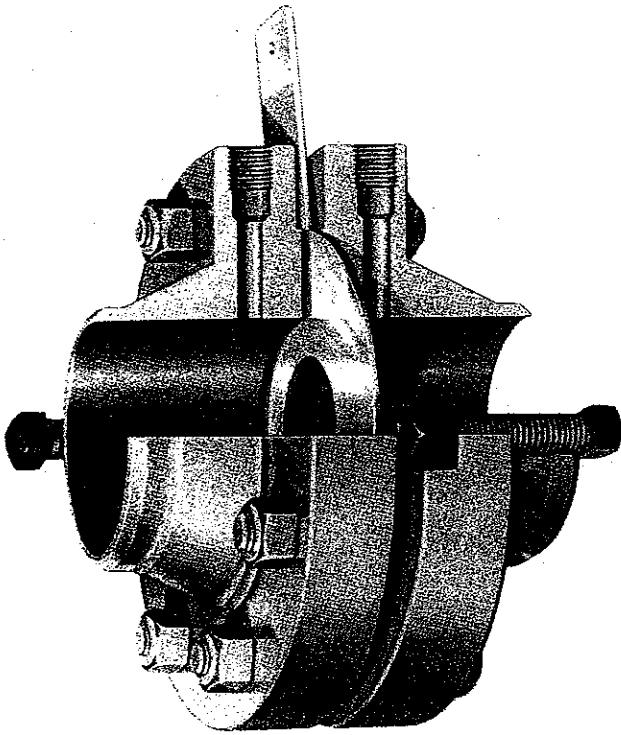


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# DANIEL



# 1 How Daniel Orifice Flanges provide Better Measurement



Orifice flanges are one of the most economical means of measuring flow, and Daniel Orifice Flanges are manufactured to be the most accurate. Automatic machine tools enable Daniel to meet the most stringent tolerances and recommendations for flanges as specified in ANSI B16.36, STEEL ORIFICE FLANGES, and ANSI/API 2530 (AGA #3), ORIFICE METERING OF NATURAL GAS, with careful attention given to tap location, bore smoothness, bolt and flange facings. Daniel Orifice Flanges are made of forged steel, A.S.T.M. A-105. Other materials are available on special order.

## Features and Advantages

**Bore Tolerances** are well within the latest recommendations of the American Gas Association for .75 Beta ratio.

**Pressure Tap Hole Location** is closely controlled. Tap hole centers are  $1/16$ " from bearing faces of flanges, placing their centerline 1" from the face of the orifice plate when  $1/16$ " gasket thickness is included. For 3" and smaller flanges: tap hole location tolerance is  $\pm 1/64$ "; for 4" and larger flanges, the location tolerance is  $\pm 1/32$ ".

**Pressure Tap Holes** — Tap hole edges on the flange bore surface are carefully inspected to be free from

burrs. All roughness is eliminated. Sizes are shown in the following tables.

**Flange Tap Connections** — Standard connections are  $1/2$ " N.P.T. Other sizes on request.

**Raised Face** — Daniel Raised Face Orifice Flanges are made to conform to the standard raised face dimensions in accordance with the A.N.S.I. B16.5 Flange Piping Code for all pressure ranges.

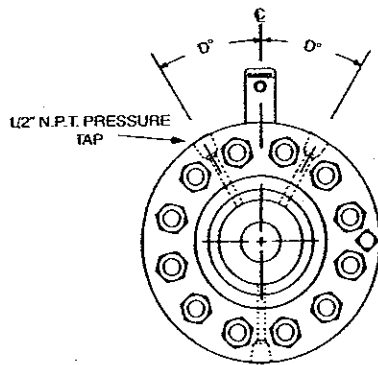
**Gaskets** — Two  $1/16$ " thick precision die-cut asbestos gaskets are furnished with all Raised Face Orifice Flanges. Non asbestos gaskets are available on request. Note: When specified gasket thickness is other than  $1/16$ ", flange pressure tap location will change.

Daniel offers orifice flanges/plates to meet the tolerances specified in API Chapter 14 Section 3, Part 2 (14.3).

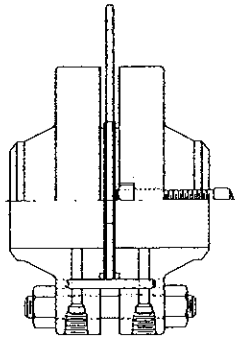
These flanges will be the units shown with precision located knock out type dowel pins as shown on page 2. Due to the strict orifice to flange bore concentricity requirements of API 14.3, the accompanying 520 paddle type orifice plates must also have similarly close tolerance machined O.D.'s.

It should be noted that due to the 14.3 concentricity requirements, slip-on and threaded orifice flanges cannot be offered to this standard.

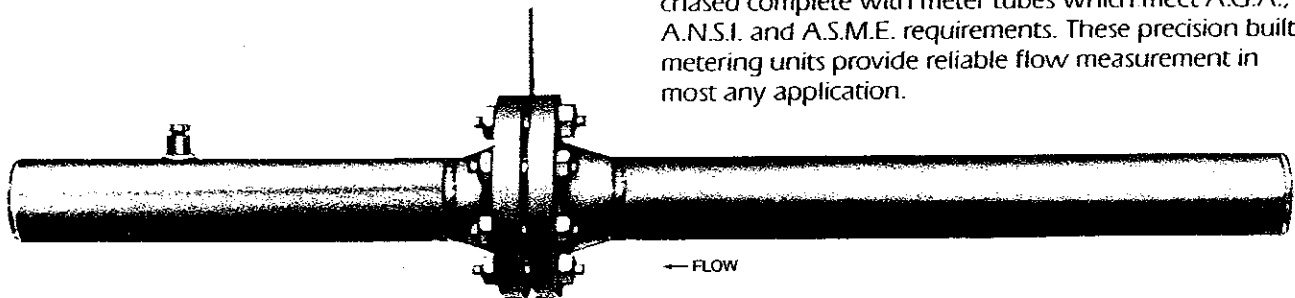
# Features and Advantages



**STAGGERED TAP HOLES:** Daniel Orifice Flanges with staggered tap holes are available on request. These locations provide convenient clearance for instrument piping when valves must be installed adjacent to orifice flanges. Extra tap holes at bottom facilitate drainage where condensate is present.



**DOWEL PINS:** Alignment dowel pins of the knock-out type are furnished on request on all Raised Face Orifice Flanges. These dowel pins assure correct alignment of the flange bores as well as centering the orifice plate within the flange bore.

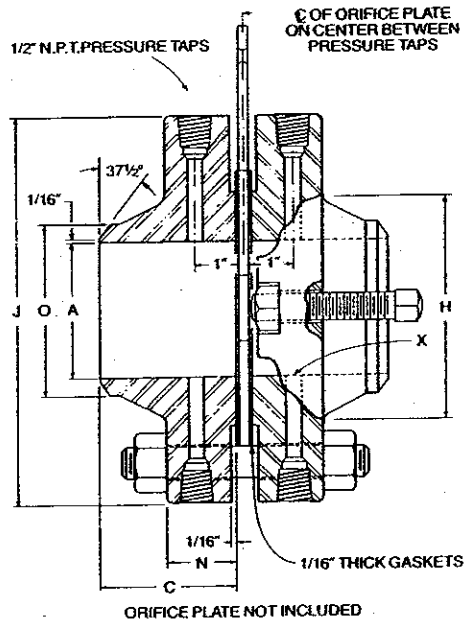
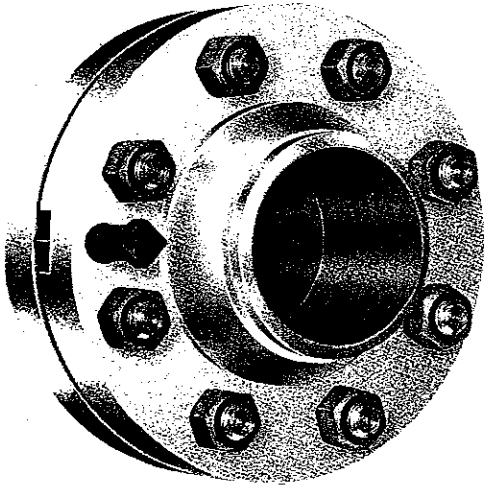


**METER TUBES:** Daniel Orifice Flanges may be purchased complete with meter tubes which meet A.G.A., A.N.S.I. and A.S.M.E. requirements. These precision built metering units provide reliable flow measurement in most any application.

For details, see Daniel Meter Tube Catalog

# Raised Face Weld Neck Orifice Flanges

All Class 300, 400 & 600, 3" and smaller.



CATALOG NO. 30 RW—CLASS 300 (740 P.S.I.G. C.W.P.)

Size in Inches	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
									Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	A	J	N*		C*	H	O	X						
1/2	.622 ± .002	3 3/4	1 1/2	1 3/8	3	1 1/2	0.84	1/4	2 5/8	3/16	4	1/2 x 3 3/4	1/2 x 3	10
3/4	.824 ± .002	4 5/8	1 1/2	1 11/16	3 3/8	1 3/8	1.05	1/4	3 1/4	11/16	4	5/8 x 5	1/2 x 3	10
1	1.049 ± .003	4 7/8	1 1/2	2	3 1/4	2 3/4	1.32	1/4	3 1/2	11/16	4	5/8 x 5	5/8 x 3	18
1 1/2	1.610 ± .003	6 1/8	1 1/2	2 1/8	3 3/8	2 3/4	1.90	1/4	4 1/2	13/16	4	3/4 x 5 1/4	5/8 x 3	25
2	2.067 ± .003	6 1/2	1 1/2	3 3/8	3 3/8	3 3/16	2.38	3/8	5	11/16	8	5/8 x 5	5/8 x 3	27
2 1/2	2.469 ± .003	7 1/2	1 1/2	4 1/8	3 1/2	3 11/16	2.88	3/8	5 7/8	13/16	8	3/4 x 5 1/4	5/8 x 3	35
3	3.068 ± .003	8 1/4	1 1/2	5	3 1/2	4 3/8	3.50	3/8	6 3/8	13/16	8	3/4 x 5 1/4	3/4 x 3	43
4	4.026 ± .004	10	1 1/2	6 3/16	3 5/8	5 3/4	4.50	1/2	7 7/8	13/16	8	3/4 x 5 1/4	3/4 x 3	66
6	6.065 ± .004	12 1/2	1 1/2	8 1/2	3 11/16	8 3/8	6.63	1/2	10 5/8	7/8	12	3/4 x 5 1/4	3/4 x 3	106
8	† ± .004	15	1 3/4	10 5/8	4 3/8	10 1/4	8.63	1/2	13	1	12	7/8 x 5 1/4	3/4 x 3	152
10	† ± .005	17 1/2	1 3/4	12 3/4	4 5/8	12 3/8	10.75	1/2	15 1/4	1 1/8	16	1 x 6 1/2	1 x 4 1/2	216
12	† ± .005	20 1/2	2	15	5 1/8	14 3/4	12.75	1/2	17 3/4	1 1/4	16	1 1/8 x 7 1/4	1 x 4 1/2	327
14	† ± .005	23	2 1/4	16 1/4	5 3/8	16 3/4	14.00	1/2	20 1/4	1 1/4	20	1 1/8 x 7 1/2	1 x 4 1/2	448
16	† ± .005	25 1/2	2 1/4	18 1/2	5 3/4	19	16.00	1/2	22 1/2	1 3/8	20	1 1/4 x 8	1 x 4 1/2	596
18	† ± .007	28	2 3/8	21	6 1/4	21	18.00	1/2	24 1/4	1 3/8	24	1 1/4 x 8 1/2	1 x 4 1/2	741
20	† ± .007	30 1/2	2 1/2	23	6 3/8	23 3/8	20.00	1/2	27	1 3/8	24	1 1/4 x 8 1/2	1 x 4 1/2	887
24	† ± .007	36	2 3/4	27 1/4	6 3/8	27 3/8	24.00	1/2	32	1 3/8	24	1 1/2 x 9 1/2	1 x 5 1/2	1311

\* Class 300 Flanges C and N dimensions include 1/16" Raised Face  
 † To be specified by purchaser.  
 NOTE: 1/2" and 3/4" 30 RW orifice flanges are not recognized by ANSI B16.36.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials, consult factory.

**Parts:** All Daniel Raised Face Weld Neck Orifice Flanges are furnished with the following items as standard:

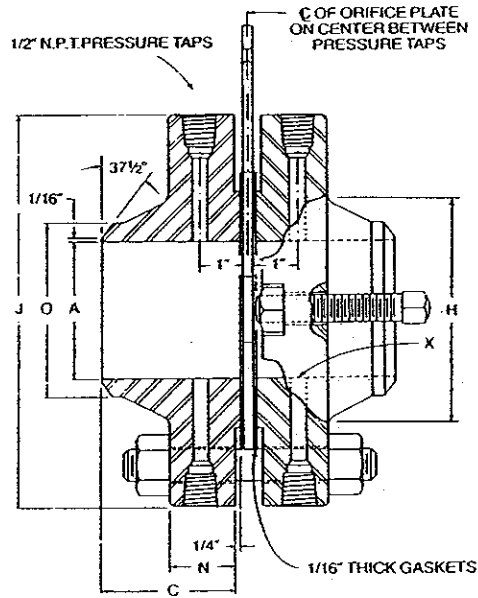
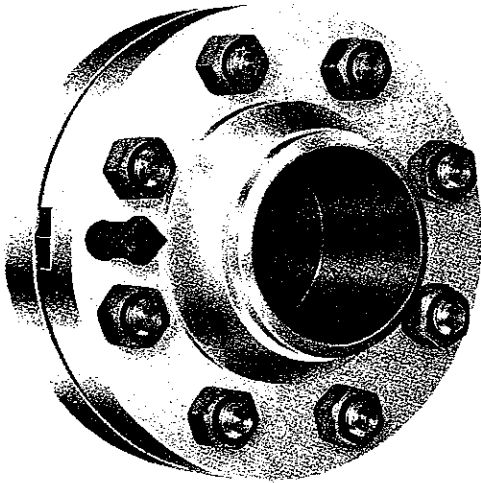
- (1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.
- (2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H Semi-finished Carbon Steel.

- (3) JACKSCREWS — (2) per union. Heat-treated Carbon Steel.
- (4) GASKETS — (2) per union. Precision cut, treated Asbestos.

NOTE: Catalog No. 520 Orifice Plates must be ordered separately. See Page No. 15.

# Raised Face Weld Neck Orifice Flanges

Class 400 & 600, 4" and larger.



ORIFICE PLATE NOT INCLUDED

## CATALOG NO. 40 RW—CLASS 400 {990 P.S.I.G. C.W.P.}††

Size in inches	Diam. internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
									Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	A	J	N*		C*	H	O	X						
4	4.026 ± .004	10	1 3/8	6 1/16	3 1/2	5 3/4	4.50	1/2	7 7/8	1	8	7/8x5 3/4	3/4x4	82
6	6.065 ± .004	12 1/2	1 3/8	8 1/2	4 1/16	8 1/8	6.63	1/2	10 5/8	1	12	1 1/8x6 1/4	3/4x4	136
8	† ± .004	15	1 3/8	10 5/8	4 5/8	10 1/4	8.63	1/2	13	1 1/8	12	1x7	3/4x4 1/2	213
10	† ± .005	17 1/2	2 1/8	12 3/4	4 7/8	12 5/8	10.75	1/2	15 1/4	1 1/4	16	1 1/8x8	1x4 1/2	309
12	† ± .005	20 1/2	2 1/4	15	5 3/8	14 3/4	12.75	1/2	17 3/4	1 3/8	16	1 1/4x8 1/2	1x4 1/2	429
14	† ± .005	23	2 3/8	16 1/4	5 7/8	16 3/4	14.00	1/2	20 1/4	1 3/8	20	1 1/4x8 3/4	1x4 1/2	554
16	† ± .005	25 1/2	2 1/2	18 1/2	6	19	16.00	1/2	22 1/2	1 1/2	20	1 3/8x9 1/2	1x5 1/2	705
18	† ± .007	28	2 5/8	21	6 1/2	21	18.00	1/2	24 3/4	1 1/2	24	1 3/8x9 3/4	1x5 1/2	863
20	† ± .007	30 1/2	2 3/4	23	6 5/8	23 1/8	20.00	1/2	27	1 3/8	24	1 1/2x10 1/4	1x5 1/2	1066
24	† ± .007	36	3	27 1/4	6 7/8	27 5/8	24.00	1/2	32	1 7/8	24	1 3/4x11 1/2	1x6 1/2	1555

## CATALOG NO. 60 RW—CLASS 600 {1480 P.S.I.G. C.W.P.}††

4	4.026 ± .004	10 3/4	1 1/2	6 3/16	4	6	4.50	1/2	8 1/2	1	8	7/8x6	3/4x4	103
6	6.065 ± .004	14	1 3/8	8 1/2	4 3/8	8 3/4	6.63	1/2	11 1/2	1 1/8	12	1x7	3/4x4	195
8	† ± .004	16 1/2	2 3/16	10 5/8	5 1/4	10 3/4	8.63	1/2	13 3/4	1 1/4	12	1 1/8x8	3/4x4 1/2	278
10	† ± .005	20	2 1/2	12 3/4	6	13 1/2	10.75	1/2	17	1 3/8	16	1 1/4x8 3/4	1x5 1/2	454
12	† ± .005	22	2 5/8	15	6 1/8	15 3/4	12.75	1/2	19 1/4	1 3/8	20	1 1/4x9	1x5 1/2	553
14	† ± .005	23 3/4	2 3/4	16 1/4	6 1/2	17	14.00	1/2	20 3/4	1 1/2	20	1 3/8x9 3/4	1x5 1/2	815
16	† ± .005	27	3	18 1/2	7	19 1/2	16.00	1/2	23 3/4	1 3/8	20	1 1/2x10 3/4	1x5 1/2	1113
18	† ± .007	29 1/4	3 1/4	21	7 1/4	21 1/2	18.00	1/2	25 3/4	1 3/4	20	1 5/8x11 1/2	1x6 1/2	1306
20	† ± .007	32	3 1/2	23	7 1/2	24	20.00	1/2	28 1/2	1 3/4	24	1 5/8x12	1x6 1/2	1622
24	† ± .007	37	4	27 1/4	8	28 1/4	24.00	1/2	33	2	24	1 7/8x13 3/4	1x8	2320

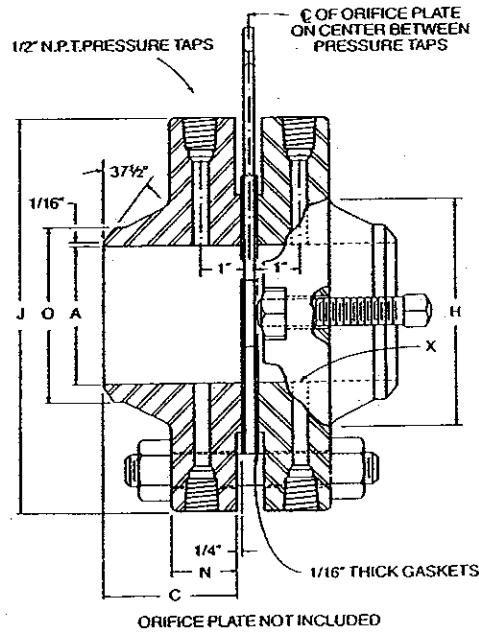
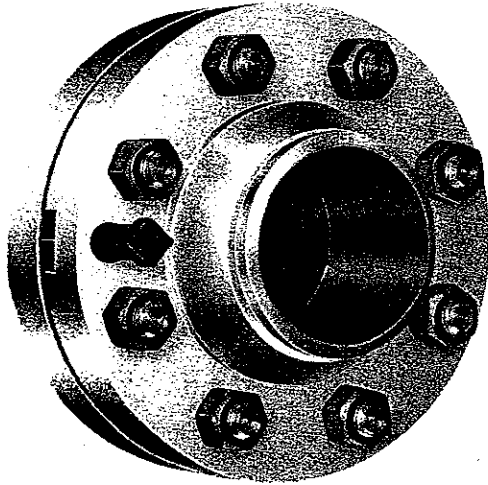
\* 4" and larger. Class 400-600 Flanges C and N dimensions do not include 1/4" Raised Face.

† To be specified by purchaser.

†† 3" and smaller, same as Class 300.

# Raised Face Weld Neck Orifice Flanges

Class 900, 1500 & 2500



CATALOG NO. 90 RW—CLASS 900 (2220 P.S.I.G. C.W.P.) ††

Size in inches	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
									Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	A	J	N*		C*	H	O	X						
3	† ± .003	9½	1½	5	4	5	3.50	¾	7½	1	8	7/8x6	¾x4	79
4	† ± .004	11½	1¾	6¾	4½	6¼	4.50	½	9¼	1¼	8	1½x7	¾x4	129
6	† ± .004	15	2¼	8½	5½	9¼	6.63	½	12½	1¼	12	1½x8	¾x4½	263
8	† ± .004	18½	2½	10¾	6¾	11¼	8.63	½	15½	1½	12	1¾x9	1x5½	445
10	† ± .005	21½	2¾	12¾	7¼	14½	10.75	½	18½	1½	16	1¾x9¾	1x5½	634
12	† ± .005	24	3¾	15	7¾	16½	12.75	½	21	1½	20	1¾x10½	1x5½	872

CATALOG NO. 150 RW—CLASS 1500 (3705 P.S.I.G. C.W.P.)

1	† ± .003	5¾	1½	2	3¼	2¼	1.32	¼	4	1	4	7/8x6	5/8x4	26
1½	† ± .003	7	1½	2¾	3½	2¾	1.90	¼	4¾	1½	4	1x6¼	5/8x4	45
2	† ± .003	8½	1½	3¾	4	4¾	2.38	¾	6½	1	8	7/8x6	5/8x4	65
2½	† ± .003	9¾	1¾	4¾	4¾	4¾	2.88	¾	7½	1½	8	1x6½	5/8x4	98
3	† ± .003	10½	1¾	5	4¾	5¼	3.50	¾	8	1¼	8	1½x7¼	¾x4	123
4	† ± .004	12¼	2½	6¾	4¾	6¾	4.50	½	9½	1¾	8	1¼x8	¾x4½	182
6	† ± .004	15½	3¼	8½	6¼	9	6.63	½	12½	1½	12	1¾x10¾	¾x5½	407
8	† ± .004	19	3¾	10¾	8¾	11½	8.63	½	15½	1¾	12	1¾x12	1x7	675
10	† ± .005	23	4¼	12¾	10	14½	10.75	½	19	2	12	1¾x14	1x8	1099
12	† ± .005	26½	4¾	15	11¾	17¾	12.75	½	22½	2½	16	2x15¾	1x9	1706

\*Does not include ¼" Raised Face.

† To be specified by purchaser.

†† 2½" and smaller, same as Class 1500.

# Raised Face Weld Neck Orifice Flanges

CATALOG NO. 250 RW—CLASS 2500 (6170 P.S.I.G. C.W.P.)

Size In Inches	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
									Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	A	J	N*		C*	H	O	X						
1	† ± .003	6¼	1½	2	3¾	2¼	1.32	¼	4¼	1	4	¾x6	¾x4	26
1½	† ± .003	8	1¾	2½	4¾	3¾	1.90	¼	5¾	1¼	4	1½x7	¾x4	56
2	† ± .003	9¼	2	3¾	5	3¾	2.38	⅜	6¾	1½	8	1x7¼	¾x4	84
2½	† ± .003	10½	2¼	4¾	5¾	4½	2.88	⅜	7¾	1¼	8	1½x8	¾x4½	104
3	† ± .003	12	2½	5	6¾	5¼	3.50	⅜	9	1¾	8	1¼x9¼	¾x5½	188
4	† ± .004	14	3	6¾	7½	6½	4.50	½	10¾	1¾	8	1½x10½	¾x5½	292
6	† ± .004	19	4¼	8½	10¾	9¼	6.63	½	14½	2½	8	2x14¼	¾x8	756
8	† ± .004	21¾	5	10¾	12½	12	8.63	½	17¼	2½	12	2x15¾	1x9	1152
10	† ± .005	26½	6½	12¾	16½	14¾	10.75	½	21¼	2¾	12	2½x20	1x11	2136
12	† ± .005	30	7¼	15	18¼	17¾	12.75	½	24¾	2¾	12	2¾x22	1x12	3216

\*Does not include ¼" Raised Face.  
† To be specified by purchaser.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials, consult factory.

**Parts:** All Daniel Raised Face Weld Neck Orifice Flanges are furnished with the following items as standard:

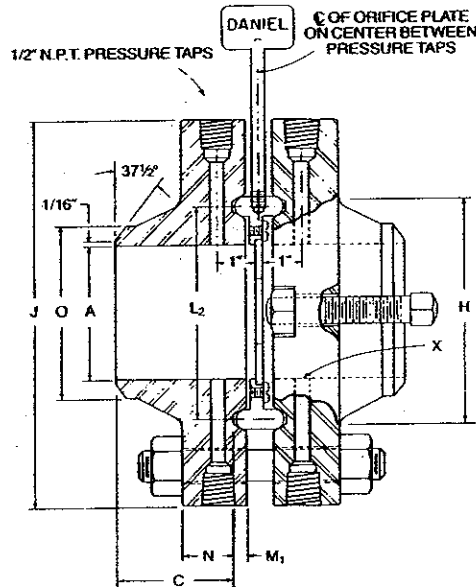
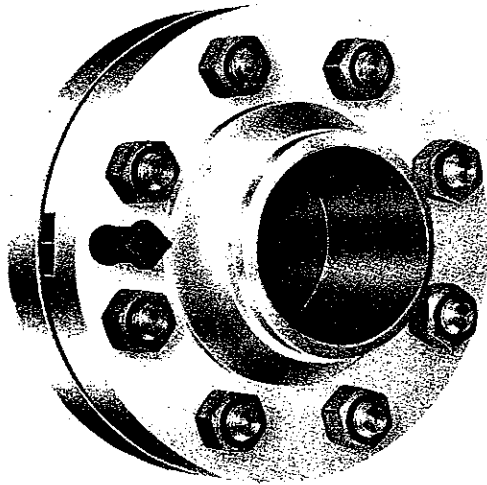
- (1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.
- (2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H Semi-finished Carbon Steel.

- (3) JACKSCREWS — (2) per union.
- (4) GASKETS — (2) per union. Precision cut, treated Asbestos.

NOTE: Catalog No. 520 Orifice Plates must be ordered separately. See Page No. 15.

# Ring-Type Joint Weld Neck Orifice Flanges

Class 300, 400 & 600



ORIFICE PLATE AND RT.J HOLDER NOT INCLUDED

CATALOG NO. 30 JW—CLASS 300 (740 P.S.I.G. C.W.P.)

Size In Inches	A.P.I. Ring Numbers	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pitch Diam. of Ring and Groove	Depth of Groove	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
											Diam. of Bot. Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
		A	J	N*	C*	H	O	L <sub>2</sub>	M <sub>1</sub>	X						
1/2	R-11	0.622 ± .002	3 3/4	1 1/2	3	1 1/2	0.84	1 1/2	3/32	1/4	2 5/8	3/4	4	1/2 x 5 1/2	1/2 x 3	10
3/4	R-13	0.824 ± .002	4 5/8	1 1/2	3 1/8	1 7/8	1.05	1 1/2	1/4	1/4	3 1/4	3/4	4	5/8 x 5 3/4	1/2 x 3 1/2	10
1	R-16	1.049 ± .003	4 7/8	1 1/2	3 1/4	2 1/8	1.32	2	1/4	1/4	3 1/2	3/4	4	5/8 x 5 1/2	3/8 x 4	15
1 1/2	R-20	1.610 ± .003	6 1/8	1 1/2	3 3/8	2 3/4	1.90	2 1/2	1/4	1/4	4 1/2	7/8	4	3/4 x 5 1/2	3/8 x 4	25
2	R-23	2.067 ± .003	6 1/2	1 1/2	3 3/8	3 3/16	2.38	3 1/4	3/16	3/8	5	7/8	8	5/8 x 5 1/2	3/8 x 4	30
2 1/2	R-26	2.469 ± .003	7 1/2	1 1/2	3 1/2	3 11/16	2.88	4	3/16	3/8	5 1/2	7/8	8	3/4 x 6 1/4	3/8 x 4	46
3	R-31	3.068 ± .003	8 3/4	1 1/2	3 1/2	4 1/8	3.50	4 7/8	3/16	3/8	6 3/8	7/8	8	3/4 x 5 1/2	3/4 x 4	56
4	R-37	4.026 ± .004	10	1 1/2	3 5/8	5 3/4	4.50	5 7/8	3/16	1/2	7 7/8	7/8	8	3/4 x 5 1/2	3/4 x 4	65
6	R-45	6.065 ± .004	12 1/2	1 7/16	3 7/8	8 1/8	6.63	8 11/16	3/16	1/2	10 5/8	7/8	12	3/4 x 6 1/4	3/4 x 4	107
8	R-49	† ± .004	15	1 5/8	4 3/8	10 1/4	8.63	10 3/8	3/16	1/2	13	1	12	7/8 x 6 3/4	3/4 x 4	169
10	R-53	† ± .005	17 1/2	1 7/8	4 3/8	12 3/8	10.75	12 3/4	3/16	1/2	15 1/4	1 1/8	16	1 x 7 1/4	1 x 4 1/2	250
12	R-57	† ± .005	20 1/2	2	5 1/8	14 3/4	12.75	15	3/16	1/2	17 3/4	1 1/4	16	1 1/8 x 8 1/4	1 x 5 1/2	365
14	R-61	† ± .005	23	2 1/8	5 5/8	16 3/4	14.00	16 1/2	3/16	1/2	20 1/4	1 1/2	20	1 1/4 x 8 1/2	1 x 5 1/2	490
16	R-65	† ± .005	25 1/2	2 1/4	5 3/4	19	16.00	18 1/2	3/16	1/2	22 1/2	1 3/8	20	1 1/2 x 9 1/4	1 x 5 1/2	640
18	R-69	† ± .007	28	2 3/8	6 1/4	21	18.00	21	3/16	1/2	24 3/4	1 3/8	24	1 1/4 x 9 1/2	1 x 5 1/2	785
20	R-73	† ± .007	30 1/2	2 1/2	6 3/8	23 1/8	20.00	23	3/8	1/2	27	1 3/8	24	1 1/4 x 10	1 x 5 1/2	960
24	R-77	† ± .007	36	2 3/4	6 3/8	27 3/4	24.00	27 1/4	1/2	1/2	32	1 5/8	24	1 1/2 x 11	1 x 7	1410

\*Does not include depth of Ring Groove.

†To be specified by purchaser.

NOTE: 30 JW Series Orifice Flanges are not recognized by ANSI B16.36.

# Ring-Type Joint Weld Neck Orifice Flanges

## CATALOG NO. 40 JW—CLASS 400 (990 P.S.I.G. C.W.P.)††

Size in Inches	A.P.I. Ring Numbers	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pitch Diam. of Ring and Groove	Depth of Groove	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
											Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
		A	J	N*	C*	H	O	L <sub>2</sub>	M <sub>1</sub>	X						
4	R-37	4.026 ± .004	10	1 3/8	3 1/2	5 3/4	4.50	5 7/8	5/16	1/2	7 7/8	1	8	7/8x6 1/4	3/4x4	90
6	R-45	6.065 ± .004	12 1/2	1 3/8	4 1/16	8 3/8	6.63	8 3/16	5/16	1/2	10 3/8	1	12	7/8x6 3/4	3/4x4 1/2	145
8	R-49	† ± .004	15	1 7/8	4 3/8	10 1/4	8.63	10 5/8	5/16	1/2	13	1 1/8	12	1x7 1/2	3/4x5 1/2	220
10	R-53	† ± .005	17 1/2	2 1/8	4 7/8	12 3/8	10.75	12 3/4	5/16	1/2	15 1/4	1 1/4	16	1 1/4x8 1/2	1x5 1/2	325
12	R-57	† ± .005	20 1/2	2 1/4	5 3/8	14 3/4	12.75	15	5/16	1/2	17 3/4	1 3/8	16	1 1/2x9	1x5 1/2	450
14	R-61	† ± .005	23	2 3/8	5 3/8	16 3/4	14.00	16 1/2	5/16	1/2	20 1/4	1 3/8	20	1 1/4x9 1/4	1x5 1/2	590
16	R-65	† ± .005	25 1/2	2 1/2	6	19	16.00	18 1/2	5/16	1/2	22 1/2	1 1/2	20	1 3/8x10	1x5 1/2	745
18	R-69	† ± .007	28	2 3/8	6 1/2	21	18.00	21	5/16	1/2	24 3/4	1 1/2	24	1 3/8x10 1/4	1x7	910
20	R-73	† ± .007	30 1/2	2 3/4	6 3/8	23 3/8	20.00	23	3/8	1/2	27	1 5/8	24	1 1/2x11	1x7	1160
24	R-77	† ± .007	36	3	6 3/8	27 3/8	24.00	27 1/4	7/16	1/2	32	1 7/8	24	1 3/4x12 1/4	1x8	1665

## CATALOG NO. 60 JW—CLASS 600 (1480 P.S.I.G. C.W.P.)††

4	R-37	4.026 ± .004	10 3/4	1 1/2	4	6	4.50	5 7/8	5/16	1/2	8 1/2	1	8	7/8x6 1/2	3/4x4	90
6	R-45	6.065 ± .004	14	1 7/8	4 3/8	8 3/4	6.63	8 3/16	5/16	1/2	11 1/2	1 1/8	12	1x7 1/2	3/4x4 1/2	197
8	R-49	† ± .004	16 1/2	2 3/16	5 1/4	10 3/4	8.63	10 5/8	5/16	1/2	13 3/4	1 1/4	12	1 1/8x8 1/2	3/4x5 1/2	284
10	R-53	† ± .005	20	2 1/2	6	13 1/2	10.75	12 3/4	5/16	1/2	17	1 3/8	16	1 1/4x9	1x5 1/2	472
12	R-57	† ± .005	22	2 5/8	6 1/8	15 3/4	12.75	15	5/16	1/2	19 1/4	1 3/8	20	1 1/4x9 3/4	1x5 1/2	571
14	R-61	† ± .005	23 3/4	2 3/4	6 1/2	17	14.00	16 1/2	5/16	1/2	20 3/4	1 1/2	20	1 3/8x10 1/4	1x7	830
16	R-65	† ± .005	27	3	7	19 1/2	16.00	18 1/2	5/16	1/2	23 3/4	1 5/8	20	1 1/2x11 1/4	1x7	1135
18	R-69	† ± .007	29 1/4	3 1/4	7 1/4	21 1/2	18.00	21	5/16	1/2	25 3/4	1 3/4	20	1 5/8x12	1x7	1330
20	R-73	† ± .007	32	3 1/2	7 1/2	24	20.00	23	3/8	1/2	28 1/2	1 3/4	24	1 5/8x12 3/4	1x8	1660
24	R-77	† ± .007	37	4	8	28 1/4	24.00	27 1/4	7/16	1/2	33	2	24	1 7/8x14 1/2	1x9	2375

\*Does not include depth of Ring Groove.

†To be specified by purchaser.

††3" and smaller, same as Class 300.

NOTE: 24" 40 JW and 60 JW Orifice Flanges are not recognized by ANSI B16.36.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials consult factory.

**Parts:** All Daniel Ring-Type Joint Weld Neck Orifice Flanges are furnished with the following items as standard:

(1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.

(2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H

Semi-finished Carbon Steel.  
(3) JACKSCREWS — (2) per union. Heat-treated Carbon Steel.

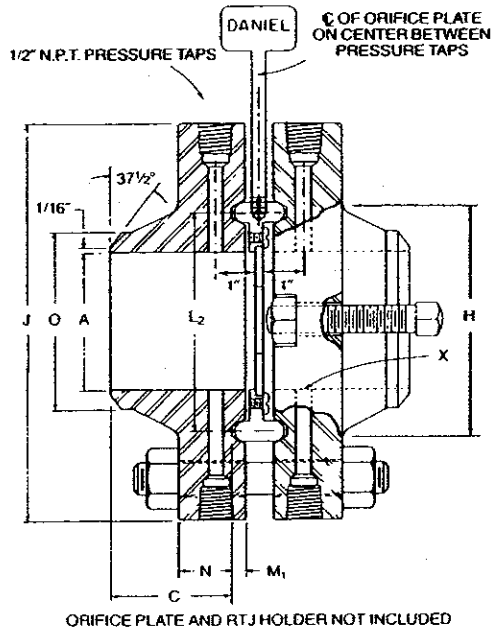
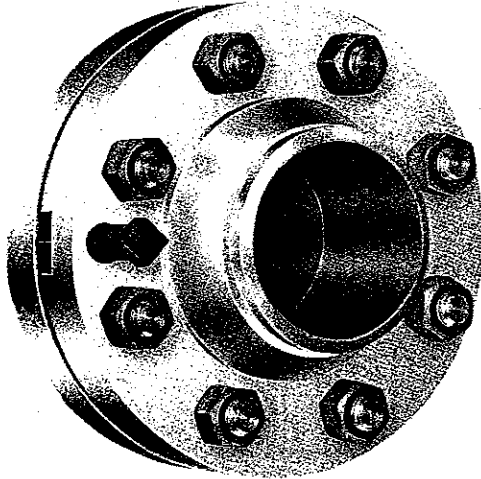
NOTE: Ring-Type Joint Plate Holders and Catalog No. 500 Orifice Plates must be ordered separately. See Page Nos. 14, 17, and 18.

NOTE: Unless otherwise specified, raised face or full face may be furnished.



# Ring-Type Joint Weld Neck Orifice Flanges

Class 900, 1500 & 2500



CATALOG NO. 90 JW—CLASS 900 (2220 P.S.I.G. C.W.P.) ††

Size in Inches	A.P.I. Ring Numbers	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pitch Diam. of Ring and Groove	Depth of Groove	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
											Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
		A	J	N'	C'	H	O	L <sub>2</sub>	M <sub>1</sub>	X						
3	R-31	† ± .003	9½	1½	4	5	3.50	4⅞	⅜	⅜	7½	1	8	⅞x6½	¾x4	85
4	R-37	† ± .004	11½	1¾	4½	6¼	4.50	5⅞	⅜	½	9¼	1¼	8	1⅞x7½	¾x4½	140
6	R-45	† ± .004	15	2⅜	5½	9¼	6.63	8⅞	⅜	½	12½	1¼	12	1⅞x8½	¾x5½	280
8	R-49	† ± .004	18½	2½	6⅞	11¾	8.63	10⅞	⅜	½	15½	1½	12	1⅞x10	1x5½	475
10	R-53	† ± .005	21½	2¾	7¼	14½	10.75	12¾	⅜	½	18½	1½	16	1⅞x10¾	1x7	675
12	R-57	† ± .005	24	3⅞	7⅞	16½	12.75	15	⅜	½	21	1½	20	1⅞x11	1x7	930

CATALOG NO. 150 JW—CLASS 1500 (3705 P.S.I.G. C.W.P.)

1	R-16	† ± .003	5⅞	1½	3¼	2⅞	1.32	2	¼	¼	4	1	4	⅞x6	⅞x4	27
1½	R-20	† ± .003	7	1½	3½	2¾	1.90	2⅞	¼	¼	4⅞	1⅞	4	1x6¼	⅞x4	41
2	R-24	† ± .003	8½	1½	4	4⅞	2.38	3¼	⅜	⅜	6½	1	8	⅞x6½	⅞x4	71
2½	R-27	† ± .003	9⅞	1⅞	4⅞	4⅞	2.88	4¼	⅜	⅜	7½	1⅞	8	1x7	⅞x4½	100
3	R-35	† ± .003	10½	1⅞	4⅞	5¼	3.50	5⅞	⅜	⅜	8	1¼	8	1⅞x7¾	¾x4½	131
4	R-39	† ± .004	12¼	2⅞	4⅞	6⅞	4.50	6⅞	⅜	½	9½	1⅞	8	1⅞x8½	¾x5½	200
6	R-46	† ± .004	15½	3¼	6¾	9	6.63	8⅞	⅜	½	12½	1½	12	1⅞x11	¾x7	435
8	R-50	† ± .004	19	3⅞	8⅞	11½	8.63	10⅞	⅜	½	15½	1¾	12	1⅞x12¾	1x8	715
10	R-54	† ± .005	23	4¼	10	14½	10.75	12¾	⅜	½	19	2	12	1⅞x14¾	1x9	1165
12**	R-58	† ± .005	26½	4⅞	11⅞	17¼	12.75	15	⅜	½	22½	2⅞	16	2x15¼	1x10	1790

\*Does not include depth of Ring Groove.

\*\*Tap hole location exceeds A.G.A. limits due to Ring Groove interference. Tap hole location from the plate is 1⅞"

†To be specified by purchaser.

††2½" and smaller, same as Class 1500.

NOTE: 8"-12" 150 JW Orifice Flanges are not recognized by ANSI B16.36.

# Ring-Type Joint Weld Neck Orifice Flanges

CATALOG NO. 250 JW—CLASS 2500 (6170 P.S.I.G. C.W.P.)

Size In Inches	A.P.I. Ring Numbers	Diam. Internal Line Bore and Tolerance	Diam. of Flange	Minimum Flange Thickness	Length Through Hub	Hub Diam. at Base	Diam. of Hub at Point of Welding	Pitch Diam. of Ring and Groove	Depth of Groove	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
											Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
		A	J	N*	C*	H	O	L <sub>2</sub>	M <sub>1</sub>	X						
1	R-18	† ± .003	6¼	1½	3⅝	2¼	1.32	2⅜	¼	¼	4¼	1	4	⅞x6¼	⅝x4	26
1½	R-23	† ± .003	8	1¾	4⅜	3⅝	1.90	3¼	⅜	¼	5¼	1¼	4	1⅞x7½	¾x4½	56
2	R-26	† ± .003	9¼	2	5	3¾	2.38	4	⅜	⅜	6¼	1⅝	8	1x7¾	¾x4½	84
2½	R-28	† ± .003	10½	2¼	5⅝	4½	2.88	4⅜	⅜	⅜	7¼	1¼	8	1⅞x8¾	¾x5½	104
3	R-32	† ± .003	12	2⅝	6⅝	5¼	3.50	5	⅜	⅜	9	1⅝	8	1¼x9¾	¾x7	188
4	R-38	† ± .004	14	3	7½	6½	4.50	6⅜	⅞	½	10¾	1⅝	8	1½x11	¾x7	292
6**	R-47	† ± .004	19	4¼	10¾	9¼	6.63	9	½	½	14½	2⅝	8	2x14¼	¾x9	756
8**	R-51	† ± .004	21¾	5	12½	12	8.63	11	⅜	½	17¼	2⅝	12	2x16¼	1x10	1152
10**	R-55	† ± .005	26½	6½	16½	14¾	10.75	13½	½	½	21¼	2⅝	12	2½x21¼	1x13	2136
12**	R-60	† ± .005	30	7¼	18¼	17⅝	12.75	16	½	½	24⅜	2⅝	12	2¾x23¼	1x13	3216

\*Does not include depth of Ring Groove.

\*\* Tap hole location exceeds A.G.A. limits due to Ring Groove interference. Tap hole location from the plate is as follows: 6"—1¼", 8"—1¼",

† To be specified by purchaser.

10"—1¼", 12"—1¼".

NOTE: 4"-12" 250 JW Orifice Flanges are not recognized by ANSI B16.36.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials, consult factory.

**Parts:** All Daniel Ring-Type Joint Weld Neck Orifice Flanges are furnished with the following items as standard:

(1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.

(2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H

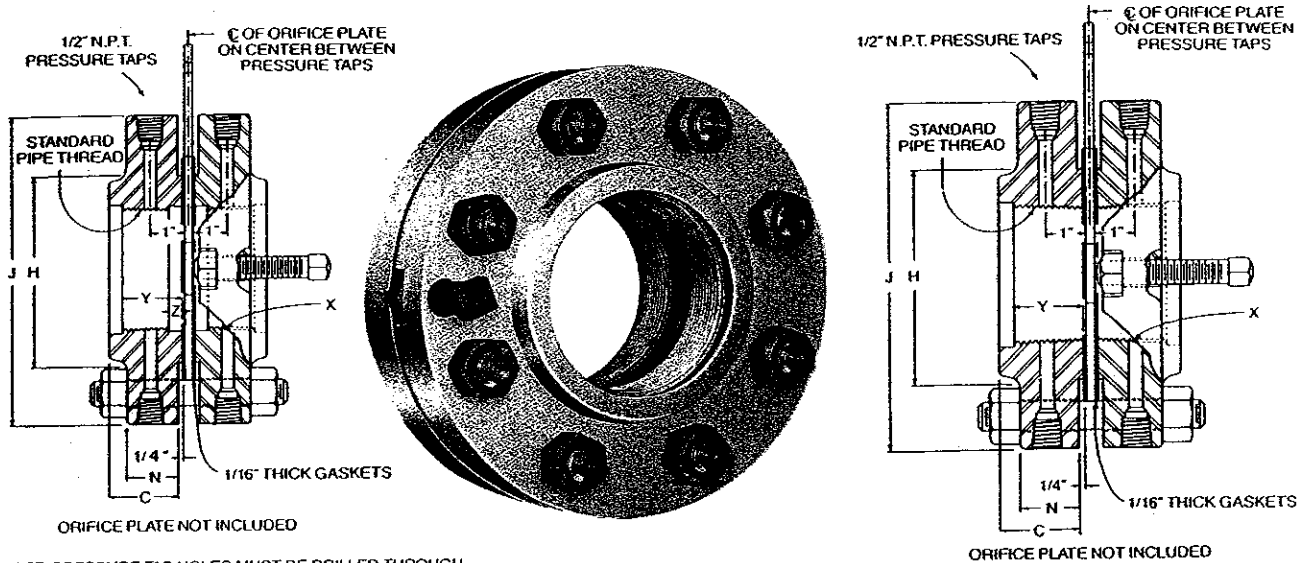
Semi-finished Carbon Steel.  
(3) JACKSCREWS — (2) per union.

NOTE: Ring-Type Joint Plate Holders and Catalog No. 500 Orifice Plates must be ordered separately. See Page Nos. 14, 17, and 18.

NOTE: Unless otherwise specified, raised face or full face may be furnished.

# Raised Face Threaded Orifice Flanges

All Class 300, 400 & 600, 3" and smaller. Class 400 & 600, 4" and larger.



NOTE: PRESSURE TAP HOLES MUST BE DRILLED THROUGH PIPEWALL AFTER INSTALLATION

### CATALOG NO. 30 RT—CLASS 300 (740 P.S.I.G. C.W.P.)

Size in inches	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Height to Counter Bore	Face Counter Bore Height	Hub Diam. at Base	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
									Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
J	N*		C*	Y	Z	H	X							
1/2	3 3/4	1 1/2	1 3/8	1 13/16	1 1/8	1/2	1 1/2	1/4	2 5/8	3/16	4	1/2 x 4 3/4	1/2 x 3	9
3/4	4 5/8	1 1/2	1 11/16	1 7/8	1 1/8	1/2	1 7/8	1/4	3 1/4	11/16	4	5/8 x 5	1/2 x 3	9
1	4 7/8	1 1/2	2	1 7/8	1 7/16	3/4	2 1/8	1/4	3 1/2	11/16	4	5/8 x 5	5/8 x 3	15
1 1/2	6 1/8	1 1/2	2 2/8	1 7/8	1 15/32	23/32	2 3/4	1/4	4 1/2	13/16	4	3/4 x 5 1/4	5/8 x 3	19
2	6 1/2	1 1/2	3 3/8	1 13/16	1 1/2	1 1/16	3 1/16	3/8	5	11/16	8	5/8 x 5	5/8 x 3	23
2 1/2	7 1/2	1 1/2	4 1/8	2	1 3/4	9/16	3 15/16	3/8	5 7/8	13/16	8	3/4 x 5 1/4	5/8 x 3	31
3	8 3/4	1 1/2	5	2 1/16	1 13/16	5/16	4 5/8	3/8	6 5/8	13/16	8	3/4 x 5 1/4	3/4 x 3	39
4	10	1 1/2	6 3/16	2 1/8	1 7/8	9/16	5 3/4	1/2	7 7/8	13/16	8	3/4 x 5 1/4	3/4 x 3	60

### CATALOG NO. 40 RT—CLASS 400 (990 P.S.I.G. C.W.P.)††

4	10	1 3/8**	6 3/16	2**	1 11/16	..	5 3/4	1/2	7 7/8	1	8	7/8 x 5 3/4	3/4 x 4	64
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### CATALOG NO. 60 RT—CLASS 600 (1480 P.S.I.G. C.W.P.)††

4	10 3/4	1 1/2**	6 3/16	2 1/8**	1 7/8	..	6	1/2	8 1/2	1	8	7/8 x 6	3/4 x 4	74
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\* Class 300 Flanges C and N dimensions include 1/16" Raised Face.

\*\* Class 400-600 Flanges C and N dimensions do not include 1/4" Raised Face. Available in Larger Sizes on Request.

†† 3" and smaller, same as Class 300.

NOTE: 1/2" and 3/4" 30 RT Flanges, 40 RT and 60 RT Series Flanges are not recognized by ANSI B16.36.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials, consult factory.

**Parts:** All Daniel Raised Face Threaded Orifice Flanges are furnished with the following items as standard:

- (1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.
- (2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H Semi-finished Carbon Steel.

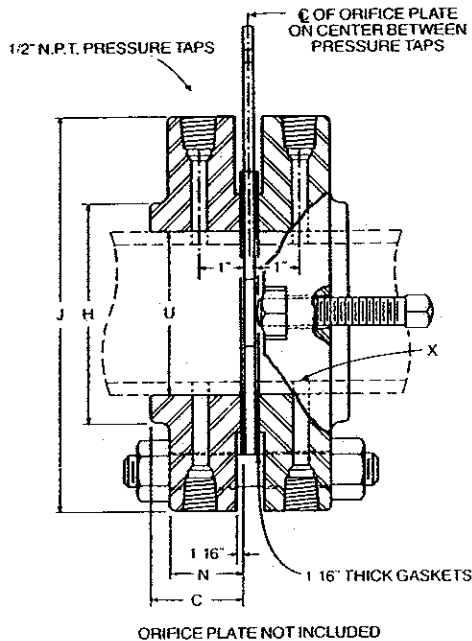
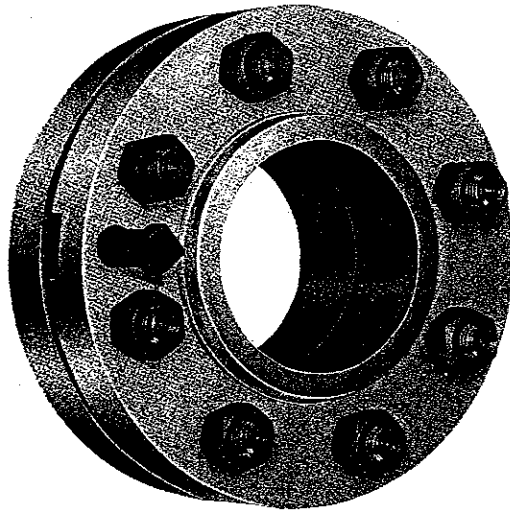
(3) JACKSCREWS — (2) per union. Heat-treated Carbon Steel.

(4) GASKETS — (2) per union. Precision cut, treated Asbestos.

NOTE: Catalog No. 520 Orifice Plates must be ordered separately. See Page No. 15.

# Raised Face Slip-On Orifice Flanges

All Class 300, 400 & 600, 3" and smaller.



NOTE: PRESSURE TAP HOLES MUST BE DRILLED THROUGH PIPEWALL AFTER INSTALLATION

ORIFICE PLATE NOT INCLUDED

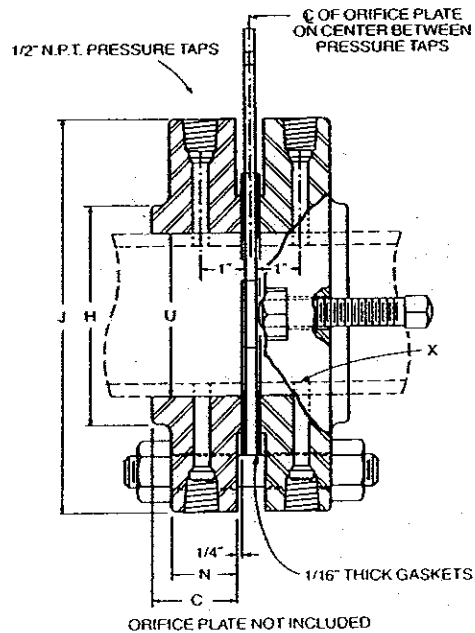
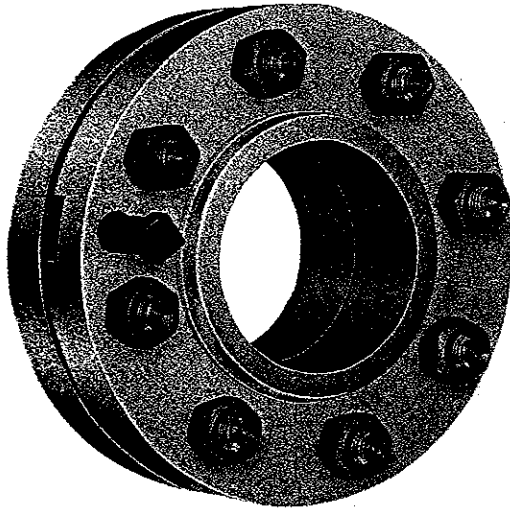
## CATALOG NO. 30 RS—CLASS 300 (740 P.S.I.G. C.W.P.)

Size in Inches	Bore of Flange	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
								Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	U	J	N*		C*	H	X						
1/2	7/8	3 3/4	1 1/2	1 3/8	1 13/16	1 1/2	1/4	2 5/8	3/16	4	1/2 x 4 1/4	1/2 x 3	9
3/4	1 1/32	4 5/8	1 1/2	1 11/16	1 7/8	1 7/8	1/4	3 1/4	1/16	4	5/8 x 5	1/2 x 3	9
1	1 3/8	4 7/8	1 1/2	2	1 7/8	2 1/8	1/4	3 1/2	1/16	4	5/8 x 5	5/8 x 3	15
1 1/2	1 31/32	6 1/8	1 1/2	2 7/8	1 7/8	2 3/4	1/4	4 1/2	13/16	4	3/4 x 5 1/4	5/8 x 3	19
2	2 1/16	6 1/2	1 1/2	3 5/8	1 11/16	3 3/16	3/8	5	1/16	8	5/8 x 5	5/8 x 3	23
2 1/2	2 15/16	7 1/2	1 1/2	4 1/8	2	3 15/16	3/8	5 7/8	13/16	8	3/4 x 5 1/4	5/8 x 3	31
3	3 19/32	8 1/4	1 1/2	5	2 1/16	4 5/8	3/8	6 5/8	13/16	8	3/4 x 5 1/4	3/4 x 3	39
4	4 19/32	10	1 1/2	6 3/16	2 1/8	5 3/4	1/2	7 7/8	13/16	8	3/4 x 5 1/4	3/4 x 3	60
6	6 23/32	12 1/2	1 1/2	8 1/2	2 1/8	8 1/8	1/2	10 5/8	7/8	12	3/4 x 5 1/4	3/4 x 3	100
8	8 23/32	15	1 5/8	10 5/8	2 1/16	10 1/4	1/2	13	1	12	7/8 x 5 3/4	3/4 x 3	134
10	10 7/8	17 1/2	1 5/8	12 3/4	2 5/8	12 5/8	1/2	15 1/4	1 1/8	16	1 x 6 1/2	1 x 4 1/2	196
12	12 7/8	20 1/2	2	15	2 7/8	14 3/4	1/2	17 3/4	1 1/4	16	1 1/8 x 7 1/4	1 x 4 1/2	281
14	14 3/32	23	2 1/8	16 1/4	3	16 3/4	1/2	20 1/4	1 1/4	20	1 1/8 x 7 1/2	1 x 4 1/2	380
16	16 3/32	25 1/2	2 1/4	18 1/2	3 1/4	19	1/2	22 1/2	1 3/8	20	1 1/4 x 8	1 x 4 1/2	530
18	18 3/16	28	2 3/8	21	3 1/2	21	1/2	24 3/4	1 3/8	24	1 1/4 x 8 1/2	1 x 4 1/2	691
20	20 7/32	30 1/2	2 1/2	23	3 3/4	23 3/8	1/2	27	1 3/8	24	1 1/2 x 8 1/2	1 x 4 1/2	781
24	24 1/4	36	2 3/4	27 1/4	4 3/16	27 5/8	1/2	32	1 5/8	24	1 1/2 x 9 1/2	1 x 5 1/2	1201

\* Class 300 Flanges C and N dimensions include 1/16" Raised Face.  
NOTE: 1/2" and 3/4" 30 RS Orifice Flanges are not recognized by ANSI B16.36.

# Raised Face Slip-on Orifice Flanges

Class 400 & 600, 4" and larger.



NOTE: PRESSURE TAP HOLES MUST BE DRILLED THROUGH PIPEWALL AFTER INSTALLATION

## CATALOG NO. 40 RS—CLASS 400 (990 P.S.I.G. C.W.P.)††

Size in Inches	Bore of Flange	Diam. of Flange	Minimum Flange Thickness	Diam. of Raised Face	Length Through Hub	Hub Diam. at Base	Pressure Tap Hole Size	FLANGE DRILLING TEMPLATE				Jack Screw Size and Length	Approx. Weight (Pounds)
								Diam. of Bolt Circle	Diam. of Holes	Number of Holes	Size and Length of Studs		
	U	J	N*		C*	H	X						
4	4 <sup>19</sup> / <sub>32</sub>	10	1 <sup>3</sup> / <sub>8</sub>	6 <sup>3</sup> / <sub>16</sub>	2	5 <sup>3</sup> / <sub>4</sub>	1/2	7 <sup>7</sup> / <sub>8</sub>	1	8	7/8x5 <sup>3</sup> / <sub>4</sub>	3/4x4	64
6	6 <sup>23</sup> / <sub>32</sub>	12 <sup>1</sup> / <sub>2</sub>	1 <sup>3</sup> / <sub>8</sub>	8 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	8 <sup>3</sup> / <sub>8</sub>	1/2	10 <sup>5</sup> / <sub>8</sub>	1	12	7/8x6 <sup>3</sup> / <sub>4</sub>	3/4x4	110
8	8 <sup>23</sup> / <sub>32</sub>	15	1 <sup>3</sup> / <sub>8</sub>	10 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>16</sub>	10 <sup>1</sup> / <sub>4</sub>	1/2	13	1 <sup>1</sup> / <sub>8</sub>	12	1x7	3/4x4 <sup>1</sup> / <sub>2</sub>	169
10	10 <sup>7</sup> / <sub>8</sub>	17 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>8</sub>	12 <sup>3</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>8</sub>	12 <sup>3</sup> / <sub>8</sub>	1/2	15 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	16	1 <sup>1</sup> / <sub>8</sub> x8	1x4 <sup>1</sup> / <sub>2</sub>	239
12	12 <sup>1</sup> / <sub>8</sub>	20 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	15	3 <sup>3</sup> / <sub>8</sub>	14 <sup>3</sup> / <sub>4</sub>	1/2	17 <sup>3</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>8</sub>	16	1 <sup>1</sup> / <sub>4</sub> x8 <sup>1</sup> / <sub>2</sub>	1x4 <sup>1</sup> / <sub>2</sub>	333

## CATALOG NO. 60 RS—CLASS 600 (1480 P.S.I.G. C.W.P.)††

4	4 <sup>19</sup> / <sub>32</sub>	10 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	6 <sup>3</sup> / <sub>16</sub>	2 <sup>1</sup> / <sub>8</sub>	6	1/2	8 <sup>1</sup> / <sub>2</sub>	1	8	7/8x6	3/4x4	74
6	6 <sup>23</sup> / <sub>32</sub>	14	1 <sup>3</sup> / <sub>8</sub>	8 <sup>1</sup> / <sub>2</sub>	2 <sup>3</sup> / <sub>8</sub>	8 <sup>3</sup> / <sub>4</sub>	1/2	11 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>8</sub>	12	1x7	3/4x4	160
8	8 <sup>23</sup> / <sub>32</sub>	16 <sup>1</sup> / <sub>2</sub>	2 <sup>3</sup> / <sub>16</sub>	10 <sup>5</sup> / <sub>8</sub>	3	10 <sup>3</sup> / <sub>4</sub>	1/2	13 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub>	12	1 <sup>1</sup> / <sub>8</sub> x8	3/4x4 <sup>1</sup> / <sub>2</sub>	230
10	10 <sup>7</sup> / <sub>8</sub>	20	2 <sup>1</sup> / <sub>2</sub>	12 <sup>3</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>8</sub>	13 <sup>1</sup> / <sub>2</sub>	1/2	17	1 <sup>3</sup> / <sub>8</sub>	16	1 <sup>1</sup> / <sub>4</sub> x8 <sup>3</sup> / <sub>4</sub>	1x5 <sup>1</sup> / <sub>2</sub>	354
12	12 <sup>1</sup> / <sub>8</sub>	22	2 <sup>3</sup> / <sub>4</sub>	15	3 <sup>3</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>4</sub>	1/2	19 <sup>1</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>8</sub>	20	1 <sup>1</sup> / <sub>4</sub> x9	1x5 <sup>1</sup> / <sub>2</sub>	430

\*\* Class 400-600 Flanges C and N dimensions do not include 1/4" Raised Face.

Available in Larger Sizes on Request.

†† 3" and smaller, same as Class 300.

NOTE: 40 RS and 60 RS Series Orifice Flanges are not recognized by ANSI B16.36.

**Material:** Daniel standard Orifice Flanges are made of forged steel per A.S.T.M. A-105, in accordance with the latest publication of A.S.T.M. For optional materials consult factory.

**Parts:** All Daniel Raised Face Slip-On Orifice Flanges are furnished with the following items as standard:

- (1) STUD BOLTS — A.S.T.M. A193, Grade B7 Alloy Steel.
- (2) HEXAGONAL NUTS — A.S.T.M. A194, Grade 2H Semi-finished Carbon Steel.

- (3) JACKSCREWS — (2) per union. Heat-treated Carbon Steel.
- (4) GASKETS — (2) per union. Precision cut, treated Asbestos.

NOTE: Catalog No. 520 Orifice Plates must be ordered separately. See Page No. 15.

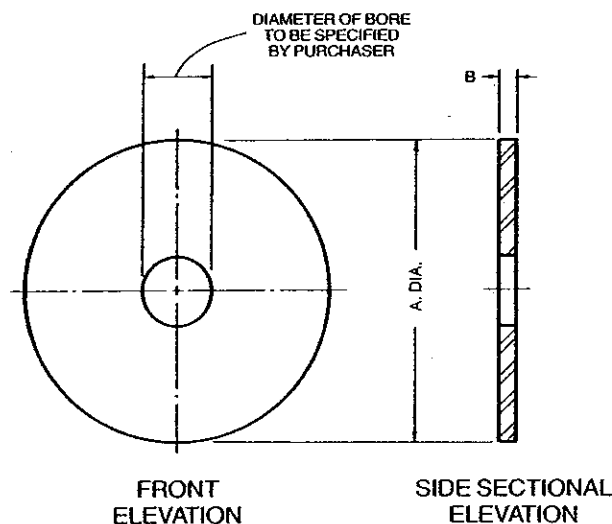
**CATALOG NO. 500 For use with Ring-Type Joint Plate Holders (Pg. 17, 18).**

Daniel Universal Size Orifice Plates are the standard used in many industries. They are interchangeable in all Daniel Orifice Fittings and Orifice Plate Holders 10" and smaller and are the most economical style of plate available. Catalog No. 500 plates effect savings in initial cost, in maintenance, and in storage. They also eliminate the necessity of stocking plates for various pressure ranges. Edges are bored square and sharp. They will

not reflect a beam of light when viewed without magnification. Finish is 15-30 micro-inch roughness and flatness is within 0.010" per inch of dam height. Plate bores are in accordance with A.G.A., A.S.M.E. and all technical societies and associations. Materials in stock include 304, 316 Stainless Steels, Monel and Hastelloy. Others on request.

Size	Dimensions		Size	Dimensions	
	A	B		A	B
3/4"	1.125"	1/8"	10"	10.687"	1/4"
1"	1.312"	1/8"	12"	12.593"	1/4"
1 1/2"	2.000"	1/8"	14"	14.000"	1/4"
2"	2.437"	1/8"	16"	16.000"	3/8"
2 1/2"	2.812"	1/8"	18"	18.000"	3/8"
3"	3.437"	1/8"	20"	20.000"	3/8"
4"	4.406"	1/8"	24"	24.000"	3/8"
6"	6.437"	1/8"	26"	26.000"	3/8"
8"	8.437"	1/8"	30"	30.000"	1/2"

\*These 12" and larger plates manufactured only for use with Daniel RTJ Plate Holders.



## Orifice Bore Calculations

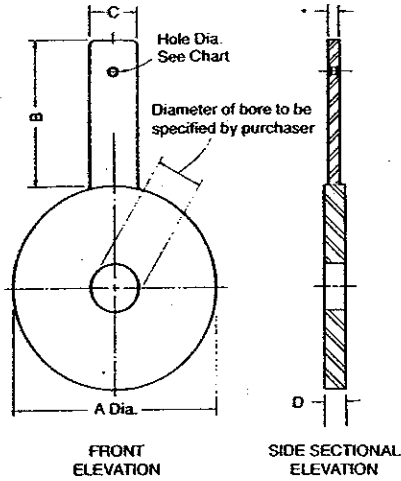
Daniel maintains one engineering section for calculation of orifice plate bores, furnishing them on reproducible data sheets. The following data should be furnished when ordering calculations:

1. Meter differential range.
2. Is the orifice to deliver maximum flow at the above differential pressure? If otherwise, please specify.
3. In liquid flow, is flow volume at operating temperature desired, or at some other base temperature?
4. In liquid or steam flows, what type meter is being used? Liquid over mercury or dry

- (mercury-less) meter?
5. Tag, identification or item number.
6. Fluid being measured.
7. Operating temperature in degrees F.
8. Operating pressure in Lbs. per square inch.
9. Flow rate.
10. Specific gravity or density.
11. Viscosity, at the operating conditions.
12. Barometric pressure.
13. Pressure base.
14. Temperature base.
15. Liquid seal and its specific gravity.
16. Pipe inside diameter, or pipe schedule.
17. Orifice plate material.
18. Orifice flange rating and facing.
19. Pressure tap location. Flange? Radius? Vena Contracta? Pipe?

# Orifice Flange Plates

## PADDLE-TYPE, CATALOG NO. 520



Daniel Paddle-Type Orifice Plates are used with Orifice Flange Unions. Blank plates and plates with popular bore sizes are stocked continuously. Each plate is stamped on its handle with line size, flange rating, orifice bore and plate material. Daniel maintains a stock in Types 304 and 316 Stainless Steels in standard thickness. Other sizes and materials are available on request.

Diameters of holes in Paddle Plate Handles are as follows:

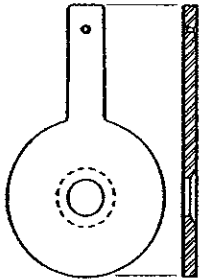
Plate Size	Hole Diameter
1/2" thru 2"	1/4"
2 1/2" thru 12"	3/8"
14" thru 24"	1/2"
26" and larger	3/4"

\*1/8" For Sizes Through 24". 1/4" For 30" & Larger

## DIMENSIONS (In inches)

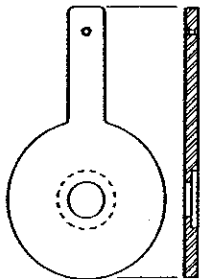
Line Size	125 Lbs. and 150 Lbs. ANSI	250 Lbs. and 300 Lbs. ANSI	400 Lbs. ANSI	600 Lbs. ANSI	900 Lbs. ANSI	1500 Lbs. ANSI	2500 Lbs. ANSI	For all Pressure Ratings 125-2500 Lbs. ANSI		
	A	A	A	A	A	A	A	B	C	D
1/2	1 7/8	2 1/8	2 1/8	2 1/8	2 1/2	2 1/2	2 3/4	4	1	1/8
3/4	2 1/4	2 5/8	2 5/8	2 5/8	2 3/4	2 3/4	3	4	1	1/8
1	2 5/8	2 7/8	2 7/8	2 7/8	3 1/8	3 1/8	3 3/8	4	1	1/8
1 1/4	3	3 1/4	3 1/4	3 1/4	3 1/2	3 1/2	4 1/8	4	1	1/8
1 1/2	3 3/8	3 3/4	3 3/4	3 3/4	3 7/8	3 7/8	4 5/8	4	1	1/8
2	4 1/8	4 3/8	4 3/8	4 3/8	5 5/8	5 5/8	5 3/4	4	1	1/8
2 1/2	4 7/8	5 1/8	5 1/8	5 1/8	6 1/2	6 1/2	6 5/8	4	1 1/4	1/8
3	5 3/8	5 7/8	5 7/8	5 7/8	6 5/8	6 5/8	7 3/4	4	1 1/4	1/8
4	6 7/8	7 1/8	7	7 5/8	8 1/8	8 1/4	9 1/4	4	1 1/4	1/8
5	7 3/4	8 1/2	8 3/8	9 1/2	9 3/4	10	11	5	1 1/2	1/8
6	8 3/4	9 7/8	9 3/4	10 1/2	11 3/8	11 1/8	12 1/2	5	1 1/2	1/8
8	11	12 1/8	12	12 5/8	14 1/8	13 7/8	15 1/4	5	1 1/2	1/8
10	13 3/8	14 1/4	14 1/8	15 3/4	17 1/8	17 1/8	18 3/4	6	1 1/2	1/4
12	16 1/8	16 5/8	16 1/2	18	19 5/8	20 1/2	21 5/8	6	1 1/2	1/4
14	17 3/4	19 1/8	19	19 3/8	20 1/2	22 3/4	—	6	1 1/2	1/4
16	20 1/4	21 1/4	21 1/8	22 1/4	22 5/8	25 1/4	—	6	1 1/2	3/8
18	21 1/2	23 3/8	23 1/4	24	25	27 5/8	—	6	1 1/2	3/8
20	23 3/4	25 5/8	25 3/8	26 3/4	27 3/8	29 5/8	—	6	1 1/2	3/8
22	26	27 3/4	27 1/2	28 7/8	—	—	—	6	1 1/2	3/8
24	28 1/8	30 3/8	30 1/8	31	32 7/8	35 1/2	—	6	1 1/2	3/8
30	34 5/8	37 3/8	37 1/4	38 1/8	—	—	—	6	1 1/2	1/2
36	41 1/8	43 7/8	43 7/8	44 3/8	—	—	—	6	1 1/2	1/2

## BORE AND BEVEL



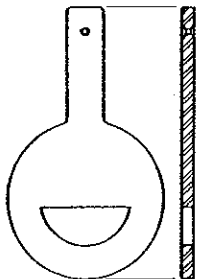
The bore and bevel is the standard method of limiting the plate edge thickness. The bevel is machined on a 45° angle to the desired edge thickness. Unless otherwise specified, plates will be bevelled to 1/50 of the line I.D. or 1/8 of the orifice bore, minimum governing.

## BORE AND COUNTERBORE



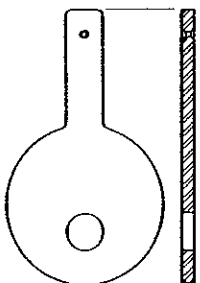
The Bore and Counterbore is a special method to limit the plate edge thickness. Instead of beveling at the normal 45 degrees, the plate is counterbored to the desired edge thickness.

## SEGMENTAL



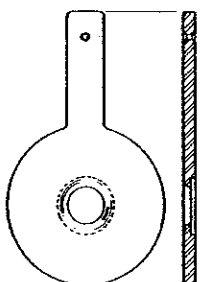
Segmentally bored orifice plates are provided for measurements where solids are entrained in a gas or liquid flow stream. The circular portion of the bore is inscribed within a circle which is normally 98% of the pipe diameter. The segmental opening may be placed either at the top or bottom of the pipe. Industries using these bores include sewage treatment, steel, chemical, water conditioning, paper, and petrochemical.

## ECCENTRIC



Eccentrically bored plates are plates with the orifice off-center, or eccentric, as opposed to concentric. The bore of the eccentric orifice normally is inscribed in a circle which is 98% of the pipe diameter, so that solids or slurries may pass through. Eccentric orifice plates are used in many industries including heavy and light chemicals, steel, paper, atomic and petrochemicals.

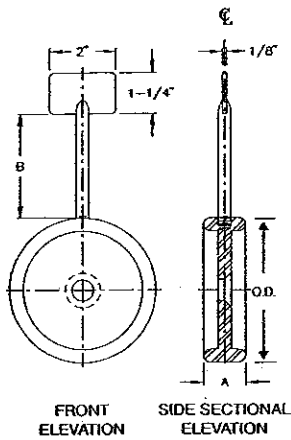
## QUARTER-ROUND



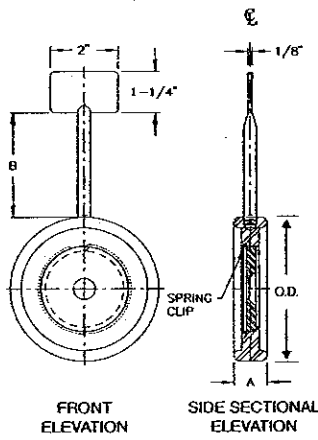
The Quarter-Round, or Quadrant bore, is an orifice with the inlet edge rounded. The radius of the quarter-circle bore is a function of the orifice-to-pipe ratio ( $d/D$ ). Thickness at the throat is equal to the radius. This bore is specifically designed for fluids of high viscosity, such as heavy crudes, syrups, and slurries. Quarter-Round bores are recommended for viscous flows having Reynolds Numbers below 4,000.



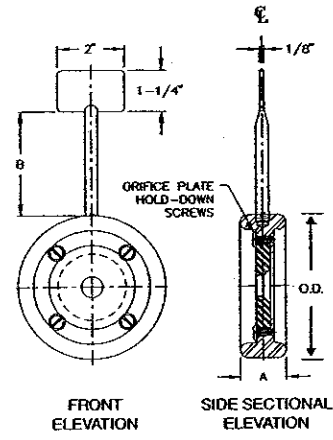
# Handle-Type Ring-Joint Orifice Plate Holders



**CATALOG NO. 560**  
Integral Plate Seal



**CATALOG NO. 580**  
With Snap-Ring Clip



**CATALOG NO. 590**  
With Hold-Down Screws

## DIMENSIONS (In inches) AND A.P.I. RING NUMBERS

Line Size	ANSI Class 1500					ANSI Class 2500				
	A.P.I. Ring Nos.	A†	B	Approx. Gap*	Ring O.D.	A.P.I. Ring Nos.	A†	B	Approx. Gap*	Ring O.D.
1/2	R-12	1	4 1/4	19/32	1.875	R-13	1	4 1/4	19/32	2.000
3/4	R-14	1	4 1/4	19/32	2.063	R-16	1	4 1/4	19/32	2.313
1	R-16	1	4 1/4	19/32	2.313	R-18	1	4 1/4	19/32	2.688
1 1/2	R-20	1	4 1/4	19/32	3.000	R-23	1 1/16	5 1/4	1/2	3.688
t2	R-24	1 1/16	5 1/4	1/2	4.188	R-26	1 1/16	5 1/4	1/2	4.438
t2 1/2	R-27	1 1/16	5 1/4	1/2	4.688	R-28	1 3/16	5 1/4	9/16	4.825
t3	R-35	1 1/16	5 1/4	1/2	5.813	R-32	1 3/16	6 1/4	9/16	5.500
t3 1/2	—	—	—	—	—	—	—	—	—	—
t4	R-39	1 1/16	5 1/4	1/2	6.813	R-38	1 5/16	6 1/4	19/32	6.813
t5	R-44	1 1/16	6 1/4	1/2	8.063	R-42	1 7/16	7 1/4	19/32	8.250
t6	R-46	1 3/16	6 1/4	9/16	8.813	R-47	1 7/16	7 1/4	19/32	9.750
t8	R-50	1 5/16	6 1/4	19/32	11.250	R-51	1 9/16	8 1/4	5/8	11.875
10	R-54	1 7/16	7 1/4	23/32	13.375	R-55	2	8 1/4	13/16	14.625
12	R-58	1 11/16	8 1/4	3/4	15.875	R-60	2 1/8	9 1/4	7/8	17.250
14	R-63	1 7/8	8 1/4	25/32	17.500	—	—	—	—	—
16	R-67	2 1/8	9 1/4	1	19.625	—	—	—	—	—
18	R-71	2 1/8	9 1/4	1	22.125	—	—	—	—	—
20	R-75	2 1/8	10 1/4	7/8	24.250	—	—	—	—	—
24	R-79	2 5/16	10 1/4	1	28.625	—	—	—	—	—

NOTE: Catalog No. 560 Plate Holders are available in all sizes and Ring Numbers. Catalog No. 580 Plate Holders are available in all A.P.I. Ring Numbers from 1-1/2" and up. Catalog 590 Plate Holders are available in 2" size and up in all Ring Numbers. Except 2" R-23 and 2-1/2", R-26.

Other sizes, materials, ANSI and special flange ratings are available on special order. When ordering, please specify: 1. Catalog No. 2. Size 3. Ring No. or ANSI Flange Pressure Rating. 4. Material. 5. Quantity. 6. Required orifice size.

\*Approximate distance between flanges.

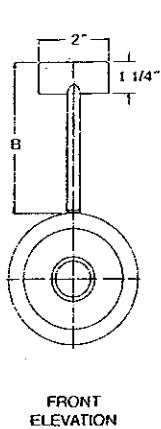
†Catalog 560 Holders in 2" through 8" sizes have 1/4" thick plates as standard. Add 1/8" to 'A' and 'Approx. Gap' dimensions for 560 Holders in these sizes.

### Universal Plates for use in RTJ Holders (no seal units included) Dimensions (Inches)\*\*

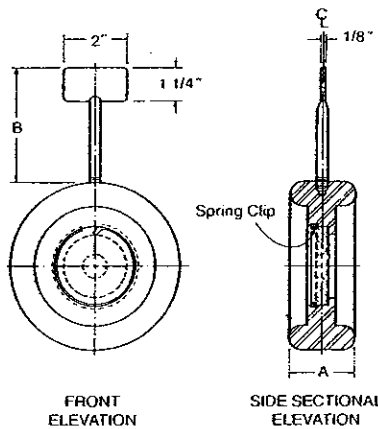
Line Size	Plate O.D. A	Plate Thickness B
12	12.593	1/4
14	14.000	1/4
16	16.000	3/8
18	18.000	3/8
20	20.000	3/8
24	24.000	3/8
26	26.000	3/8
30	30.000	1/2

\*\*Dimensions for 10" size and below on Page 2

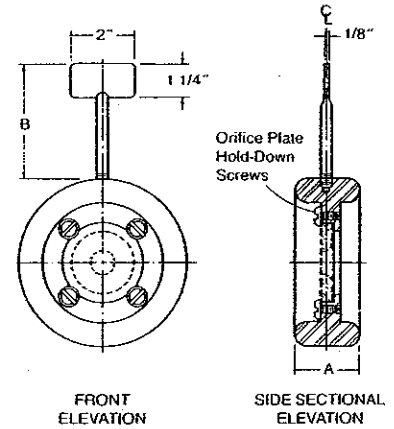
# Handle-Type Ring-Joint Orifice Plate Holders



**CATALOG NO. 560**  
Integral Plate Seal



**CATALOG NO. 580**  
With Snap-Ring Clip



**CATALOG NO. 590**  
With Hold-Down Screws

**DIMENSIONS (In inches) AND A.P.I. RING NUMBERS**

Line Size	ANSI Class 1500				ANSI Class 2500			
	A.P.I. Ring Nos.	A†	B	Approx. Gap*	A.P.I. Ring Nos.	A†	B	Approx. Gap*
1/2	R-12	1	4 1/4	19/32	R-13	1	4 1/4	19/32
3/4	R-14	1	4 1/4	19/32	R-16	1	4 1/4	19/32
1	R-16	1	4 1/4	19/32	R-18	1	4 1/4	19/32
1 1/2	R-20	1	4 1/4	19/32	R-23	1 1/16	5 1/4	1/2
†2	R-24	1 1/16	5 1/4	1/2	R-26	1 1/16	5 1/4	1/2
†2 1/2	R-27	1 1/16	5 1/4	1/2	R-28	1 3/16	5 1/4	9/16
†3	R-35	1 1/16	5 1/4	1/2	R-32	1 3/16	6 1/4	9/16
†3 1/2	—	—	—	—	—	—	—	—
†4	R-39	1 1/16	5 1/4	1/2	R-38	1 5/16	6 1/4	19/32
†5	R-44	1 1/16	6 1/4	1/2	R-42	1 7/16	7 1/4	19/32
†6	R-46	1 3/16	6 1/4	9/16	R-47	1 7/16	7 1/4	19/32
†8	R-50	1 5/16	6 1/4	19/32	R-51	1 9/16	8 1/4	5/8
10	R-54	1 7/16	7 1/4	23/32	R-55	2	8 1/4	13/16
12	R-58	1 11/16	8 1/4	3/4	R-60	2 1/8	9 1/4	7/8
14	R-63	1 7/8	8 1/4	25/32	—	—	—	—
16	R-67	2 1/8	9 1/4	1	—	—	—	—
18	R-71	2 1/8	9 1/4	1	—	—	—	—
20	R-75	2 1/8	10 1/4	7/8	—	—	—	—
24	R-79	2 5/16	11 1/4	1	—	—	—	—

NOTE: Catalog No. 560 Plate Holders are available in all sizes and Ring Numbers. Catalog No. 580 Plate Holders are available in all A.P.I. Ring Numbers from 1-1/2" and up. Catalog No. 590 Plate Holders are available in 2" size and up in all Ring Numbers, except 2" R-23 and 2-1/2" R-26.

Other sizes, materials, ANSI and special flange ratings are available on special order. When ordering, please specify: 1 Catalog No. 2 Size. 3 Ring No. or ANSI Flange Pressure Rating. 4 Material. 5 Quantity. 6 Required orifice size.

\*Approximate distance between flanges

†Cat. 560 Holders in 2" through 8" sizes have 1/4" thick plates as standard. Add 1/8" to 'A' and 'Approx. Gap' dimensions for 560 Holders in these sizes.

**DANIEL**

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**DANIEL MEASUREMENT AND CONTROL**

Houston, Texas, Telephone: (713) 467-6000, Fax: (713) 827-3880  
Larbert, Scotland, Telephone: + 44-1324-556111, Fax: + 44-1324-562290

**OFFICES AND REPRESENTATIVES WORLDWIDE**

*www.danielind.com*

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3				ROTAMETER (VARIABLE AREA FLOWMETERS)				SHEET 1 OF 1						
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : FLOW INDICATORS				NO		BY		DATE		REVISION				
				0		RDD		03/11/05		ISSUE FOR PURCHASE		JOB # 054468		
												DATE 03/11/2005		
												REQ.		
								BY		CHK'D		APPR.		
1	TAG NO.			FI-601/ 602			FI-611							
G 2	SERVICE			GAS/GAS EXCHANGER			CHILLER							
E 3	LINE NO. / VESSEL NO.			E-600			E-610							
N 4	FUNCTION			INDICATE			INDICATE							
E 5	MOUNTING			IN LINE			IN LINE							
R 6	POWER SUPPLY													
A 7	CONN. SIZE		TYPE		21 MM		NPT		21 MM		NPT			
L 8	INLET DIR.		OUTLET DIR.											
9	FITTING MATERIAL			ALUMINUM			ALUMINUM							
10	PACKING OR O-RING MTL.			MFR STD			MFR STD							
11	ENCLOSURE TYPE			MFR STD			MFR STD							
M 12	SIZE		FLOAT GUIDE											
E 13	TUBE MTL.		FLOAT MTL.		ALUMINUM		CELCON		ALUMINUM		CELCON			
T 14	METER SCALE: LENGTH & TYPE			MFR STD			MFR STD							
E 15	METER SCALE RANGE			0.5 - 3.75 L/MIN			0.5 - 3.75 L/MIN							
R 16	METER FACTOR													
17	RATED ACCURACY			5%			5%							
18	HYDRAULIC CALIB. REQUIRED			NO			NO							
F 19	FLUID			80% E.GLYCOL			80% E.GLYCOL							
L 20	COLOR OR TRANSPARENCY			CLEAR			CLEAR							
U 21	MAXIMUM FLOW RATE			3.75		LPM		3.75		LPM		LPM		
I 22	NORMAL FLOW		MIN. FLOW		0.95		LPM		0.5		LPM		LPM	
D 23	OPER. SPEC. GRAVITY (LIG)			1.07			1.07							
24	MAX. OPER. VISCOSITY cP			5			5							
D 25	OPER. PRESS.		OPER. TEMP.		7240		kPa(g)		43		° C		7240	
A 26	OPER. DENSITY ( GASES)													
T 27	STD. DENSITY		MOL. WT.											
A 28	MAX. ALLOWABLE PRES. DROP			70		kPa		70		kPa		kPa		
29	DESIGN PRESS @ TEMP			8963		kPa(g) @ 66+		° C		8963		kPa(g) @ 66		
E 30	EXTENSION WELL MATERIAL													
X 31	GASKET MATERIAL													
X 32	TRANSMITTER OUTPUT													
M 33	TRANS. ENCLOSURE CLASS													
T 34	SCALE RANGE													
A 35	NO. OF CONTC.		FORM											
L 36	RATING		HOUSING											
A 37	ACTION													
R 38														
O 39	VALVE SIZE & MATERIAL													
P 40	VALVE LOCATION													
T 41	CONST. DIFF. RELAY MTL.													
I 42	PURGE METER TUBING													
O 43	AIRSET													
N 43														
44	MANUFACTURER			HEDLAND			HEDLAND							
45	MODEL NO.			H613A-001			H613A-001							
46	TUBE NUMBER													
47	FLOAT NUMBER													
48	P. O. NUMBER													

NOTES:

AREA. UNIT # :

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				TURBINE FLOWMETERS				SHEET 1 OF 1	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : FLOWMETER				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.F
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
				BY	CHK'D	APPR.			
1	TAG NO.	FM-630							
2	SERVICE	CONDENSATE							
3	METER LOCATION								
4	LINE SIZE	33	mm		mm		mm	mm	
5	END CONNECTIONS	33	NPT		mm		mm	mm	
6	BODY RATING	3792	kPa @ ° C		kPa @ ° C		kPa @ ° C	kPa @ ° C	
7	NOMINAL FLOW RANGE	22.7-283 L/MIN							
M 8	ACCURACY		%		%		%	%	
E 9	LINEARITY	1%	%		%		%	%	
T 10	K FACTOR CYCL.PER VOL.UNIT	277 PULSES / L							
E 11	EXCITATION	---							
R 12	MATERIALS: BODY	316SS							
13	MATERIALS: SUPPORT	316SS							
14	MATERIALS: SHAFT	TUNGSTEN CARBIDE							
15	MATERIALS: FLANGES	316SS							
16	MATERIALS: ROTOR	17-4 PH SS							
17	BEARINGS: TYPE	SLEEVE							
18	BEARING MATERIAL	TUNGSTEN CARBIDE							
19	MAX. SPEED	---							
20	MIN. OUTPUT VOLTAGE	---							
21	PICKOFF TYPE	MAGNETIC							
22	MATERIAL ENCLOSURE CLASS	X.P.							
23									
24									
F 25	FLUID	H.C. LIQUIDS							
L 26	FLOW MIN.	FLOW MAX.	L/s	L/s	L/s	L/s	L/s	L/s	
U 27	NORMAL FLOW	46.3	L/s	L/s	L/s	L/s	L/s	L/s	
I 28	OPERATING PRESSURE	1950	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	
D 29	BACK PRESSURE	100	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	
30	TEMP. MAX.	TEMP. MIN.	65 ° C	-29 ° C	° C	° C	° C	° C	
D 31	OPER. SP. GR.	0.576							
A 32	VISCOSITY RANGE	cP	0.16						
T 33	PERCENT SOLIDS & TYPE								
A 34									
35									
S 36	SECONDARY INST. TAG NO.	FQI-630							
E 37	PREAMPLIFIER	NO							
C 38	FUNCTION	TOTALIZER							
I 39	MOUNTING	TOP							
N 40	POWER SUPPLY	BATTERY							
S 41	SCALE RANGE								
T 42	OUTPUT RANGE								
O 43	TOTALIZER TYPE	NON-RESET							
P 44	COMPENSATION	NONE							
T 45	PRESET COUNTER								
I 46	OPTIONS ENCLOSURE CLASS	X.P.							
N 47	STRAINER SIZE & MESH	NO							
48									
49									
50	MANUFACTURER	BARTON							
51	METER MODEL NO.	8001							
52	SECONDARY INST. MODEL NO.	FIRST RATE PLUS							
53	P. O. NUMBER								

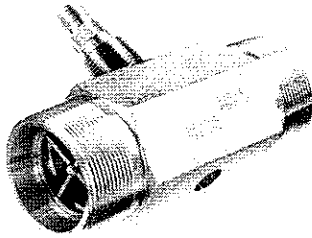
NOTES:

AREA. UNIT # :

**Barton®**

**Series 8000**

**Industrial Liquid Turbine Meters**



**Installation Manual**

Version 01F05f

ID#11400

6/2001

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**SECTION 1 - INTRODUCTION**

**General**

The Barton Series 8000 Liquid Turbine Meters are electromechanical volumetric flow measurement instruments. Available in seven models, these meters are designed for waterflood and commercial applications.

**Product Description**

The 8000 meter series consists of the following models:

- 8084 — 1/2-inch
- 8086 — 3/4-inch
- 8001 — 1-inch
- 8023 — 1-1/2 inch
- 8002 — 2-inch
- 8003 — 3-inch
- 8004 — 4-inch

The 8000 meters will accept an auxiliary snap-in pickup coil without disturbing the primary pickup. The auxiliary receptacle is located in the meter body at a point 180° from the primary pickup.



**Before installing this instrument**, become familiar with the installation instructions in Section 2. **WARNING** notes that appear on the following pages of this manual should be reviewed before proceeding: **12**.

**CAUTION** notes indicate the presence of a hazard which **will** or **can** cause **moderate** personal injury or property damage if warning is ignored.

**Product Description** (continued)

A full line of electronic analog and digital instruments are available for indicating, totalizing, recording, and controlling flowrate and total volume. The 8000 meter can interface with Barton 818A/818EU pre-amplifiers; BA200, BA400, and the Scanner line of electronics.

**Theory of Operation**

Liquid flow through the meter causes the blade rotor within the meter housing to turn at an angular velocity directly proportional to the velocity of the liquid.

As the blades of the rotor pass beneath a magnetic pickup coil, an AC signal is generated. Each AC pulse is equivalent to a discrete volume of liquid. Since the AC frequency is directly proportional to the rotor angular velocity and since the cross-sectional area of the meter is fixed, the frequency is directly proportional to flow rate. The generated waveform is sinusoidal in nature and is readily transmitted to local or remote electronic instrumentation.

The symmetrical design of the Series 8000 permits reverse flow metering. When metering reverse flow, the K-factor may vary to an insignificant degree.

In addition, these meters can be operated in either horizontal or vertical positions.

**Specifications**

**General:**

Temperature Range ..... -30°F to +225°F  
Flow Direction ..... Bi-directional

**Accuracy:**

Linearity ..... ±1% of reading over flow range  
Repeatability ..... ±0.1% of reading over flow range (calibrated using water @60°F, SG=1.00, 1.0 centistokes)

**Pressure:**

Working ..... 5,000 psig (Models 8084, 8086, 8001, 8023, and 8002)  
2,500 psig (Models 8003 and 8004)  
Proof\* ..... 7,500 psig (Models 8084, 8086, 8001, 8023, and 8002)  
3,750 psig (Models 8003 and 8004)

\* **Note:** Applies only to NPT connections. Refer to ANSI B16.5 for pressure applicable to R.F. Flange Connections.

**Specifications (continued)**

**Overall Length:**

300, 600, and 1500 lb. R.F. Flanges are available. For overall length, see ODD drawings on pages 4 and 5.

Meter	NPT (Inches)	150 lb R.F. Flange (Inches)
8084 (1/2-inch)	3	5
8086 (3/4-inch)	4	5-1/2
8001 (1-inch)	4	5-1/2
8023 (1-1/2 inch)	6	6
8002 (2-inch)	6	6-1/2
8003 (3-inch)	10	10
8004 (4-inch)	12	12

**Rated Capacities:**

Meter	Flowrate		"K" Factor (nominal)	Frequency (Hz) at Max. Rated Flow	BBL/Day	
	Min.	Max.			Min.	Max.
8084 (1/2-inch)	0.9	10	12600 ±5%	2100 ±5%	31	343
8086 (3/4-inch)	2.5	30	2890 ±5%	1500 ±5%	86	1028
8001 (1-inch)	6.0	75	1050 ±5%	1313 ±5%	205	2571
8023 (1-1/2 inch)	15.0	180	295 ±5%	885 ±5%	514	6171
8002 (2-inch)	25.0	300	138 ±5%	690 ±5%	857	10285
8003 (3-inch)	55.0	660	41 ±5%	450 ±5%	1885	22628
8004 (4-inch)	100	1200	19 ±5%	385 ±5%	3,429	41,143

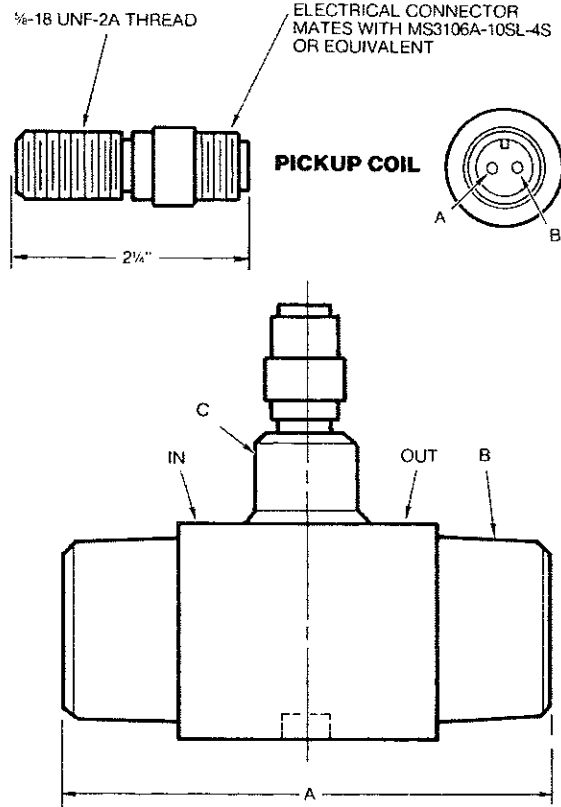
**Overrange Capabilities:**

Meters can operate at the following overrange in either direction for a period of 15 minutes without damage.

Meter	Overrange	Gallons per Minute
8084 (1/2-inch)	150%	15
8086 (3/4-inch)	150%	45
8001 (1-inch)	200%	150
8023 (1-1/2 inch)	130%	234
8002 (2-inch)	160%	480
8003 (3-inch)	150%	990
8004 (4-inch)	150%	1800

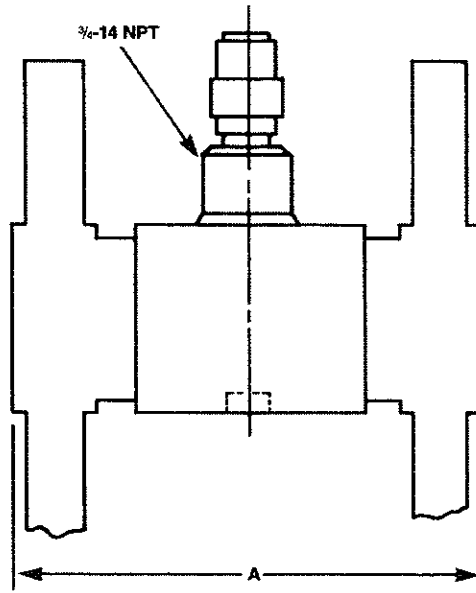


**8000 Outline Dimension Drawing**



Model No.	Dim. A	Dim. B End Conn. Male NPT	Dim. C (Boss)	Wrench Flat Size
8084 (1/2-inch)	3"	1/2" - 14	3/4"-14	1-1/16
8086 (3/4-inch)	4"	3/4" - 14	3/4"-14	1-1/4
8001 (1-inch)	4"	1" - 11-1/2	3/4"-14	1-1/2
8023 (1-1/2-inch)	6"	1-1/2" - 11-1/2	3/4"-14	2-1/8
8002 (2-inch)	6"	2" - 11-1/2	3/4"-14	2-1/2
8003 (3-inch)	10"	3" - 8	3/4"-14	3-1/2
8004 (4-inch)	12"	4" - 8	3/4"-14	4-1/2

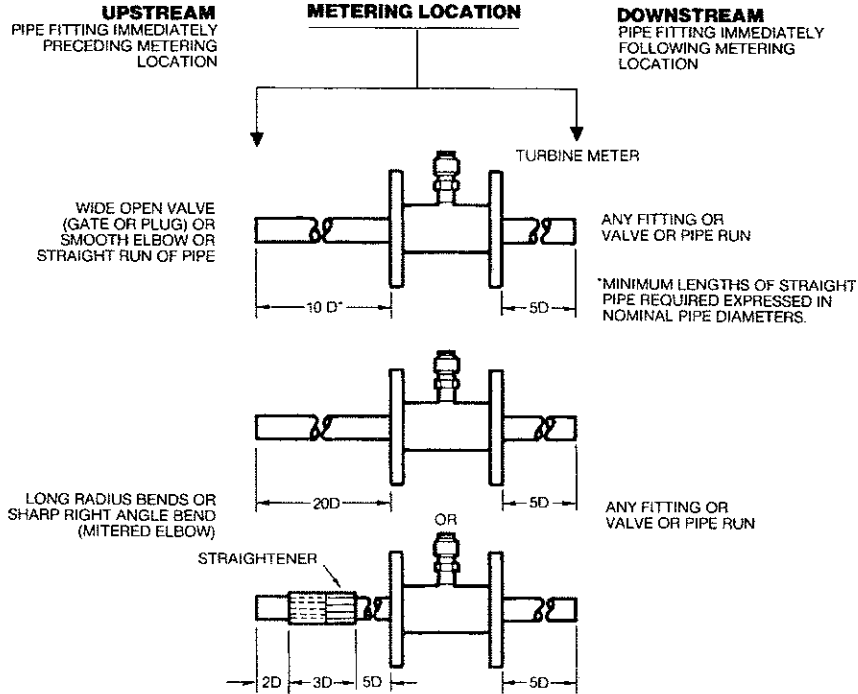
**8000 Outline Dimension Drawing (continued)**



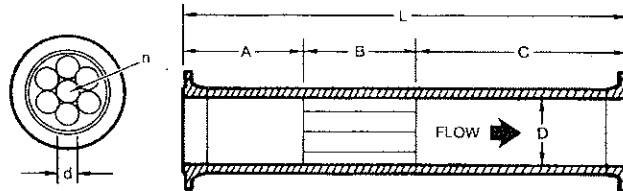
Model No.	Dimension A		
	150#	300#	600#
8084	5"	5"	5"
8086	5-1/2"	5-1/2"	5-1/2"
8001	5-1/2"	5-1/2"	5-1/2"
8023	6"	6"	6"
8002	6-1/2"	6-1/2"	6-1/2"
8003	10"	10"	10"
8004	12"	12"	12"

## Typical Meter Runs

### THREE TYPICAL METERING RUNS



### RECOMMENDED FLOW STRAIGHTENER ASSEMBLY



- LEGEND:
- L = OVERALL LENGTH OF STRAIGHTENER ASSEMBLY = 10D MINIMUM.
  - A = LENGTH OF UPSTREAM PLENUM = 2D TO 3D.
  - B = LENGTH OF TUBE OR VANE SECTION = 2D TO 3D.
  - C = LENGTH OF DOWNSTREAM PLENUM = 5D MINIMUM.
  - D = NOMINAL DIAMETER OF METER.
  - n = NUMBER OF INDIVIDUAL TUBES OR VANES. n SHOULD BE AT LEAST 4.
  - d = NOMINAL DIAMETER OF INDIVIDUAL TUBES. B/d SHOULD BE AT LEAST 10.

## SECTION 2 - INSTALLATION

### **General**

The instrument should be inspected at time of unpacking to detect any damage that may have occurred during shipment.

### **Unpacking**

Unpack the meter and verify the accuracy of the information on the packing slip for model number, serial number, and calibration date.

Remove the meter from the box and remove the thread protectors from the meter housing. The turbine meter is a precision instrument and should be handled carefully.

Place the meter on a flat surface and (using a small dowel) carefully turn the rotor. The rotor should turn freely with no evidence of roughness or binding.

Without disassembling the meter, visually inspect the meter inside and outside. Report any visible damage to Barton Instrument Systems immediately.

Replace the threaded protectors and return the meter to the original box for storage or transport to the job site.

### **Installation Procedure**

#### **A. Preliminary Items**

Prior to installing the turbine meter into the system, do the following:

1. Install a "spool piece" and allow sufficient flow through the system to completely flush any foreign material from the system. If particulate foreign material is expected in the flow, the fluid should be filtered.
2. Remove gas slugs from the fluid lines.
3. Plan the installation, considering the following:
  - a. **Meter Position** — turbine meters are calibrated in a horizontal position. Therefore, the best correlation to calibration occurs when the meter is operated in this plane. However, the meter will operate satisfactorily in any position.
  - b. **Flow Direction** — turbine meters are stamped IN and OUT to identify the proper direction of flow.
  - c. **Meter Location** — to get optimum efficiency, several factors should be considered when planning a meter location:
    - 1) **Location Relative to System** — when flow is expected to be intermittent, the meter should not be mounted at a low point in the piping system. Otherwise, solids can settle on or congeal around the rotor. Solids can cause the rotor to freeze or become damaged.
    - 2) **Tolerance to Mechanical Vibration** — meter life can be extended by locating the meter so that it is protected from direct mechanical vibration shock.
    - 3) **Tolerance to Electrical Interference** — to obtain the best electrical signal output from the meter, it should be located at a distance from sources of electrical interference (e.g., motors, solenoids, and transformers). A preamplifier is recommended to minimize effects of undesired noise.

## SECTION 2 - INSTALLATION (continued)

### Installation Procedure (continued)

#### A. Preliminary Items (continued)

- d. **System Pressure** — the maximum and minimum system pressures must be considered:
  - 1) **Minimum System Pressure** — to obtain the proper rotor response, a back pressure should be applied to the meter. This back pressure should be at least twice the pressure drop of the meter maximum flow plus twice the fluid vapor pressure.  $\text{Min. Pressure at meter} = (2 \times \text{net pressure drop at max. flow}) + (2 \times \text{vapor pressure of fluid})$ 

**Note:** Some piping arrangements provide this amount of back pressure at the meter due to downstreams restrictions, valves, etc.. If additional back pressure is required, a downstream valve can be added in accordance with the piping arrangements shown on page 6.
  - 2) **Maximum Meter Pressure** — maximum gage working pressure of the meter is determined by the size and type of connecting fittings used and materials of construction.

#### B. Piping Installation

##### 1. General Considerations

The fluid moving through the meter engages the angled blades of the rotor. The rotational velocity of the rotor is a function of the fluid velocity and the blade angle engagement. Swirl in the fluid ahead of the meter can cause a change in the effective angle of engagement, and thus cause a deviation from factory calibration (performed under controlled flow conditions). Proper installation of the meter will minimize the adverse effects of fluid swirl.

##### 2. Meter Location

The section of pipe immediately preceding, including, and immediately following the meter, is known as the "Metering Location." Three typical metering arrangements are illustrated on the next page. Note: Although the meters shown are of flanged design, these examples are applicable to non-flanged meters.

Each arrangement is designed to minimize swirl. A flow straightener is also depicted and should be used when the installation does not allow for the otherwise required straight run of pipe ahead of the meter.

**Note:** The lengths of pipe in the typical meter run illustration on page 6 are expressed in pipe diameters and represent the minimum recommended distances between components to prevent or eliminate flow disturbance.

**B. Piping Installation** (continued)

**3. Meter Bypass**

Whenever possible, such as in new piping systems, it is advisable to install a valved meter bypass around the meter. This arrangement permits inspection of the meter without interrupting the system flow. However, the bypass connections are not to be placed within the area of the recommended metering run.

**4. Line Purge**

In newly installed piping systems or in a system in which the fittings have been disturbed, the line should be flushed prior to installation of the meter. This minimizes the possibility of damage to the meter by foreign materials contained within the system piping.

**C. Electrical Installation**

The turbine meter pickup coil has a Type MS 3106-10SL-4P male connector. The mating connector supplied with the meter is a Type MS 3106-10SL-4S female connector. Assemble the female connector to a single pair and connect the preamplifier. Wire the preamplifier to the readout device.

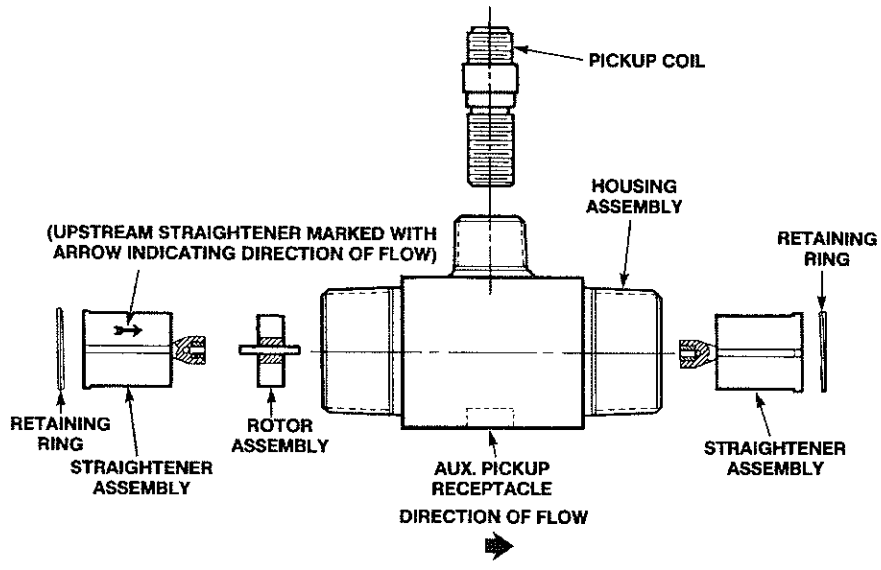
If no preamplifier is used, assemble the female connector to a two-conductor shielded cable (Beldon Type 8761 or equivalent). Isolate the shield at the turbine meter end to prevent ground loops. Connect the two conductor cables to the readout device per the manual for the readout device. Connect the cable shield to the appropriate connector at the readout device.

If possible, isolate the conductor cable from high power lines and other noise producing environments by utilizing a separate conduit for conveyance. This will also protect the cable from physical damage.

**NOTICE**

*The maximum single transmission distance is approximately 200 feet without the use of a preamplifier.*

**Turbine Meter Components**



## **SECTION 3 - MAINTENANCE**

*(Refer to component illustration on page 10)*

### **Removal From Service**

1. Remove the flow from the meter by shunting through the meter bypass.
2. Disconnect the electrical cable at the pickup coil.
3. Remove the meter from the piping system.

### **Tools Required**

- Small (pocket-size) screwdriver or scribe
- Needle-nose pliers

### **Turbine Meter Disassembly**

#### **NOTICE**

*It is not necessary to remove both straightener assemblies to remove or replace the rotor assembly. The rotor assembly is accessible by removing either straightener assembly.*

1. Insert a screwdriver blade or scribe point into the notch of the Spirolex retaining ring and gently work it up and out of the groove so that it separates from the spiral behind it.
2. Continue to separate the spirals and work the ring outward until it can be removed from the meter housing bore.
3. Slide the straightener assembly out of the meter housing bore.
4. Grasp the exposed end of the rotor assembly shaft with needle-nose pliers and gently pull the rotor assembly out of the meter housing.
5. If both straightener assemblies need to be removed, proceed as in steps 1, 2, and 3 to remove the other retaining ring and straightener assembly.

### **Turbine Meter Assembly**

The following procedure assumes that both straightener assemblies have been removed; if not, perform steps 1 through 5 of the Turbine Meter Disassembly procedure above, then continue with this procedure.

1. Check the meter housing, both straighteners, and the rotor assembly to determine their relationship to the direction of process flow. The meter housing is marked IN on one end and OUT on the other end; one blade of each straightener assembly is marked with an arrow that indicates the direction of flow; one end of the rotor assembly is marked IN to indicate the end that should be located upstream. In all cases, IN means upstream and OUT means downstream.
2. Align one of the four blades of the straightener assembly between the two notches punched into the meter housing bore so that the arrow marked on one of the blades is pointing toward the OUT end of the meter housing.
3. Insert the straightener assembly into the meter housing bore until it seats beyond the retainer ring groove.

#### **NOTICE**

*If the straightener assembly rotates more than one or two degrees, it is not assembled properly. In that case, remove the straightener assembly and repeat steps 2 and 3.*



### **SECTION 3 - MAINTENANCE** (continued)

(Refer to component illustration on page 10)

#### **Turbine Meter Assembly** (continued)

4. Select a Spirolex retaining ring, separate the coil, and insert one end of the ring into the groove in the meter housing bore.
5. Keeping the coil separated, spiral the ring into the groove until an audible snap indicates that the ring has seated.
6. Grasp the rotor assembly with needle-nose pliers and gently insert the free end of the rotor shaft into the exposed bearing of the straightener assembly.

#### **NOTICE**

*Make certain that the end of the rotor assembly marked IN is facing upstream.*

7. Align one of the four blades of the other straightener assembly between the two notches punched into the meter housing bore and insert the assembly into the meter body. The rotor shaft will engage the bearing in the end of the straightener assembly, allowing it to seat beyond the retaining ring.

#### **NOTICE**

*If the straightener assembly rotates more than one or two degrees, it is not assembled properly. In that case, remove the straightener assembly and repeat step 7.*

8. Install a Spirolex retaining ring, as in steps 4 and 5.



#### **CAUTION**

***Make sure that the retaining ring is properly seated so, when turbine meter is installed in the line, components will not be flushed downstream with the process flow.***

#### **Pickup Coil Removal**

The pickup coil should be removable without the use of tools.

1. Grasp the knurled portion of the coil and turn the coil counterclockwise until free of the coil boss threads.
2. Lift the pickup coil clear of the housing receptacle.

#### **NOTICE**

*If the coil is seated too tight to be removed by hand, wrap the knurled portion with electrical tape or cloth and carefully use pliers to loosen.*

#### **Pickup Coil Replacement**

To replace the pickup coil, simply position the coil in the housing receptacle and, turning clockwise, hand-tighten until seated.

#### **NOTICE**

***Do not use pliers or any other tool to tighten the coil.***

### **Pickup Coil Electrical Check**

#### **A. Resistance Check**

1. Measure the resistance between pins A and B. The resistance should be between 900 and 1,300 Ohms.
2. Measure the resistance between pin A and the pickup coil housing, and between pin B and the pickup coil housing. The resistance between each pin and the coil housing should be at least 100 megohms.
3. If any of the measured resistances fall outside the specified limits, replace the pickup coil.

#### **B. Peak-to-Peak Voltage Check**

Connect an oscilloscope to the pickup coil and check the signal-to-noise ratio, as follows:

1. Compare the peak-to-peak voltage while the meter is operating at the minimum flow rate.
2. Compare the peak-to-peak voltage at no flow.

The ratio should be approximately 20:1 or higher. If the signal-to-noise ratio is not at least 20:1, examine the immediate area for either radiated or conducted electrical interference. Minimize the electrical interference by removing the source or re-orienting the meter.

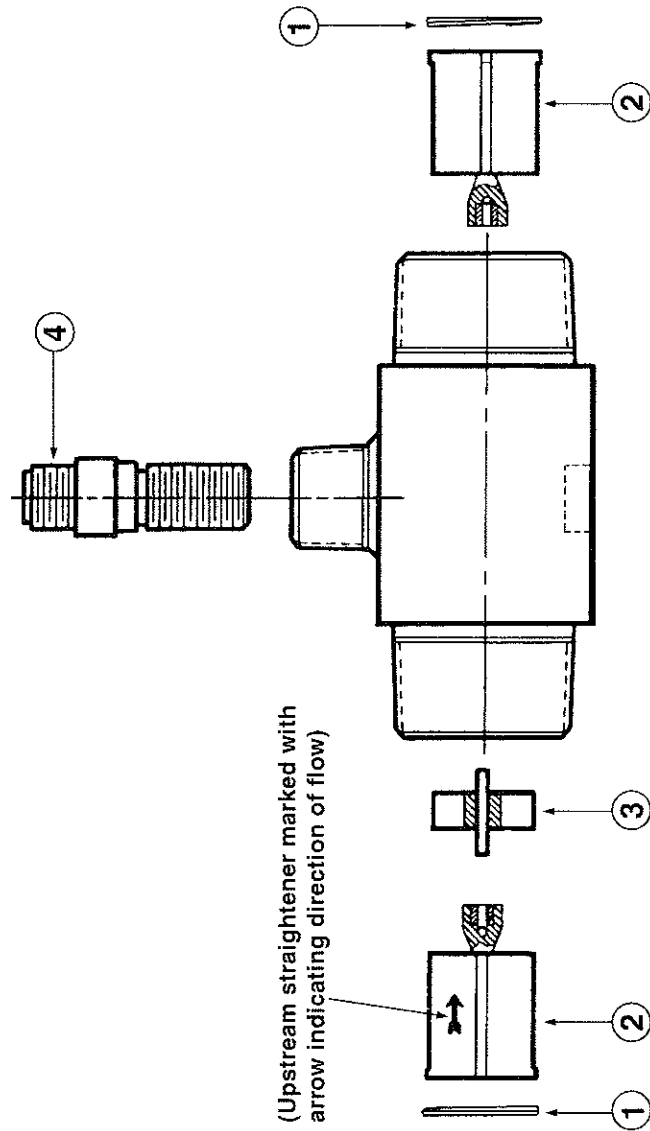
The most effective method of determining the source of electrical interference is to turn off the power to electrical machinery or to electronic equipment one item at a time and observe the change in interference signal amplitude.

If no line amplifier is used, the addition of a Barton Model 818A or 818EU Preamplifier at the turbine meter will improve the signal-to-noise ratio.

**Note:** A low signal-to-noise ratio can feed deceptive information to electronic instruments in the system.

SECTION 4 - PARTS DRAWING/LIST

8000 Parts Drawing



(Upstream straightener marked with arrow indicating direction of flow)

### 8000 Component Parts List

Item	Description	Part Number	Qty/Unit
1*	Ring, Retaining (Sprolex):		2
	8084 (1/2-inch)	0087-1046T	
	8086 (3/4-inch)	0087-1027T	
	8001 (1-inch)	0087-1019T	
	8023 (1-1/2 inch)	0087-1022T	
	8002 (2-inch)	0087-1017T	
	8003 (3-inch)	0087-1026T	
	8004 (4-inch)	0087-1047T	
2**	Assembly, Straightener	Not Available Separately	2
3**	Assembly, Rotor	Not Available Separately	1
4	Coil, Pickup	0137-1001T	1
<b>Notes:</b> * Available separately. When ordering, supply name of part, part number, meter model number, and meter serial number. ** Not available separately. These parts must be ordered as part of the meter replacement parts kit (see below).			

### 8000 Replacement Parts Kits

Parts included in the kits are pre-calibrated at the factory. Each complete kit consists of items 1, 2, and 3 listed in Components Parts List table above. Except for the Retaining Ring (Item 1) and the Pickup Coil (Item 4), spare parts are not identified separately.

Meter	Replacement Parts Kit No.	Housing Stamp No.
8084 (1/2-inch)	8084-1014B	8084
8086 (3/4-inch)	8086-1057B	8086
8001 (1-inch)	0503-1028B	8000-1
8023 (1-1/2 inch)	0526-1019B	8000-1.5
8002 (2-inch)	0504-1020B	8000-2
8003 (3-inch)	8003-1057B	8003
8004 (4-inch)	8004-1022B	8004

### **Product Warranty**

#### **A. Warranty**

Barton Instrument Systems, L.L.C. warrants that at the time of shipment the products manufactured by Barton Instrument Systems, L.L.C. and sold hereunder will be free from defects in material and workmanship, and will conform to the specifications furnished by or approved by Barton Instrument Systems, L.L.C..

#### **B. Warranty Adjustment**

- (1) If any defect within this warranty appears, Buyer shall notify Barton Instrument Systems, L.L.C. immediately.
- (2) Barton Instrument Systems, L.L.C. agrees to repair or furnish a replacement for, but not install, any product which within one (1) year from the date of shipment by Barton Instrument Systems, L.L.C. shall, upon test and examination by Barton Instrument Systems, L.L.C., prove defective within the above warranty.
- (3) No product will be accepted for return or replacement without the written authorization of Barton Instrument Systems, L.L.C.. Upon such authorization, and in accordance with instructions by Barton Instrument Systems, L.L.C., the product will be returned shipping charges prepaid by Buyer. Replacements made under this warranty will be shipped prepaid.

#### **C. Exclusions from Warranty**

- (1) THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.
- (2) Components manufactured by any supplier other than Barton Instrument Systems, L.L.C. shall bear only the warranty made by the manufacturer of that product, and Barton Instrument Systems, L.L.C. assumes no responsibility for the performance or reliability of the unit as a whole.
- (3) "In no event shall Barton Instrument Systems, L.L.C. be liable for indirect, incidental, or consequential damages nor shall the liability of Barton Instrument Systems, L.L.C. arising in connection with any products sold hereunder (whether such liability arises from a claim based on contract, warranty, tort, or otherwise) exceed the actual amount paid by Buyer to Barton Instrument Systems, L.L.C. for the products delivered hereunder."
- (4) The warranty does not extend to any product manufactured by Barton Instrument Systems, L.L.C. which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by Barton Instrument Systems, L.L.C..
- (5) The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than at Barton Instrument Systems, L.L.C.'s factory or service locations by persons not expressly approved by Barton Instrument Systems, L.L.C..

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Barton Instrument Systems, LLC makes no warranty of any kind with regard to this manual, materials attached to or provided with, including, but not limited to, implied warranties of merchantability and fitness for a particular purpose. Barton Instrument Systems, LLC shall not be liable for errors contained in this manual, including materials attached to or provided with, or for incidental or consequential damages in connection with the furnishing, performance, or use of this information. The information contained in this manual (along with attached or provided materials) is subject to change without notice. The contents of this manual and all attached/provided materials may be revised without prior notice.

### **Barton Instrument Systems, LLC**

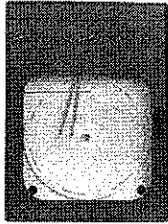
900 S. Turnbull Canyon Rd.  
City of Industry, CA 91745 USA  
(626) 961-2547

*On the Web at [www.barton-instruments.com](http://www.barton-instruments.com)*

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 **NuFlo**

## **Barton® MODEL 202E DIFFERENTIAL PRESSURE RECORDERS**



User Manual  
Manual No. 10060, Rev. B  
05/2004

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### **SECTION 1 - INTRODUCTION**

#### **General**

The Barton® Model 202E single DP Flow Recorders measure and record system operation parameters including gas and liquid flow rate, liquid level in a vessel, and other system variables that can be measured by differential pressure and static pressure methods.

#### **Main Components**

##### **Differential Pressure Unit**

The Barton® Model 199 Differential Pressure Unit (DPU) actuates the recorders. The DPU is a dual bellows assembly enclosed within pressure housings. The bellows are liquid filled and withstand overranges equal to the working pressure of the housing without calibration change. Movement of the bellows is transmitted through a torque tube from the DPU to the recording mechanism. The torque tube is hermetically sealed to eliminate friction and leakage; it does not require lubrication.

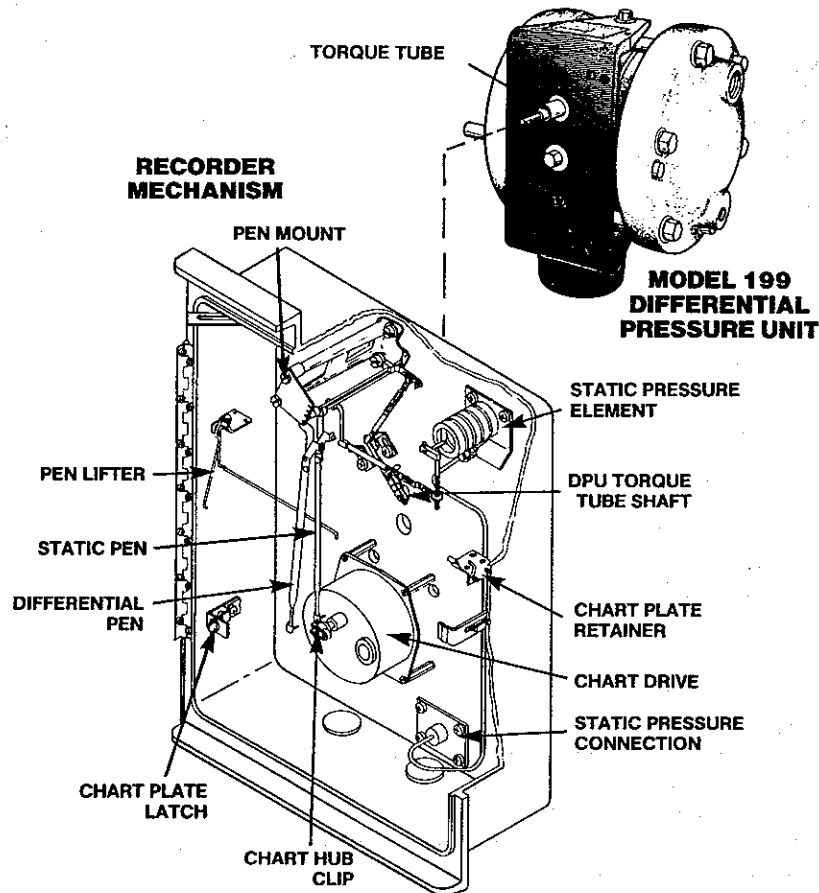


**SAFETY!**

Before installing this instrument, become familiar with the installation instructions in Section 2. WARNING notes that appear on the following pages of this manual should be reviewed before proceeding: 8, 20, 21, 22, and 25.

WARNING notes indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if warning is ignored.  
CAUTION notes indicate the presence of a hazard which can cause moderate personal injury or property damage if warning is ignored.

The DPU is attached to the back of the recorder case. The torque tube is inserted through a hole in the case and connected to the DP drive arm of the recorder mechanism. *Movement of the bellows is transmitted by the DPU drive arm to the **torque tube** as a rotary motion, which in turn rotates the recorder mechanism.* The pressure housings of the DPU are connected by pipe or tubing to the high- and low-pressure sides of the primary device located in the process system.

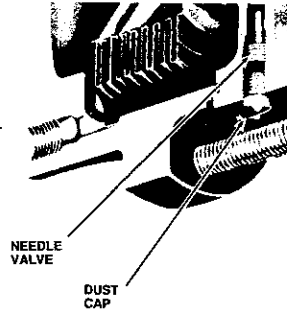


The range of the DPU is determined by the force required to move the bellows through their normal range of travel. The **Range Springs**, which are available in various ranges, balance the DP applied to the unit. The number of springs and their ratings depends on individual DP range requirements. See BUA photos on page 6.

The built-in **Pulsation Dampener** controls the flow of fill-liquid between the high and low pressure bellows, with an externally adjustable needle valve. In applications where pulsation is not a problem, the needle is set to the full open position.

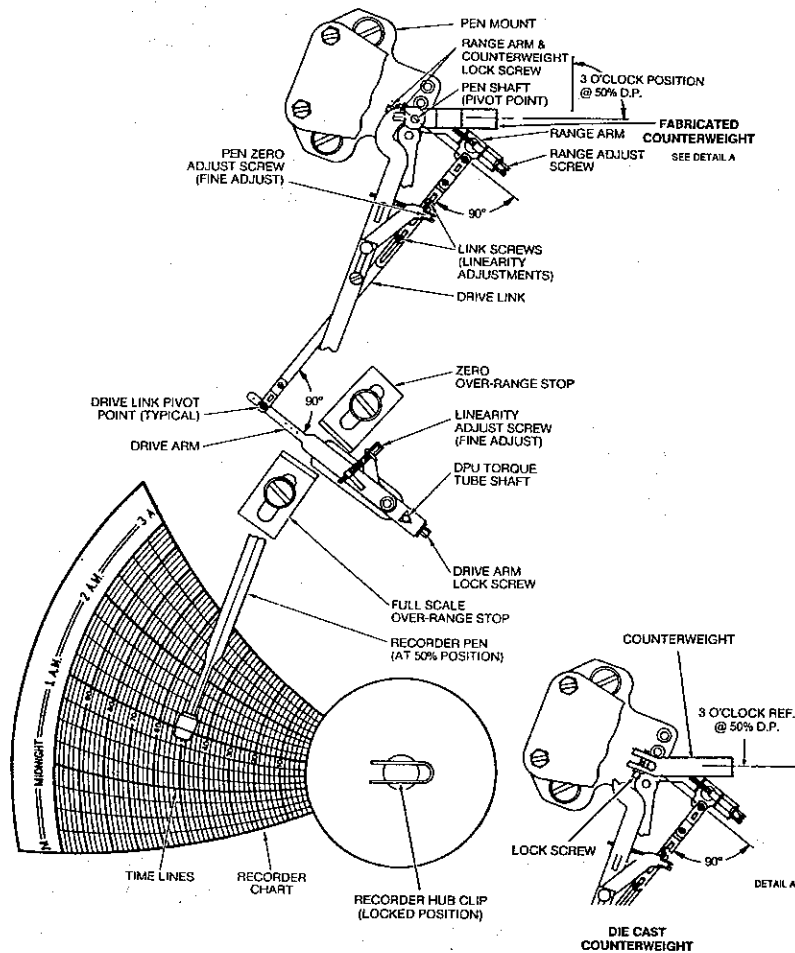
### Adjusting Pulsation Dampener

1. Remove dust cover and insert 1/8 hex key into needle valve.
2. Turn valve clockwise to closed position, approx. 3 turns.
3. Back out valve 1/2 turn, or as required to reduce pulsations or shock pressures.



### Recording Mechanism

The recording mechanism is a linkage and pen system that permanently records data. It converts mechanical inputs from the DPU and static pressure element to transcribe lines on a revolving chart. All operative parts of the recorder mechanism are made of stainless steel for a longer field life. The pen mount is exceptionally rugged. All lines are adjustable. Screw adjustments for zero, range, and linearity assure fast and accurate calibration. The **DP Pen mechanism** is shown below:

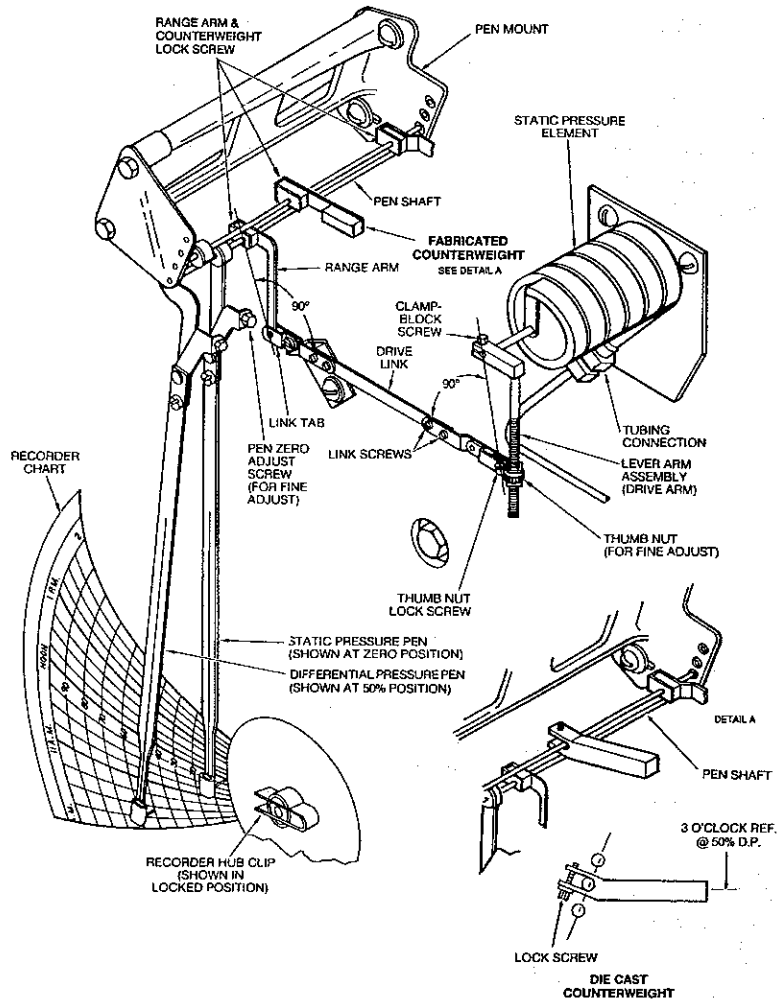




### Static Pressure Element

This element measures static pressure in a piping system from 0 to 30 inches of Hg (mercury) vacuum or from 0 to 10,000 psi. The sensor element is a bourdon tube consisting of a slightly flattened cross-section of tubing coiled into a helix or flat spiral. The outer end of the tubing is sealed and attached to a drive arm, which is attached to the static pressure connection tubing.

The **Static Pen mechanism** is shown below:



The static pressure connection is located on the back of the recorder case. Static pressure introduced through the tubing causes the spiral or helix to unwind. A reduction of pressure within the tubing causes the element to wind more tightly. Sensor elements are available in various alloys for a variety of pressure ranges.

*(See Static Pressure Element Table on next page.)*

**Static Pressure Element Table:**

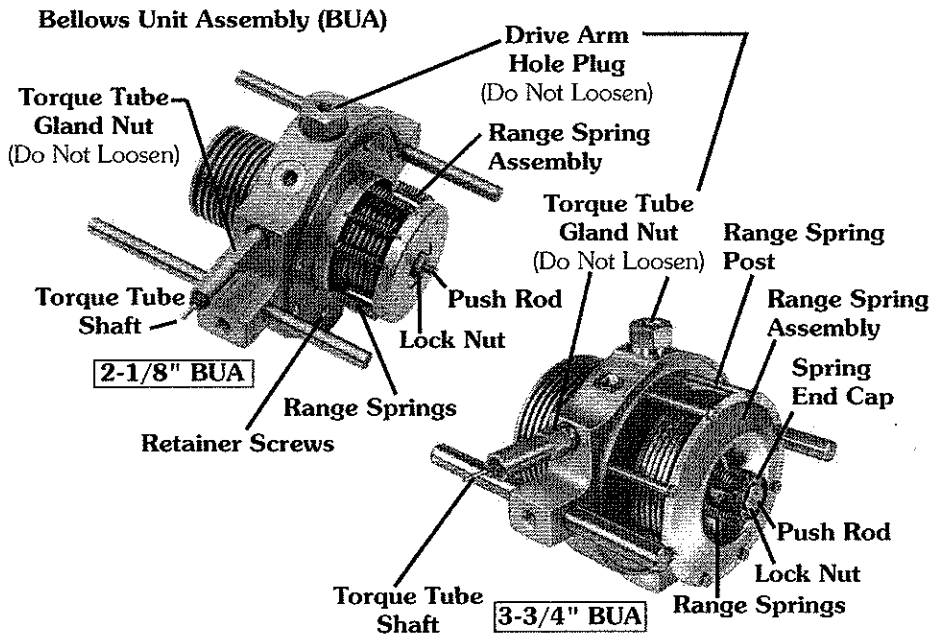
Range		Beryllium Copper Part Number	316 Stainless Steel Steel Part Number	Ni-Span "C" Part Number
0-20 to 0-33	psi	—	—	—
0-34 to 0-65	psi	0044.0028.T	0044.0040.T	0044.0102.T
0-66 to 0-120	psi	—	0044.0035.T	0044.0103.T
0-66 to 0-132	psi	0044.0029.T	—	—
0-121 to 0-180	psi	—	0044.0099.T	0044.0104.T
0-121 to 0-183	psi	—	—	—
0-133 to 0-240	psi	0044.0101.T	—	—
0-181 to 0-272	psi	—	0044.0036.T	0044.0105.T
0-184 to 0-264	psi	—	—	—
0-241 to 0-370	psi	0044.0097.T	—	—
0-265 to 0-390	psi	—	—	—
0-273 to 0-420	psi	—	0044.0044.T	0044.0106.T
0-371 to 0-600	psi	0044.0018.T	—	—
0-391 to 0-600	psi	—	—	—
0-421 to 0-615	psi	—	0044.0041.T	0044.0107.T
0-601 to 0-850	psi	0044.0098.T	—	—
0-616 to 0-850	psi	—	0044.0100.T	0044.0108.T
0-851 to 0-1200	psi	0044.0019.T	0044.0042.T	0044.0109.T
0-1201 to 0-1870	psi	0044.0020.T	0044.0046.T	0044.0110.T
0-1871 to 0-3100	psi	0044.0022.T	0044.0048.T	0044.0111.T
0-3101 to 0-4800	psi	0044.0024.T	0044.0050.T	0044.0112.T
0-4801 to 0-6800	psi	—	0044.0054.T	—
0-4801 to 0-7200	psi	0044.0026.T	—	0044.0113.T

### Chart Drive

Spiral wound chart drives (electrical or mechanical) can be selected to fit a wide variety of chart speeds or time intervals to reduce maintenance time. All chart drives are interchangeable and fitted with a flow recorder hub clip, which locks the chart in place. Explosion proof electrical drives are also available.

Rotation	Spring Wound		
	Lux Wind Part Number	Macnick (8-Day Wind) Part Number	Electric* 110V, 60 Cycle Part Number
96-Minute	—	—	0043.0001.T
2 Hour	0042.0022.T	—	—
3 Hour	0042.0023.T	—	—
4 Hour	0042.0024.T	Consult Factory	—
6 Hour	0042.0025.T	—	—
8 Hour	0042.0026.T	—	0043.0006.T
12 Hour	0042.0027.T	—	0043.0002.T
24 Hour	0042.0015.T	0042.0001.T	0043.0003.T
72 Hour	—	—	0043.0008.T
7 Day	0042.0016.T	Consult Factory	0043.0004.T
8 Day	0042.0030.T	Consult Factory	—
30 Day	—	—	0043.0011.T
24 Hour-96 Minute	0042.0020.T	—	—
24 Hour-7 Day	0042.0017.T	—	—
24 Hour-8 Day	0042.0031.T	—	—

\*All electric Drive Rotation can be increased 60 times by the use of a 60 RPM motor.



## SECTION 2 - INSTALLATION/CALIBRATION CHECK

### General

The instrument should be inspected at time of unpacking to detect any damage that may have occurred during shipment.

### Standard Practice Considerations

The following practices should be observed upon installation:

1. The distances between the primary device and the DPU should be minimized. Distances exceeding 100 feet are not recommended. For distances up to 50 feet, use 1/4-inch or 2/8-inch pipe or tubing. For runs of 50 to 100 feet, use 1/2-inch pipe or tubing. *The recommended limitation does not apply when an air purge or blow-back system is used.*
2. Slope all piping at least 1-inch/linear foot to avoid liquid or gas entrapment.
3. Provide two feet of uninsulated piping between the DPU and the primary device for each 100°F (+37.8°C) in excess of 200°F (+93.3°C).
4. Assure that the temperature of the DPU never exceeds 180°F (+162°C). When steam tracing is necessary, the steam pressure should not exceed five pounds per square inch and insulation should not be used. If pressure must exceed five pounds per square inch, limit the length of tubing around the DPU to two turns and do not insulate.
5. Install a suitable pulsation dampening device upstream of DPU. Severe pulsation will affect the accuracy of flow measurement. Avoid severe pulsating flows, such as reciprocating pumps or compressors.
6. Mount the DPU on a solid support to minimize vibration. Tighten all points, using a suitable compound. Leaks in piping can cause measurement errors.
7. Rotate the housing as necessary to place the connection in the proper position. The DPU has connections in the pressure housings to accommodate various pipe sizes (See Section 5).
8. Install a valve manifold connecting the DPU and the source of differential pressure to facilitate operation and checking of the DPU.
9. Locate all shutoff and bypass valves so they are accessible from the front of the instrument. Locate block valves at the source of differential pressure.

### Application Considerations

**Flow** — Make sure the DPU high pressure housing is connected to the upstream tap of the primary device. **Note:** To prevent overheating the DPU during blowdown, the operator should monitor the temperature by placing a hand on the pipe between the DPU and the manifold pipe containing the vent valves.

**Liquid Level** — The process media can be used as a reference leg seal fluid when it is of a type that will condense in the reference leg under all conditions. If process or process media characteristics prevent meeting the above requirements, a special reference leg seal fluid will be required. The special seal fluid must not be volatile and must not be miscible with the process media. Also, the difference in the densities of the special seal fluid and the process media will require compensation in calculating the DP range of the DPU.

### WARNING

**Explosion Hazard. No Organic compounds, oil, grease, dirt, or scale of any kind can be tolerated in an oxygen installation.**

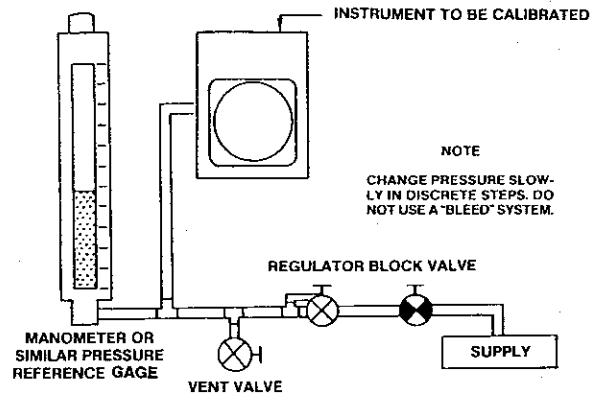
### Calibration Check

**Note:** There should be enough pen pressure to produce a continuous line. The pen should spring free of chart when chart is pushed inward about 1/8-inch. If necessary, adjust pen pressure by bending pen arm in the required direction.

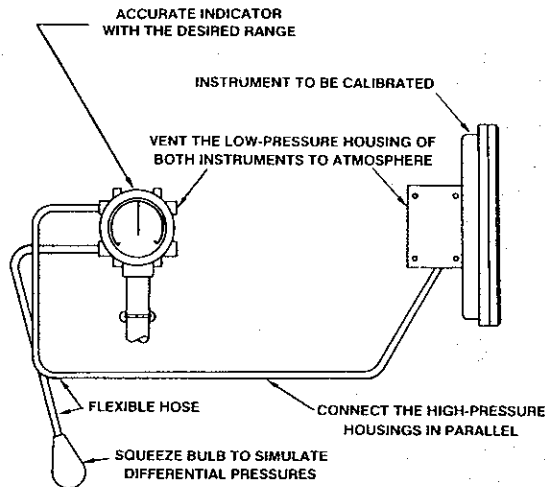
#### A. Differential Pressure Pen

To adjust the instrument to factory set calibration levels:

1. Verify the instrument is positioned approximately level and is securely mounted.
2. Connect the high pressure housing into the calibration setup:



TYPICAL CALIBRATION SETUP



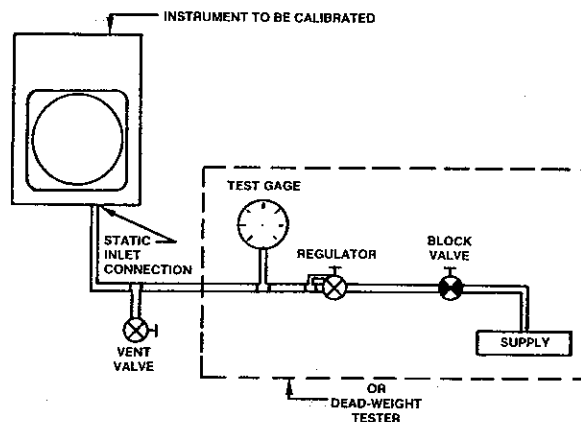
PORTABLE CALIBRATION SETUP

3. Vent the DPU low pressure side to atmosphere by removing one vent plug from the low pressure housing.
4. Remove the dust cap of the pulsation dampener valve, using a regular screwdriver. Open the dampener valve by turning it fully counterclockwise until it stops turning (using a 1/8-inch Allen wrench).
5. Place a recording chart onto the chart plate. Lock the chart into position with the hub clip.
6. Set the pen precisely at zero, using the pen zero adjustment screw.
7. Apply 100% pressure. Verify that the pen moves across scale to the 100% pressure indication.
8. Apply 50% pressure. Verify that the pen indicates 50% pressure on the chart.
9. If the pen does not accurately indicate the pressure being applied, further adjustments are necessary; perform the calibration procedure outlined in DP Pen Calibration on page 13.

**B. Static Pressure Pen**

If the instrument includes a static pressure element, use the following to check the static calibration:

1. Connect the static pressure element into the calibration setup:



2. Release pressure. Set the pen to zero, using the zero adjustment screw.
3. Apply 100% pressure. Verify that the SP pen moves across scale to the 100% pressure indication.
4. Apply 50% pressure. Verify that the SP pen indicates 50% pressure on the chart.
5. If the pen does not accurately indicate the pressure being applied, further adjustments are necessary; perform the calibration procedure outlined in SP Pen Calibration on page 17.

## **Recorder Mounting**

### **Notes**

*Before installation, perform a calibration check (page 8). Do not place unit near vents or bleed holes that discharge corrosive vapors or gases. Do not apply wrench/bar pressure to recorder case. All fittings must be leaktight. All tubing must be secure to minimize vibration. Mount the instrument as level as possible.*

1. Flush Mounting
  - a. Cut opening in panel to the dimensions shown in Section 5.
  - b. Drill out pilot holes located on top and bottom of case. Use a No. 1 (0.288) drill. Limit drill penetration and remove chips.
  - c. Attach mounting brackets to case bottom with supplied self-tapping screws.
  - d. Slide case (from front of panel) into the panel cutout.
  - e. Attach remaining mounting bracket and install panel mounting screws.
2. Pipe Mounting
  - a. Place a suitable length of 2-inch pipe into a well-secured floor or wall flange; or attach the 2-inch pipe to existing pipe with a saddle that is fitted with a 2-inch NPT outlet.
  - b. Thread the DPU onto the pipe, orient the instrument (with wrench or bar applied to the DPU bracket only), and tighten retaining screws.

## **Piping**

Connect the pressure element to system pressure using tubing or pipe. Pressure connection on outside of recorder case is 1/4-inch NPT, female.

## **Electrical Connections**

Two knockouts are on the bottom of the case. One knockout is on the back of the case to accommodate conduit clamping connections, through which wiring is fed to the terminal strip. The terminal strip is below the chart drive motor. The standard electrical power supply requirement is 110 VAC, 60 Hz (50 Hz wiring available upon request).

## **Chart Installation**

Perform the following steps to install the chart:

1. Open the recorder door and release the chart lock (on chart drive hub).
2. Raise the pen lifter arm and slide the chart between the pen(s) and the chart plate. Insert the chart in the chart guides in the chart plate, and locate the hole in the chart onto the chart hub. Place the pressure chart onto the chart hub. Then, lower the pen lifter arm and position the chart to place the pen(s) on the desired chart time line.
3. Secure the chart in place with the chart hub lock.

## **Startup**

**Note:** Be careful not to subject the DPU to unnecessary shock or overrange pressure during operations.

1. Always start with the block valves closed. **Note:** Do not perform a zero check with only one block valve closed. If seal pots are used, some of the sealing fluid will be lost or displaced. In gas service, a standard wave effect may occur that will displace the zero reading.

2. Perform a **zero check** on the instrument, per the following:

**For Gas Service:**

- a. Verify the instrument is mounted approximately level and is properly connected to the pressure source.
- b. Tighten process connections to each DPU housing. Check manifold and piping for leaks:
  - 1) Close shutoff valves, open the equalizer or bypass valve(s), and then slowly open one shutoff valve to pressurize the instrument.
  - 2) When system is pressurized, close both valves opened in Step 1.
  - 3) Any leakage will be indicated by pen movement, up or down the scale. If leakage is indicated, check all manifold and piping joints. Tighten as necessary.
  - 4) Repeat Steps b.1) through b.3) until no pen movement occurs.
- c. The pen should indicate zero. If it does not indicate zero, check for gas or liquid entrapment in the lines or in the DPU (depending upon orientation of piping and service). If no entrapment is found, set the pen to zero using the pen zero adjustment screw.
- d. Close equalizer valve and observe the pen:
  - 1) If zero, no further check is needed.
  - 2) If upscale, a leak may exist on the low pressure side. Check and tighten connections.
  - 3) If downscale, a leak may exist on the high pressure side. Check and tighten connections.
  - 4) If still slightly off, make a fine adjustment using the pen zero adjustment screw.

**For Liquid Service:**

- a. Fill service lines with process fluid. Vent and bleed each side of the DPU before tightening the vent plugs.
  - b. Perform Steps 2.a. through 2.d. in **For Gas Service** procedure above.
  - c. Open shutoff valve. Leave the equalizer valve closed. Flow recorder is now operational.
3. Adjust the dampener valve as required.

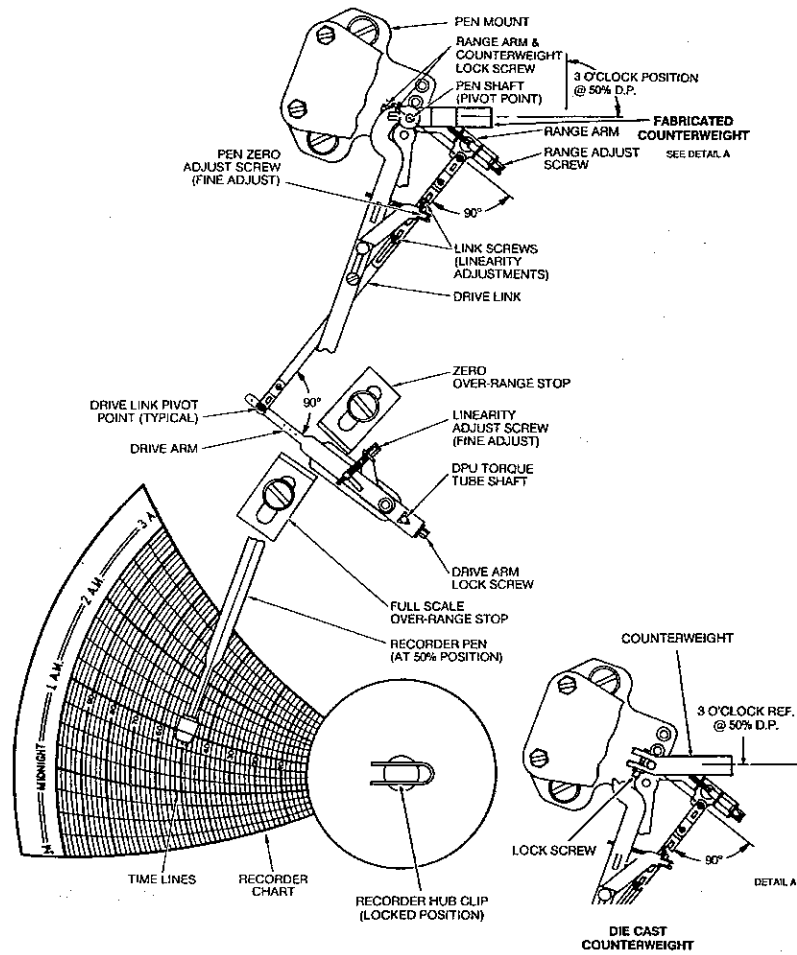
**Operation**

To place the instrument into operation:

1. Turn on the drive.
2. Verify that the pen has ink and is in contact with chart.
3. Turn on pressure to the recorder.



# DP Pen Mechanism



## SECTION 3 - MAINTENANCE AND CALIBRATION

### Required Tools

<b>Tool</b>	<b>Purpose</b>
1/2-inch Open-End Wrench	Pushrod - Bellows Cup Connection
Modified Box/Open-End 7/16-inch Wrench	Kickoff Spring Lock Nut
Torque Wrench (100 ft/lbs)	Pressure Housing Bolts
Screwdriver	Bracket Screws

### Maintenance

Generally, Barton recorders require no maintenance other than replacement of the chart, replenishment of the ink, winding of the spring-wound chart drives, and occasional calibration. In addition, the operator should periodically check the door seal for wear and the pressure fittings for tightness.

### Differential Pressure Pen Calibration (Refer to page 12)

To calibrate the DP pen:

1. Make sure chart plate is on same plane and flush with hub flange. The chart must be flat with the hub locked. Also, make sure the pens and pen arms are correctly connected and that they do not interfere with one another.
2. With a chart locked into place, move the pen from zero to full span and back to ensure that the pen travels along the time line. If adjustments are needed: loosen the two pen mount screws, adjust the pen mount position until the pen follows the time line, then tighten the pen mount screws.
3. Disconnect the differential pressure drive link from the range arm. Move both differential and static pressure pens to full span. Adjust the static pen so that pens are approximately 7-15 minutes apart by adjusting the static pen arm mounting location on the pen arm shaft assembly. Move both pens to the 50% indicating position. Ensure that the pens don't interfere with one another. Adjust static pens as necessary; do not alter the differential pressure pen once it has been adjusted to the time line.
4. Assure that there is enough pen pressure against the chart to produce a continuous line. If necessary, adjust the pen pressure by bending the arm in the required direction.
5. Unlock the flow recorder hub clip. Remove the chart and chart plate.

**Note** — Prepare a calibration chart by cutting a chart into the wedge shape and gluing it to a piece of similarly shaped cardboard of stiffener. This allows calibration of the pens and permits access to the flow recorder mechanism when linkage adjustments are necessary.

6. Mount a calibration chart onto the flow recorder hub. Lock the chart in place. Move overrange stops out of play.

**Notice** — Verify that all linkage is free. Adjust range arm and drive arm at precisely the same distance back of the case. Adjust the lever arm and pen zero adjust screws to their midpoints all 90° midscale linkage angles must be measured.

7. Apply 50% differential pressure to the high-pressure side. Arrange the differential pressure linkage as shown on page 12. Set a 90° angle between the drive arm and link. By varying the length of the link, set a 90° angle between the range arm and link. Slip the range arm to 50% on the chart.
8. Remove pressure. The pen should indicate zero. If the pen deviates less than 10% from zero in either direction, perform fine adjustment by using the pen zero adjust screw (refer to page 12) and proceed to step 8.b. If the pen deviates more than 10% from zero, make adjustments as follows:
  - a. Rotate pen arm and shaft by gripping the range arm and forcing (or slipping) the pen until it indicates zero. The pen arm and shaft should rotate at the range arm pivot point without loosening the range arm lock screw.
  - b. Apply 100% pressure. Make the necessary adjustment by turning the range arm adjust screw counterclockwise if the pen is slightly underranged and clockwise if the pen is slightly overranged. Repeat zero and 100% adjustments until calibration at these points is achieved.
  - c. Apply 50% pressure. The pen should be on the 50% chart line. If the pen is low, lengthen the linkage to make a correction 40 times as great in the low direction. Adjust the pen to 50% as in step 8.a. (refer to page 12). If the pen is high, shorten the linkage to make a correction 40 times as great in the high direction. Adjust the pen to 50% as in step 8.a. Assure all linkage screws are retightened.
9. Repeat step 8 until calibration of all three points (0, 50, and 100% indication) is achieved. To assure accuracy, a nine-point calibration check (1, 24, 50, 74, and 100% ascending and descending) must be run.

**Adding Counterweight to #2 Pen (DP)** (Refer to page 12)

A. Fabricated Counterweight

For 3 or 4 Pen Flow Recorders:

1. Disconnect the drive link from the range arm.
2. Remove the #2 pen from the pen mount (note approximate position from range arm).
3. Remove the range arm from the shaft, and slip the counterweight to about mid point. Position approximately as shown on page 12 and secure in place. Replace the range arm to approximate position (note step 2) and secure in place.
4. Reassemble in pen mount and prepare for calibration.

For 2 Pen Flow Recorders:

1. Disconnect the drive link from the range arm.
2. Remove the #2 pen from the pen mount.
3. Slip the counterweight over the shaft in front of the pen (shaft length is approximately 9/16") and position approx. as shown on page 12 and secure in place.
4. Reassemble in pen mount and prepare for calibration.

B. Die Cast Counterweight

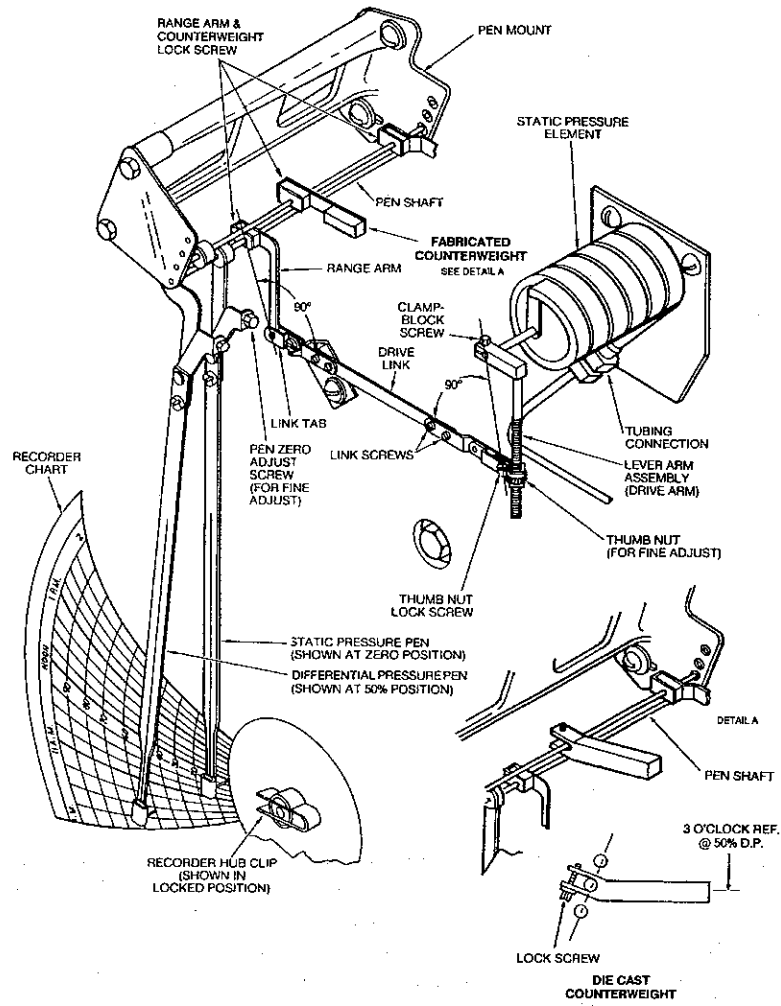
These counterweights slip over the pen shaft without disassembly. This is applicable to a 2 pen or 3 pen assembly:

1. Remove lockscrew from counterweight.
2. Slip over #2 shaft at any convenient location. Replace lockscrew carefully, orienting the counterweight in the position shown on page 12.  
**Note:** The counterweight is die cast zinc, subject to bending if too much torque is applied to the lockscrew.

C. Calibration

1. After removal of the range arm, complete recalibration is required. In the previous section CALIBRATION OF DIFFERENTIAL PRESSURE PEN, include step 7: set the counterweight to the 3 o'clock position shown on page 12 with the differential set at 50%.
2. After the addition of the counterweight in front of the DP (#2) pen, apply 50% differential and set the counterweight at the 3 o'clock position.  
1-5. The addition of the counterweight causes a zero offset, but has little effect on span. Reset zero, check span and adjust as necessary.
3. After addition of the die cast counterweight, orient to 3 o'clock position at 50% differential as shown on page 12. Reset zero and check span. Adjust as necessary for proper calibration.

# SP Pen Mechanism



**Static Pressure Pen Calibration** (Refer to page 16)

To calibrate the static pressure pen and associated linkage, proceed as follows:

1. Adjust the static range arm and drive arm at precisely the same distance from the back of the case.
2. Place static drive link in the fourth hole from the pen shaft of the range arm.
3. Adjust static pressure linkage to form 90° angles between the drive link (see above illustration) and pivot points of the associated linkage, as follows:
  - a. Apply 50% static pressure, center thumb nut on the drive arm, and arrange static linkage as shown on page 16.
  - b. Set a 90° angle between drive arm & link. Tighten clamp block screw.
  - c. Vary the length of link to get a 90° angle between range arm and link.
  - d. Slip the range arm on pen shaft to 50% on chart.

**Notice** — Verify that all linkage is free. Adjust range arm and drive arm at precisely the same distance back of the case. Adjust the lever arm and pen zero adjust screws to their midpoints all 90° midscale linkage angles must be measured.

4. Release pressure and reset the pen to zero indication, using pen zero adjust screw for fine adjustment (10% or less). For major adjustments (more than 10%), loosen range arm lock screw and slip the pen to zero on chart and retighten lock screw.

**Note** — It may be necessary to raise or lower the pivot point of the drive link on the range arm, as in step 3. If counterclockwise movement of thumb nut (step 5) does not increase span sufficiently, move the pivot pin up to next pivot hole; if clockwise, movement of the thumb nut does not decrease span sufficiently, move pivot pin down to the next pivot hole.

5. Apply 100% pressure and observe the pen. Make the necessary adjustments by turning the drive arm thumb nut counterclockwise if the pen is slightly underranged and clockwise if the pen is slightly overranged. Repeat zero and 100% adjustment until calibration at these two points is achieved.
6. Repeat steps 3, 4, and 5 until full scale calibration is obtained.
7. Apply 50% pressure and observe pen indication.
  - a. If pen indicates high or low, adjust drive link to make a correction approximately 40 times the error — in the direction of the error.
  - b. Reset the pen to the 50% line by slipping the pen shaft at the range arm pivot point.
  - c. Repeat this step (7), as necessary.
8. Release pressure and reset the pen to zero indication, using pen zero adjust screw for precise adjustment.
9. Repeat steps 4 through 8 until calibration of zero, linearity, and span (0%, 50%, and 100% indication) is achieved.
10. Assure range arm lock screws, thumb nut lock screw, and link screws are tight.
11. Reconnect the DP link and range arm.
12. Unlock the recorder hub clip and remove temporary calibration chart.
13. Replace the chart plate by sliding it into the chart plate retainer brackets and engaging each side into the chart plate latches.

### **Static Pressure Element Replacement**

If the static pressure element needs replacement, proceed as follows:

1. Close all valves and turn off the power switch to the recorder.
2. Separate the drive link arm by opening the link table and disengaging the pivot pin from the clamp.
3. Loosen the clamp block screw on the lever arm assembly and separate the drive arm from the static pressure element shaft.
4. Disconnect the tubing from the static pressure element at the tubing connection (refer to page 16).
5. Remove the mounting screws from the static pressure element and discard the damaged element.
6. Install the new element, using the old mounting screws.
7. Connect tubing to the element at the tubing connection.
8. Assemble the lever arm assembly onto the static pressure element shaft; do not tighten the clamp block screw yet.
9. Connect the drive link to the drive arm by engaging the pivot pin and locking the link tab into place.
10. Align the static pressure linkage (range arm, drive link, and drive arm) so that it lies in the same plane without binding or bending.
11. Tighten clamp block screw.
12. Calibrate in accordance with the procedure outlined in SP Pen Calibration on page 17.

### **Chart Drive Replacement**

To replace the chart drive, proceed as follows:

1. Release the pressure to the recorder.
2. Turn off the chart drive.
3. Raise the pen lifter and remove the chart and chart plate.
4. Remove chart drive mounting screws and remove chart drive.
5. Position new chart drive at the back of recorder case and attach with mounting screws.
6. Replace chart plate and chart. Lower the pen to the recording position.
7. Check the time line on first pen from chart, zero, and span elements.

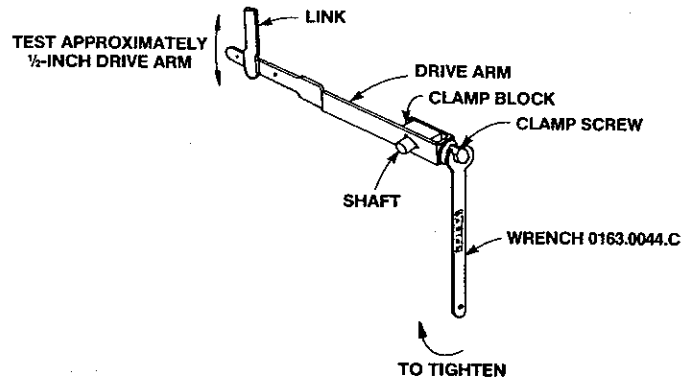
### **Linkage Adjustments** (see linkage illustration on page 19)

#### A. Range Arm and Drive Arm Lock Screws:

**Note:** Tightening lock screws fingertight is often not tight enough, but tightening them more than a full turn often breaks them.

1. Tighten the lock screw until snug.
2. Hold the drive arm at the clamp block by hand or with a 1/4-inch open wrench. If a wrench is used, place it between the torque tube shaft and the lock screw, taking care not to damage the torque tube shaft or bearing. (In the case of the range arm lock screw, place the wrench between the shaft and lock screw.)
3. Tighten the lock screw 1/3 to 1/2 turn beyond snug.

A. Range Arm and Drive Arm Lock Screws (Continued)



4. Test for tightness by moving free end of drive arm approximately 1/2-inch in either direction. Drive arm should spring back without yielding.

B. Overage Stops Adjustment (Refer to pages 2 and 12)

**Note** — Prepare a calibration chart by cutting a chart into the wedge shape shown on page 12 and gluing it to a piece of similarly shaped cardboard of stiffer. This allows calibration of the pens and permits access to the flow recorder mechanism when linkage adjustments are necessary.

Overrange stops may be adjusted to prevent the pen from excessive overtravel (check for interference at zero and full span), per the following:

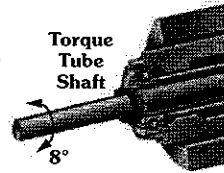
1. Unlock the flow recorder hub clip. Remove the chart.
2. Remove the chart plate by disengaging the chart plate latches on both sides and sliding the chart plate retainer brackets.
3. Mount a calibration chart onto the flow recorder hub and lock in place.
4. Loosen the screws on zero and full scale overrange stops.
5. Vent the DPU low-pressure housing. Apply sufficient pressure to the high-pressure housing to move the pen approximately 3/8-inch above 100% indication.
6. Position the zero overrange stop so that it contacts the drive arm.
7. Tighten the zero scale overrange stop screw.
8. Apply sufficient pressure to the DPU low-pressure housing to move the pen approximately 3/8-inch below zero indication.
9. Position the full scale overrange stop so it is in contact with drive arm.
10. Tighten the full scale overrange stop screw.
11. Unlock the flow recorder hub clip. Remove temporary calibration chart.
12. Replace the chart plate by sliding it into the chart plate retainer brackets and engaging each side into the chart plate latches.
13. Install a regular recorder chart and lock it into place with chart hub clip.
14. Check the pens to make sure that they touch the chart; if necessary, straighten pens by sliding them between two fingers and curling in and out.



### **DPU Replacement**

Before installing a replacement DPU, the new DPU should be checked for proper torque tube rotation:

1. Mount the DPU on a suitable pipe stand and connect to a standard pressure source.
2. Adapt a graduated degree scale to torque tube housing.
3. Adapt a pointer to exposed end of the torque shaft.
4. Apply 100 percent differential pressure to the high-pressure housing of the DPU. The pointer attached to the torque tube shaft should indicate 8 degrees of travel.



### **DPU Cleaning and Inspection**

#### **WARNING**

**(HIGH-PRESSURE GAS INSTALLATIONS AND PRESSURES GREATER THAN 200 PSIG)**

**HIGH-PRESSURE GAS HAZARD ON DISASSEMBLY OF THE DPU. BEFORE REMOVING THE DPU HOUSING BOLTS, PERFORM THE PRESSURE CHECK PROCEDURE (See STEP "A" below).**

*Notice – If accumulation of solids or semi-solids is extensive, remove the housings carefully to prevent damaging the bellows.*

#### **A. Pressure Check Procedure**

#### **WARNING**

**FAILURE TO PERFORM THIS PROCEDURE CAN RESULT IN SEVERE INJURY, DEATH OR SUBSTANTIAL PROPERTY DAMAGE DUE TO THE RELEASE OF INTERNAL PRESSURE.**

This procedure should be performed prior to removing the DPU housing bolts, if the DPU has been installed in gas applications with working pressures greater than 200 psig.

1. Back off all housing bolts 4 turns.
2. Check for internal pressure by attempting to move the housing in and out along the bolts.
  - a. If the housing moves freely – no pressure is present – servicing or repair may continue.
  - b. If the housing does not move freely – the bellows may be pressurized and is potentially hazardous if further disassembled.  
Tighten the bolts and return the unit to the factory or authorized NuFlo service center for repair.  
Tag the unit and specify "Gas in Bellows".

#### **B. Cleaning/Inspection Procedure**

Instruments used where solids or semi-solids may accumulate inside the pressure housings require periodic inspection and cleaning, as follows.

1. Remove the DPU from service and remove the pressure housings.
2. Carefully remove the pressure housings from the bellows unit assembly.

**CAUTION**

**IF THE ACCUMULATION OF MATERIAL INSIDE THE HOUSING IS EXTENSIVE, RAPID REMOVAL OF THE HOUSING MAY DAMAGE THE BELLOWS CONVOLUTIONS.**

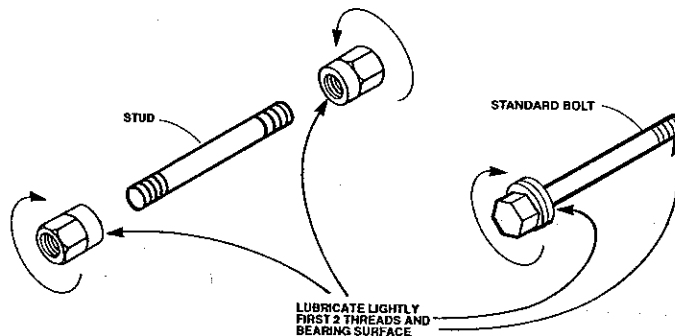
3. Remove the accumulation from between the bellows convolutions and from the inside of the housings. Use a solvent if possible. Do not use a sharp instrument to clean between convolutions.
4. Assure that there are no broken range springs.
5. Replace the housings and O-rings.
6. Set the pressure housing bolts to the **TORQUE VALUES** listed below:

Housing		Bolt				Lube (Note 1)	Torque Lb/Ft (Note 2)	Rotation Degrees (Note 3)
SWP	Matl.	Matl.	Size	Qty.	Part No.			
1000	SST Alum.	Steel	3/8-16 x 4.2	12 6	0199.1345.C	Yes	40 40	180 270
2500 3000	Steel	Steel	1/2-13 x 5.5	6 8	0199.0085.C	Yes	95	180
3000	SST	Steel	1/2-13 x 5.5	12	0199.0085.C	Yes	80	180
4500	Steel	Steel	1/2-13 x 5.5	12	0199.0085.C	Yes	95	180
6000	Steel SST	Steel	1/2-20 x 6	12	0199.1346.C	Yes	105	180
		Steel Nut	1/2-20	12	0199.1002.C	Yes	105	180 (Note 4)
		Steel Stud	1/2-20 x 6.6	12	0199.1001.C	Yes	105	180
		Steel Nut	1/2-20	24	0199.1002.C	Yes	105	180 (Note 4)

**NOTES:**

- (1) Lubricants: Molykote G paste, Teflon-base pipe dope, graphite-base grease, or similar lubricants. Lube first 2 threads only.
- (2) Torque on bolts is accomplished in 3 or 4 steps. Tighten UNIFORMLY.
- (3) Rotation of bolt head is measured after bolt is "snug", with approximately 5 lb/ft torque. **DO NOT EXCEED THIS ROTATION.** To tighten bolts without torque wrench, use rotation values.
- (4) Rotation reference for bolt with nut is the sum total of bolt head plus nut, or total of 2 nuts.

**ROTATION OF HEAD BOLT  
AND NUTS WHEN TIGHTENING**



### **Range Change**

Changing the range of the Model 199 DPU requires replacing the bellows unit assembly with a unit of the desired range (see BUA Replacement, page 25).

#### **WARNING**

#### **(HIGH-PRESSURE GAS INSTALLATIONS) (PRESSURES GREATER THAN 200 PSI)**

**HIGH-PRESSURE GAS HAZARD ON DISASSEMBLY OF THE DPU.  
BEFORE REMOVING THE DPU HOUSING BOLTS, PERFORM THE  
PRESSURE CHECK PROCEDURE**

*(See Cleaning and Inspection on page 20).*

**NOTE** — The calibration range of the DPU was carefully set at the factory. The following procedure maintains the original factory bellows travel setting while the range spring change is performed. **This procedure must be strictly followed while changing the range spring assembly or altering the adjustment.**

To replace the range spring assembly with either a new assembly of the same range or one with a different range value, proceed as follows (this procedure assumes that the DPU is either connected to an indicating instrument or fitted with a scale and pointer to measure torque tube shaft movement):

#### **A. 2-1/8-Inch Diameter Bellows**

1. Remove the DPU from service.
2. Remove the pressure housing bolts and the low-pressure housing.
3. With the pointer at zero, remove the spring retainer screw, retainer springs, and the range spring assembly.

**NOTE** — The pointer will shift from zero. This is a normal action and the pointer should not be readjusted at this point.

4. Install the new range spring assembly onto the push rod, and replace the spring retainer screw.
5. If the pointer is set above zero, rotate the spring adjustment clockwise until the pointer is set at zero. If the pointer is below zero rotate the spring adjustment counterclockwise until the pointer is set at zero.
6. Replace and tighten the lock nut. If the pointer shifts from zero, loosen the lock nut and reset the pointer as in step 5. Tighten the lock nut.
7. Replace the low-pressure housing and bolts (new gaskets are recommended). Use the torque values listed on page 21.
8. Calibrate in accordance with the technical manual for the actuated instrument.

#### **B. 3-3/4-Inch Diameter Bellows Without Kickoff Spring (above 50-inches w.c.)**

1. Remove the instrument from service.
2. Remove the pressure housing bolts and the low-pressure housing.
3. With the pointer set at zero, remove the lock nut retainer nuts, and the range spring assembly. To remove the range spring assembly, rotate the assembly counterclockwise while pulling outward on the assembly.

**NOTE** — The pointer will shift from zero. This is a normal action and the pointer should not be readjusted at this point.

B. 3-3/4-Inch Diameter Bellows Without Kickoff Spring (Continued)

4. Thread the new assembly onto the push rod, and align the holes in the range spring assembly with the spring posts. Replace and tighten the retainer nuts.
5. Using a spanner wrench, rotate the spring adjustment until the pointer is set at exact zero. Replace and tighten the lock nut. The pointer must remain at the zero setting. If the pointer shifts from zero, loosen the lock nut and repeat this step.
6. Replace the low-pressure housing and bolts (new gaskets are recommended). Use the torque values listed on page 21.
7. Calibrate in accordance with the technical manual for the actuated instrument.

C. 3-3/4-Inch Diameter Bellows With Kickoff ("anti-stick") Spring

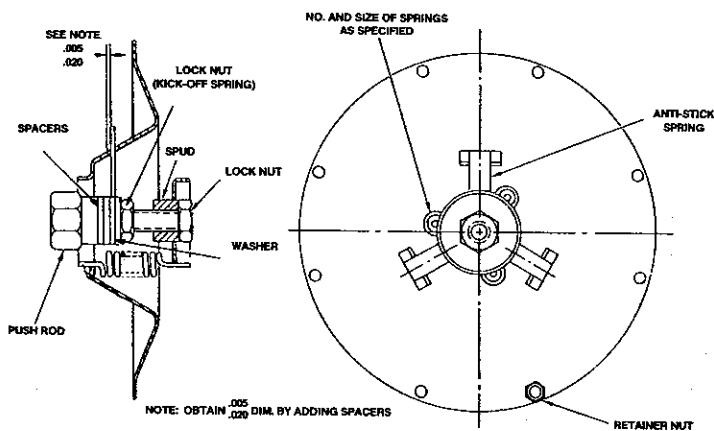
**NOTE** — The kickoff spring is supplied with the 0-40" w.c. and lower range DPUs as standard equipment. It is optional with 0-50" w.c. DPUs.

1. Remove the instrument from service. Set the pointer (or pen) at zero, using the instrument zero adjustment.
2. Remove the pressure housing bolts and remove the low-pressure housing.
3. With the pointer set at zero, remove the lock nut, four spring retainer nuts, washer and lock nut, and range spring assembly.

**NOTE** — The pointer will shift from zero. This is a normal action and the pointer should not be readjusted at this time.

4. Install the range spring assembly, using a 1/2-inch open-ended wrench to connect the push rod to the low-pressure bellows cup.

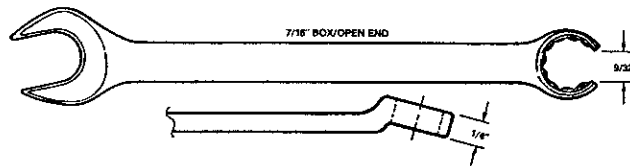
**NOTE** — The range spring assembly consists of the range springs, kickoff spring assembly, and the push rod. The assembly is furnished as a complete and assembled unit.



5. Position the range spring assembly over the retainer posts and replace the retainer nuts.

6. Insert the tubing between the range springs and tighten the inboard lock nut.
7. Zero the pointer by adjusting the spud on the push rod. Be sure that the kickoff spring is not engaged during this operation.
8. Position the kickoff spring to prevent interference with the coil springs and tighten the kickoff spring lock nut. If clearance is needed for the wrench during this operation, note the position of the spud (measure with a scale or count threads to the end of the push rod) and move the spud for the required clearance. After the lock nut is tightened, return the spud to the original position.

**NOTE** — The lock nut requires a special wrench for tightening. See illustration below for information on how to modify a 7/16-inch, 12 point box wrench:



9. Check the back-clearance between the kickoff spring and the slot. Use a wire feeler gage or comparable measuring device. The clearance will vary between each individual slot but must be at least 0.005-inch for any one slot to prevent interference with instrument zero. Add or remove washers as required to obtain the proper clearance. Tighten the lock nut securely.
10. Install the jam nut and lock the spud to the push rod. Hold with pliers. If the spud was moved in step 9, return the spud to the proper position before tightening the jam nut.
11. Apply 100 percent negative pressure to the high-pressure side of the DPU and repeat the clearance check and adjustment of step 9.
12. Apply 100 percent positive pressure to the high-pressure side of the DPU and repeat the clearance check and adjustment of step 9.
13. Release all pressure from the instrument and replace the low-pressure housing. Use new gaskets.
14. Replace the housing bolts. Use the torque values listed on page 21.

#### **Setting Bellows Travel**

The travel of the DPU bellows must be adjusted if one of the following occurs.

1. The range spring assembly is removed without following the procedure.
2. Broken range springs are replaced.
3. The indicator pointer has excessive overtravel.
4. The indicator pointer has excessive undertravel.

To set the bellows travel requires that the DPU be attached to the actuated instrument and connected to a test pressure source. The procedure for this adjustment is presented in the technical manual of the actuated instrument.

**Bellows Unit Assembly (BUA) Replacement** (Refer to page 6.)

**WARNING**

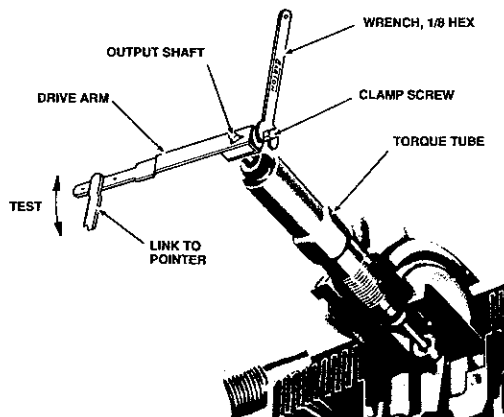
**(HIGH-PRESSURE GAS INSTALLATIONS AND PRESSURES  
GREATER THAN 200 PSI)**

**HIGH-PRESSURE GAS HAZARD ON DISASSEMBLY OF THE DPU.  
BEFORE REMOVING THE DPU HOUSING BOLTS, PERFORM THE  
PRESSURE CHECK PROCEDURE ON PAGE 20).**

**NOTES** — Support the DPU during disassembly. Do not loosen the drive arm hold plug located in the top of the BUA center plate, when removing the mounting bracket. If the plug is loosened, the bellows fill fluid will be lost.

The reference designations (#) relate to 199 Parts Drawing on page •••

1. Disconnect the DPU piping and remove the instrument from service.
2. Loosen the actuated instrument drive arm and slide off of the torque tube shaft. Do not disconnect the instrument linkage.
3. Remove the four case-retaining screws and remove the case assembly.
4. Remove three mounting bracket screws and remove bracket (18).
5. Remove the pressure housings bolts and pressure housings (26).
6. Place the pressure housings (26) on the replacement bellows unit assembly (1) and insert and start (only) the pressure housing bolts.
7. Attach the case mounting bracket (18) to the replacement assembly, using three mounting bracket screws.
8. Support the DPU and tighten and torque the pressure housing bolts to the specifications listed on page 21.
9. Attach the case assembly using four case retaining screws.
10. Attach linkage to DPU torque tube shaft.
  - a. Tighten clamp screw until "snug."
  - b. Tighten further, 1/3 to 1/2 turn of screw.
  - c. Test by moving end of drive arm, approx. 1/2".
11. Replace/adjust components removed or moved to gain access to DPU case mounting screws.
12. Calibrate the instrument before returning it to service.



## SECTION 4 - TROUBLESHOOTING

**Recorder Troubleshooting Table**

Problem	Possible Sources	Probable Cause	Corrective Action
Low or No Indication	Mechanism	Loose links or movements	Tighten or replace
		Out of Calibration	Recalibrate
		Corrosion or dirt in mechanism	Clean or replace
	Pen arm	Pen arm loose	Tighten
High Indication	Mechanism	Pen arm bent	Straighten or replace pen arm
		Loose links or movements	Tighten or replace
Erratic Indication	Mechanism	Out of calibration	Recalibrate
		Excessive vibration	Secure the means of mounting
	Mechanism	Linkage dragging or dirty	Adjust or clean
No Chart Rotation	Chart Drive	Excessive pen pressure on chart	Adjust
		Fuse Blown	Check and Replace Fuse
		Electric drive not turned on	Turn on Chart Drive
	Defective Drive	Replace Drive	
Wrong Chart Speed	Chart Hub Lock	Clock motor not wound	Wind Chart Drive
	Chart Drive	Lock not latched	Latch Hub Lock
		Wrong Chart Drive	Replace with proper Chart Drive

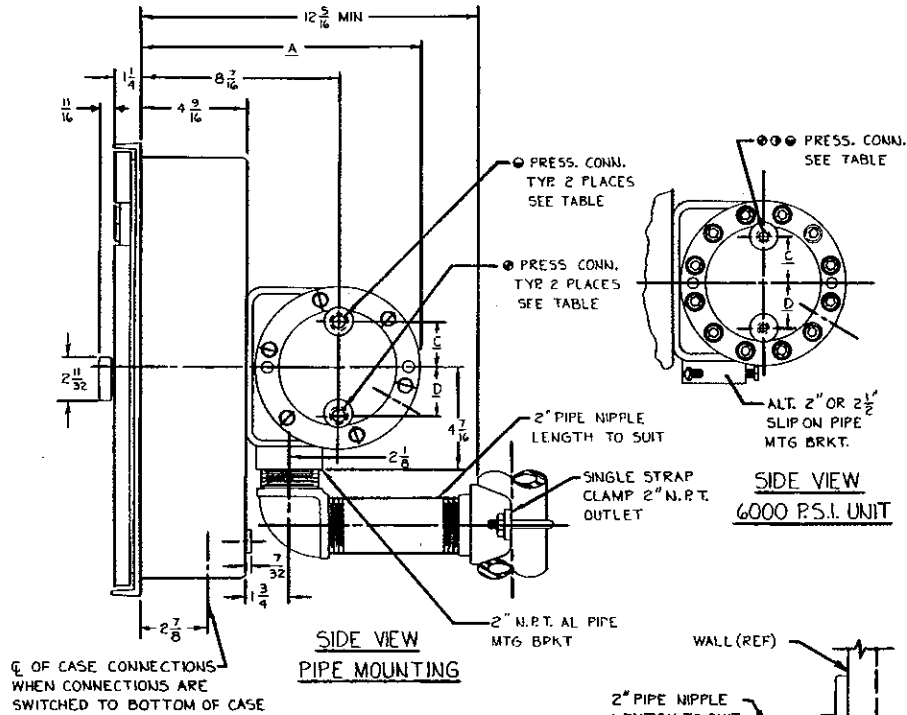
**DPU Troubleshooting Table**

Problem	Possible Sources	Probable Cause	Corrective Action
Low or No Indication	Primary Element or DPU	Orifice Installed Backwards or Oversized	Replace Orifice
		Flow Blocked Upstream from Run	Clean Out Run or Open Valve
		Loss of Liquid in Reference Leg (Liquid Level)	Refill Reference Leg
	Piping from Primary Element to DPU	Density Changes in Process Media or Reference Leg	Refill Reference Leg with Same Density Liquid as Process Media
		Pressure tap holes plugged and/or Piping Plugged	Clean Out Piping
		Bypass Valve Open or Leaking	Close Bypass Valve(s) or Repair Leaks
		Liquids or Gases Trapped in Piping	Vent Piping
		Block or Shut-off Valves Closed	Open Block or Shut-off Valves
	Bellows Unit	Piping Leaks on High Pressure Side	Repair Leaks
		Housings Filled Up with Solids Restricting Bellows Movement	Clean Out Housing
		Gas Trapped in Housing in Liquid Service or Liquid Trapped in Housing in Gas Service	Vent Housing
		High Pressure Housing Gasket Leaks	Replace Gasket
		DPU Tampered With	Return BUA for Repair
High Indication	Primary Source	Orifice Partially Restricted or too Small	Clean Out or Replace
	Piping from Primary Element to DPU	Leak in Low Pressure Side Piping	Repair
	Bellows Unit	Gas Trapped in Low Pressure Housing in Liquid Service or Liquid Trapped in Housing in Gas Service	Vent Housing
		Low Pressure Housing Gasket Leaks	Replace Gasket
		Range Spring Broken or DPU Tampered With	Return BUA for Repair
Erratic Indication	Primary Element	Flow Pulsating	Install Dampening Device Upstream of DPU Run
	Piping from Primary Element to DPU	Liquid Trapped in Gas Piping or Gas Bubble in Liquid Piping	Remove
		Vapor Generator Incorrectly Installed	Repipe
		Reference Leg Gassy or Liquid Vaporizing	See Piping Instructions
	Bellows Unit	Obstructed Bellows Travel	Clean Bellows
		Gas Trapped in DPU High Pressure or Low Pressure Housing	Remove (See Startup Procedure)



## SECTION 5 - INSTALL/DIMENSIONAL DRAWINGS

**Model 202E (0202-1010-3)**



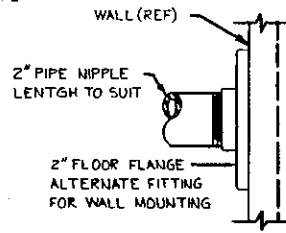
☉ OF CASE CONNECTIONS WHEN CONNECTIONS ARE SWITCHED TO BOTTOM OF CASE

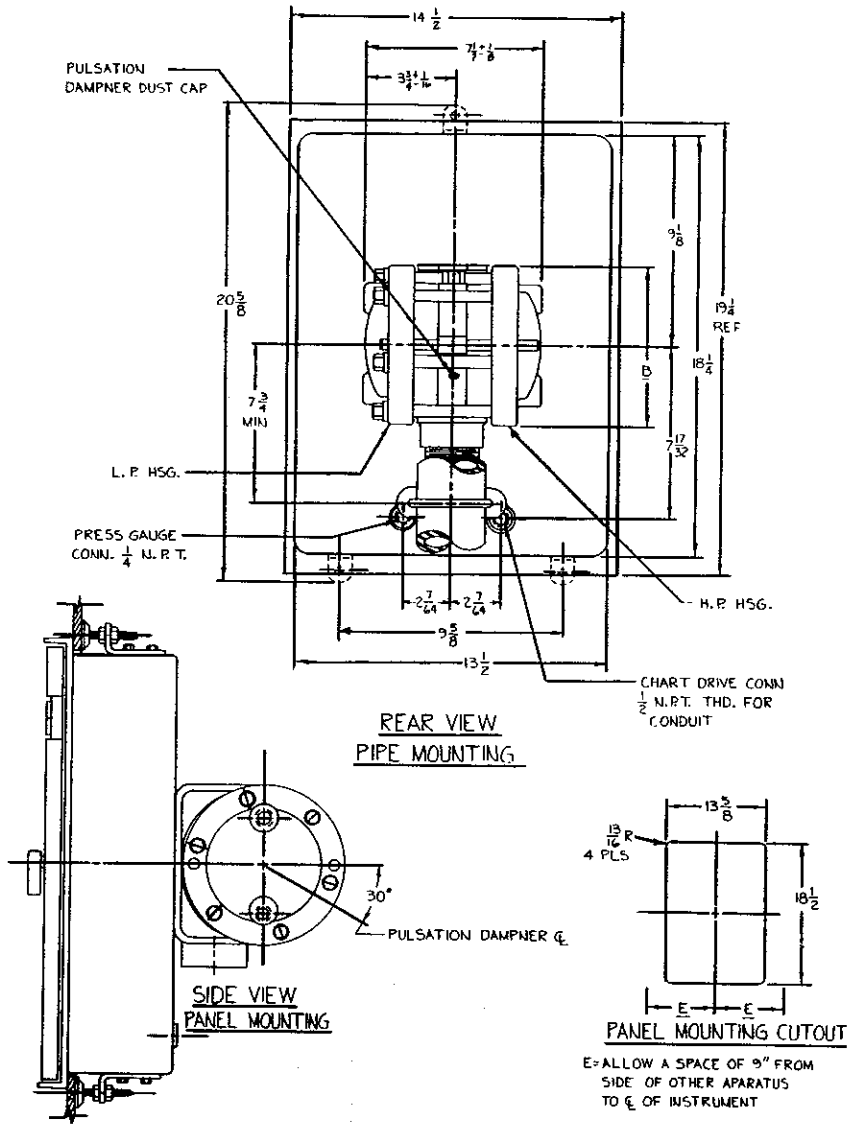
3. ALL STANDARD PIPE FITTINGS FURNISHED BY CUSTOMER.
2. ☉ SUITABLE FOR USE WITH AMINCO FITTINGS AMERICAN INST. CO. SILVER SPRINGS MD. OR EQUAL.
1. ☉☉ CAN BE REVERSED WHEN ORDERED OR CAN BE ROTATED 180° IN THE FIELD.

NOTES:

6000 P.S.I.	11 15/16	7 1/8 DIA	2	2 3/64	☉ 1/2 N.P.T.	☉ 1/4 N.P.T.	12	FORGED ALLOY STL 4140 FORGED STNL. STL. 329
6000 P.S.I.	11 15/16	7 1/8 DIA	2	2	☉ 3/16 18UNF	☉ 3/16 18UNF	12	FORGED ALLOY STL 4140 FORGED STNL. STL 329
4500 P.S.I.	11 15/16	7 1/8 DIA	2	2 3/64	☉ 1/2 N.P.T.	☉ 1/4 N.P.T.	12	FORGED ALLOY STL. 4140
3000 P.S.I.	11 15/16	7 1/8 DIA	2	2 3/64	☉ 1/2 N.P.T.	☉ 1/4 N.P.T.	12	FORGED ST. STL. 316 MONEL K500
2500 P.S.I.	11 15/16	7 3/8 DIA	2	2 9/64	☉ 1/2 N.P.T.	☉ 1/4 N.P.T.	6	FORGED STL. A.I.S.I.
1000 P.S.I.	11 11/16	6 3/8 DIA	2	2 3/64	☉ 1/2 N.P.T.	☉ 1/4 N.P.T.	6	FORGED STNL. STL 316
	FORGED STL. A.I.S.I. C1018 CAST ALUMINUM 356T6							
PRESSURE RATING	DIM. A	DIM. B	DIM. C	DIM. D	TOP PRESS CONNECTION	BOT TOM PRESS CONNECTION	NO. OF BOLTS	HOUSING MATERIAL

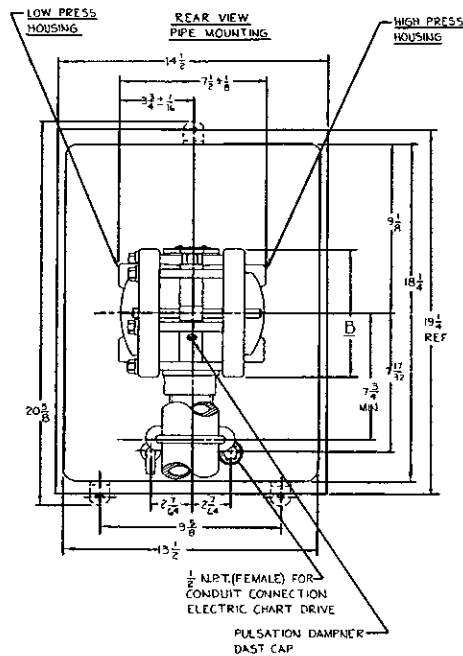
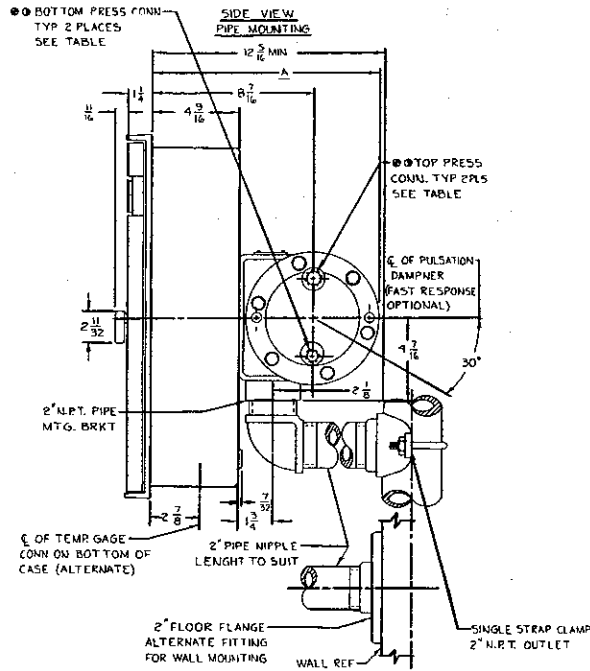
WALL MOUNTING



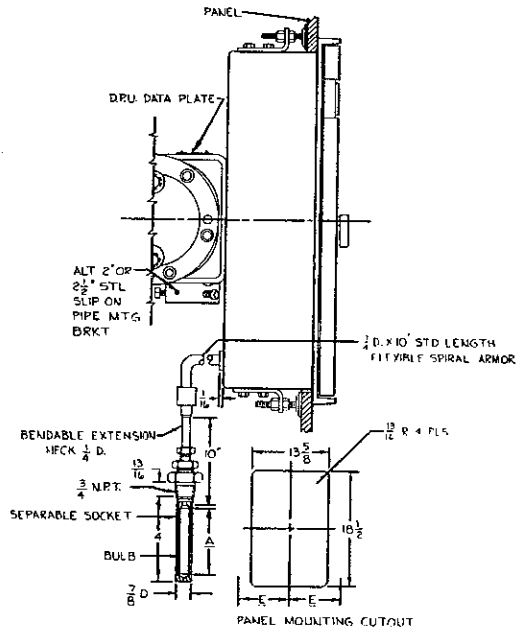


**SECTION 5 - INSTALL/DIMENSIONAL DRAWINGS (Cont.)**

**Model 202E w/Temp. Element (0202-1011.3)**



SIDE VIEW  
PANEL MOUNTING



0-300°F	2 1/8"
0-200°F	2 7/8"
0-150°F	3 3/32"
0-120°F	3 1/2"
0-100°F	3 5/16"
RANGE	DIM. A MAX.
TEMP. ELEM. DATA	

1250 PSI	1100 PSI	1000 PSI
AT 207°F	AT 400°F	AT 600°F
100°F		
SEPARABLE SOCKET		
PRESSURE RATING		

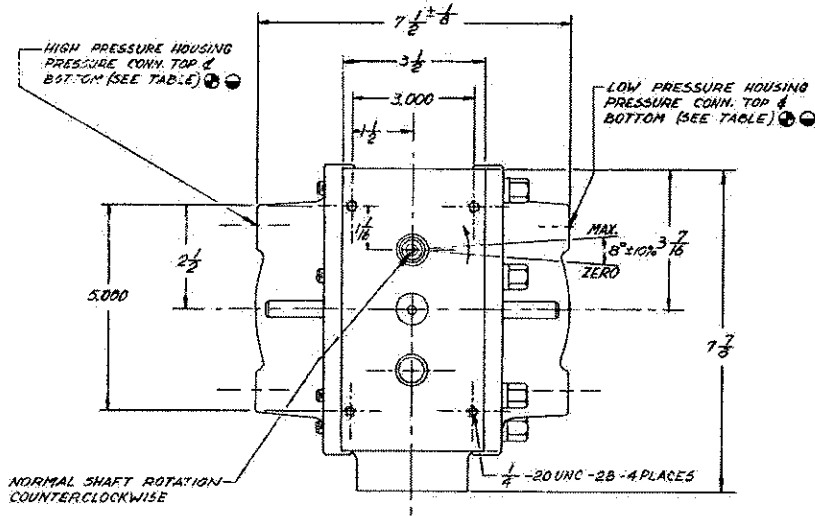
ALLOW A SPACE OF 9" FROM SIDE OF OTHER APARATUS TO C OF INSTRUMENT

6000 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	12	FORGED ALLOY STL 4142 FORGED STL. STL 329
6000 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	12	FORGED ALLOY STL 4142 FORGED STL. STL 329
4500 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	12	FORGED ALLOY STL 4142
3000 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	12	FORGED STL. STL 316 MONEL K-500
2500 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	6	FORGED STL. A.I.S.I. 304
1000 P.S.I.	1 15/16"	7/8" DIA	2	2 3/4"	1/2 N.P.T.	1/2 N.P.T.	6	FORGED STL. STL. 316 FORGED STL. A.I.S.I. 304 CAST ALUMINUM 350/6
D.P.U. PRESS. RATING	DIM A	DIM B	DIM C	DIM D	TOP PRESS. CONNECTION	BOTTOM PRESS. CONNECTION	NO. OF PORTS	HOUSING MATERIAL

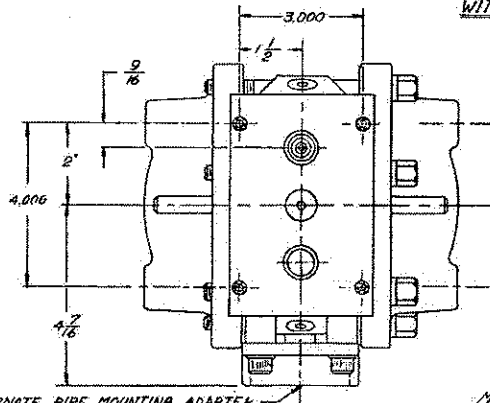
4. ALL DIMENSIONS IN INCHES.
  3. ALL STANDARD PIPE FITTINGS FURNISHED BY CUSTOMER.
  2. SUITABLE FOR USE WITH AMINCO FITTINGS, (AMERICAN INST. CO. SILVER SPRING, MD.) OR EQUIV.
  1. CAN BE REVERSED WHEN ORDERED OR CAN BE ROTATED 180° IN THE FIELD.
- NOTES:

**SECTION 5 - INSTALL/DIMENSIONAL DRAWINGS (Cont.)**

**Model 199 DPU (0199.0903.3)**



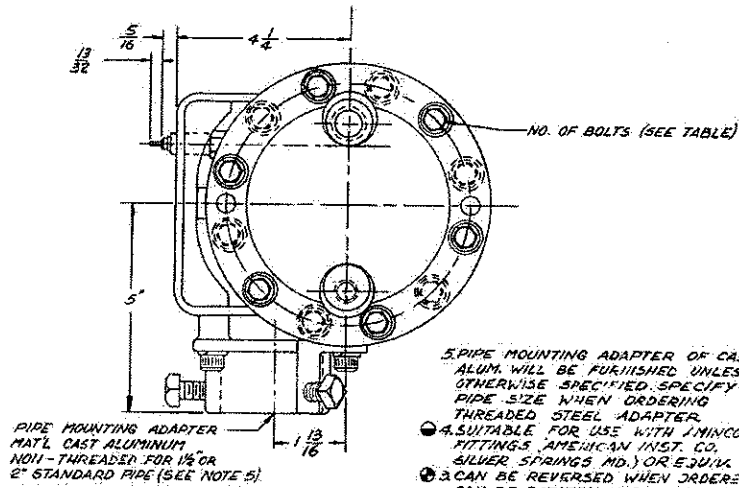
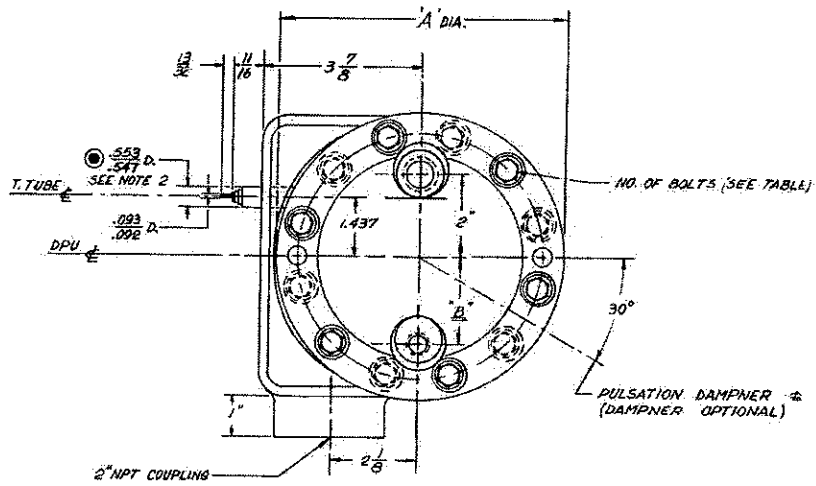
**MODEL 199 DPU  
WITH RECORDER BRACKET**



**MODEL 199 DPU  
WITH INDICATOR BRACKET**

ALL OTHER DIMENSIONS AND  
INFORMATION AS ABOVE

1000 PSI	FORGED SST 316	12	6-5/8	2-9/64	1/2 NPT	1/4 NPT
	CAST ALUM 356 T6	6				
2800 PSI	FORGED ST AISI C1018	6	7-1/8	2	9/16-18UNF	9/16-18UNF
	CAST MONEL K500	12				
3000 PSI	FORGED SST 316	12	7-1/8	2	9/16-18UNF	9/16-18UNF
	FORGED ST AISI C1018	6				
4500 PSI	FORGED ALLOY ST 4142	12	7-1/8	2	9/16-18UNF	9/16-18UNF
6000 PSI	FORGED ALLOY ST 4142	12				
6000 PSI	FORGED SST 17-4PH	12	7-1/8	2	9/16-18UNF	9/16-18UNF
	FORGED ALLOY ST 4142	12				
6000 PSI	FORGED ALLOY ST 4142	12	7-1/8	2	9/16-18UNF	9/16-18UNF
	FORGED SST 17-4PH	12				
PRESSURE RATING	HOUSING MATERIAL	NO. OF BOLTS	DIM "A"	DIM "B"	TOP PRESSURE CONNECTION	BOTTOM PRESSURE CONNECTION

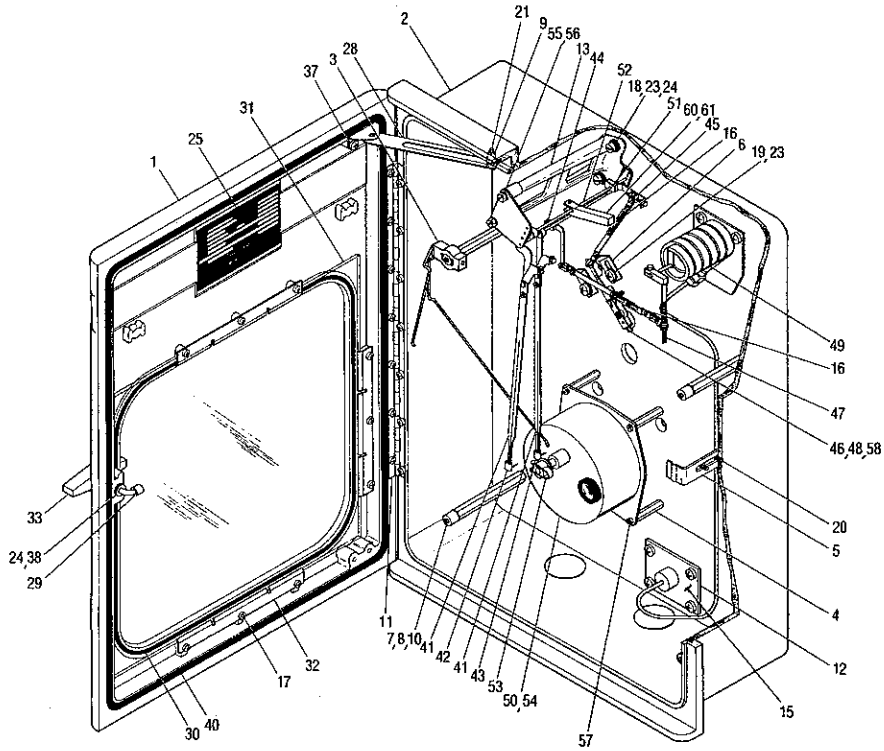


5. PIPE MOUNTING ADAPTER OF CAST ALUM. WILL BE FURNISHED UNLESS OTHERWISE SPECIFIED. SPECIFY PIPE SIZE WHEN ORDERING THREADED STEEL ADAPTER.
- 1. SUITABLE FOR USE WITH WINCO FITTINGS, AMERICAN INST. CO., SILVER SPRING, MD., OR EQUIV.
  - 2. CAN BE REVERSED WHEN ORDERED OR CAN BE ROTATED 180° IN THE FIELD.
  - 3. USE A  $\frac{5}{16}$  D. CLEARANCE HOLE ON CASE FOR DIMENSION MARKED (1).
  - 4. MAXIMUM TEMPERATURE RATING: 200°F.

**NOTES:**

**SECTION 6 - PARTS DRAWING/LIST**

**202E Parts Drawing**



**202E Parts List**

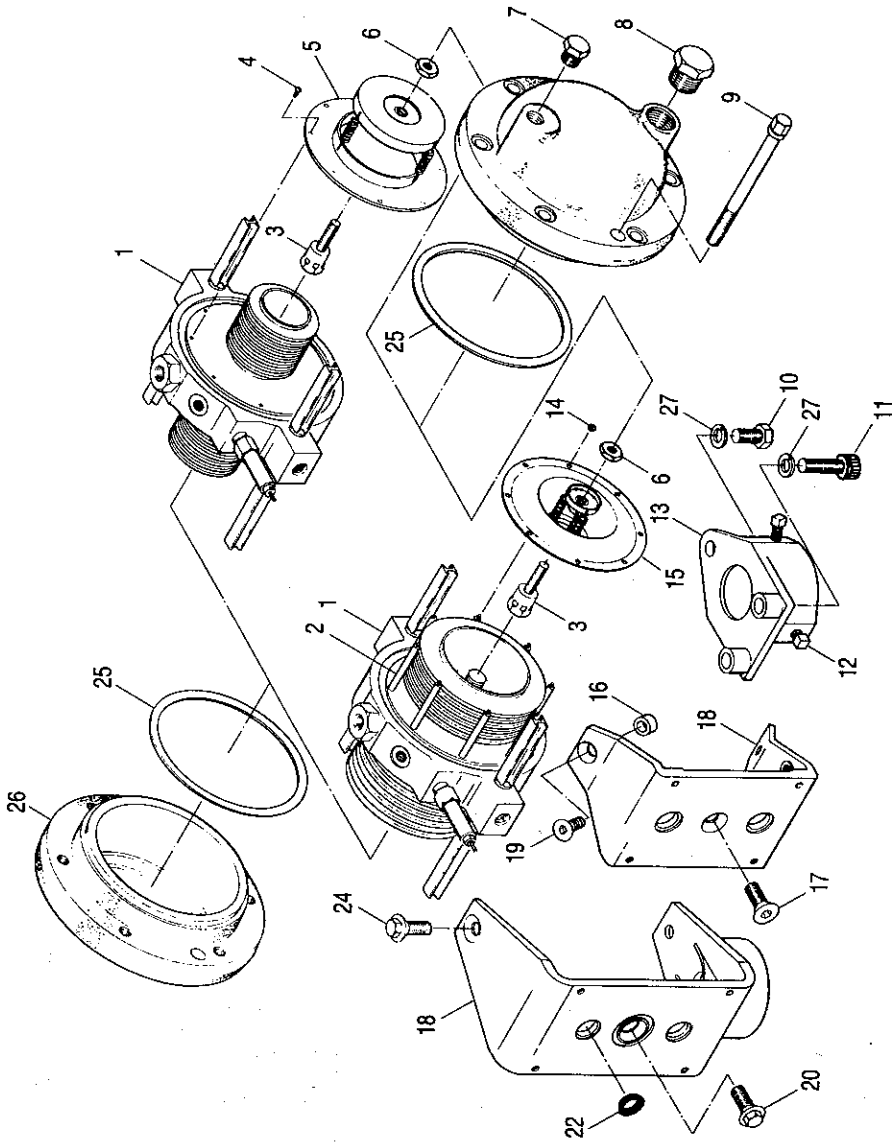
<b>Item</b>	<b>Description</b>	<b>Part No.</b>	<b>Per Unit</b>
1	Door Assembly, Flow Recorder	0238.1023.B	1
2	Case, Flow Recorder	0238.1186.C	1
3	Assembly, Pen Lifter	0238.1159.B	1
4	Riser, Chart Drive	0238.0007.C	3
5	Door Latch	0238.0071.C	1
6	Overrange Stop	0238.0082.C	2
7	Riser, Chart Plate	0238.1210.C	4
8	Screw, Fil. Hd. (Chart Plate)	0114.1036.J	4
9	Bushing, Door Stop	0238.1018.C	1
10	Screw, Cap 1/4-20 x 5/8 (Riser)	S797.0048.Z	4
11	Hinge, Door	0238.1034.C	1
12	Gasket, Cover Plate Connection	0238.0019.C	1
13	Pen Mount Assembly, Dual	0238.0014.B	1
14	Pen Mount Assembly, Single (Not Shown)	0238.0013.B	1
15	Static Pressure Connection Assembly	0238.0046.B	1
16	Link Assembly	0238.0015.B	2
17	Screw, Rd. Hd., Self-Tapping 6-32 x 1/4	0938.0001.J	26
18	Screw, Fil. Hd., 10-32 x 1/2	0114.0031.J	2
19	Screw, Rd. Hd., 10-32 x 5/16	0111.0085.J	10
20	Screw, Self-Tapping, 10-24 x 1/4	0946.0002.J	10
21	Screw, 10-24 x 5/8 SST	0918.1009.J	1
22	Screw, Rd. Hd., (Plug) 10-32 x 1/4 (Not Shown)	0111.0086.J	1
23	Washer, No. 10 Flat	0003.0047.K	4
24	Washer, No. 10, Shakeproof	0003.0033.K	3
25	Plate, Data Flow Recorder	0238.1026.G	1
26	Screw, Self-Tap, 1/4-20 (Not Shown) Hex Hd., C'Sunk Washer	0938.0004.J	4
27	Chart Plate (Not Shown)	0238.0903.C	1
28	Door Stop Assembly	0238.1019.B	1
29	Door Latch Hook Assembly	0238.0029.B	1
30	Gasket, Cover Glass	0238.0015.C	A/R
31	Glass, Cover	0238.0016.C	1
32	Clip, Cover Glass	0238.0017.C	4
33	Assembly, Handle-Door Latch	0238.1038.B	1
34	Bushing, Door Handle (Not Shown)	0238.0094.C	1
35	Not Used	—	—
36	Not Used	—	—
37	Screw, Self-Tapping	0946.0002.J	2
38	Flat Washer	0003.1064.K	2



**202E Parts List (continued)**

Item	Description	Part No.	Per Unit
39	Pin (Not Shown)	0003.0022.T	1
40	Gasket, Door	0096.1003.T	A/R
41	Arm, Fountain Pen (1st or 2nd from Chart)	0238.0088.C	A/R
42	Pen, Fountain (Static) (1st from Chart)	0014.0001.T	1
43	Pen, Fountain (Differential) (2nd from Chart)	0014.0002.T	1
44	Static Shaft Arm Assembly	0202.0034.B	1
45	Range Arm Assembly	0238.0012.B	1
46	Block, Clamp	0250.0003.C	1
47	Lever Arm Assembly	0238.0031.B	1
48	Drive Arm Assembly	0238.0004.B	1
49	Element, Static Pressure	See Table 1-2	
50	Drive Chart	See Table 1-3	
51	Shaft, Pen Arm (1st from Chart)	0238.0006.B	1
52	Shaft, Pen Arm (2nd from Chart)	0238.0007.B	1
53	Hub, Chart	0238.0033.B	1
54	Chart Drive (Not Shown)		1
	Rotation:		
	30 Day	0042.1006.T	
	31 Day	0042.1004.T	
	24 Hour/7 Day	0042.0017.T	
	24 Hour/8 Day	0042.0031.T	
55	Screw, Sl. Hex Hd., 8-32 x 1/4 (Pen Mount, Top Plate)	0116.0014.J	2
56	Washer, Lock #8 (Pen Mount, Top Plate)	0003.0036.K	2
57	Screw, Sl. Fil. Hd., 6-40 x 1/4 (Chart Drive)	0114.0017.J	3
58	Screw, Set, 2-56 x 5/32 (Drive Arm)	0200.0040.C	3
59	Differential Pressure Unit (Not Shown)	Specify	1
60	Counterweight	0238.1165.C	1
61	Screw, Counterweight Clamp	0238.1201.C	1

199 DPU Parts Drawing



**199 DPU Parts List**

Item	Description	Part No.	Units
1	Bellows Unit Assembly	(Specify)	1
*2	Post, Calibration Spring Retainer (For 3-3/4" Bellows)	0199.0019.C	4
3	Rod, Spring Push	0199.0049.C	1
*4	Screw, Retainer, 6-32 x 5/16" (For 2-1/8" Bellows)	0111.0049.J	8
*5	Spring Assembly, Calibration Tension (For 2-1/8" Bellows)	(Specify)	1
6	Nut, Lock	0199.0144.C	1
7	Plug, Pipe, 1/4" NPT, Steel	0199.0191.C	2
8	Plug, Pipe, 1/2" NPT, Steel	0199.0192.C	2
9	Bolt, Housing		A/R
	Stainless Steel, 1000 psi Units	0199.1345.C	
	Steel, 2500, 3000, and 4500 psi Units	0199.0085.C	
	Alloy Steel (Stud), 1/2-20 x 6-5/8", 6000 psi Units	0199.1001.C	
*10	Screw, Pipe Mounting Adapter	0210.0012.J	1
11	Screw, SCH Cap, Steel, 3/8-16, 1-1/2" Lg.	0220.1102.J	2
*12	Screw, 3/8-16 x 5/8", Steel (For Item 13)	0310.0013.J	3
13	Adapter, Pipe Mounting	0199.0988.C	1
*14	Nut, Spring Retainer, Stainless Steel (For 3-3/4" Bellows)	0500.0028.J	8
*15	Assembly, Range Spring (For 3-3/4" Bellows)	(Specify)	1
16	Spacer, Indicator Bracket	0199.0006.C	2
17	Screw, Indicator Bracket	0240.0003.J	1
18	Bracket	(Specify)	1
19	Screw, Indicator Bracket	0002.1009.T	2
20	Screw, Recorder Bracket	0002.0034.T	1
21	Deleted		
*22	Gasket, Torque Tube	0199.0209.C	1
23	Deleted	-	-
24	Screw, Recorder Bracket	0002.0033.T	2
*25	Gasket, Pressure Housing		2
	1000 psi Aluminum Units	0199.0026.C	
	2500, 3000 and 4500 psi Steel Units	0199.0027.C	
	1000, 3000, and 6000 psi Stainless Steel & Monel Units	0199.0184.C	
26	Housing, Pressure		
27	Washer, Lock, 3/8" (Used with Items 10 & 11)	(Specify)	2
28	Deleted	0003.0012.K	3
29	Nut, 1/2-20, 6000 and 3000 psi Monel Units (Used with Item 9)	-	-
		0199.1002.C	24
*30	Plug, Dampener Valve (Not Shown)	0117.0015.J	1
31	Deleted	-	-
*32	Wrench, Range Spring Adjustment (Not Shown)	0199.0142.C	1
33	Keys, Set of Hex, (Not Shown)	0016.0013.T	1

\* Indicates recommended spare parts  
When ordering parts, specify instrument serial number.

A/R As Required

**199 DPU Specifications**

MODEL	BODY	AVAILABLE DIFFERENTIAL PRESSURE RANGES		
		Stainless Steel Bellows		Inconel Bellows
199	Housing Material	2-1/8" (55 mm) O.D.	3-3/4" (95 mm) O.D.	3-3/4" (95 mm) O.D.
SWP - psi (bar)				
1,000 (69)	Cast Aluminum 356T6 Forged Stainless Steel 316			
2,500 (172)	Forged Steel A.I.S.I. C1018			
3,000 (207)	Forged Stainless Steel 316	0-15 psi (0-1 bar) to 0-100 psi (0-6.9 bar)	0-10" w.c. (0-25 mbar) to 0-400" w.c. (0-993 mbar)	0-20" w.c. (0-50 mbar) to 0-400" w.c. (0-993 mbar)
4,500 (310)	Forged Alloy Steel 4142			
6,000 (414)	Forged Alloy Steel 4142 Forged Stainless Steel 17-4 PH			
Net Volume (cu. in.)	L.P. Head	35" (575 cc)	30" (490 cc)	30" (490 cc)
	H.P. Head	31" (510 cc)	26" (425 cc)	26" (425 cc)
Displacement in cu. in. for full-scale travel		0.5" (8.2 cc)	1.5" (25 cc)	0.5" (8.2 cc) 1.5" (25 cc)
<b>PERFORMANCE SPECIFICATIONS</b>				
Torque Tube Rotation (full scale D.P.)		8° ±10%		
Torque Tube Material		Beryllium Copper (BeCu)		
Temperature Limits		-40° F° C to +180° F (+82° C)		
Maximum Non-Linearity				
0-20" to 0-400" w.c. (0-50 mbar to 0-993 mbar)		±0.5% of full scale w/appropriate linkage		
0-15 to 0-100 psi (0-1 bar to 0-6.9 bar)		±0.75% of full scale w/appropriate linkage		
Sensitivity		0.05% of full scale D.P.		
Repeatability		0.10% of full scale D.P.		

**NOTES:** Zero center or split ranges available on special order [e.g., a 0-50" w.c. (0-124 mbar) range may be ordered 25-0-25" w.c. (62-0-62 mbar) or 10-0-40" w.c. (25-0-99 mbar)]. Intermediate differential pressure ranges available from 0-20" w.c. to 0-100 psi (0-50 mbar to 0-6.9 bar). Other sizes and types of connections (welding stubs, MS, A.N.D., etc.) available upon request. Standard pressure connections are 1/2" (top) and 1/4" (bottom) NPT. Range springs are not interchangeable between the different size bellows; the Inconel bellows, or the 10" w.c. (25 mbar) range. Can be specified to meet NACE MFR-01-75 (Revised '80). Metric conversions are approximate. Outline dimension drawings available upon request.

### **Instrument Specifications**

Case ..... Die-cast aluminum, black epoxy resin paint,  
waterproof and weather resistant hinged door;  
neoprene gasket seal

DP Accuracy:

0-20" w.c. to 0-349" w.c. .... ±0.5% of full scale

0-350" w.c. to 0-75 psi ..... ±0.75% of full scale

SP Accuracy ..... ±1.0% of full scale

### **Product Warranty**

A. Warranty

NuFlo Technologies, Inc. warrants that at the time of shipment the products manufactured by NuFlo Technologies, Inc. and sold hereunder will be free from defects in material and workmanship, and will conform to the specifications furnished by or approved by NuFlo Technologies, Inc.

B. Warranty Adjustment

- (1) If any defect within this warranty appears, Buyer shall notify NuFlo Technologies, Inc. immediately.
- (2) NuFlo Technologies, Inc. agrees to repair or furnish a replacement for, but not install, any product which within one (1) year from the date of shipment by NuFlo Technologies, Inc. shall, upon test and examination by NuFlo Technologies, Inc., prove defective within the above warranty.
- (3) No product will be accepted for return or replacement without the written authorization of NuFlo Technologies, Inc. Upon such authorization, and in accordance with instructions by NuFlo Technologies, Inc., the product will be returned shipping charges prepaid by Buyer. Replacements made under this warranty will be shipped prepaid.

C. Exclusions from Warranty

- (1) THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.
- (2) Components manufactured by any supplier other than NuFlo Technologies, Inc. shall bear only the warranty made by the manufacturer of that product, and NuFlo Technologies, Inc. assumes no responsibility for the performance or reliability of the unit as a whole.
- (3) "In no event shall NuFlo Technologies, Inc. be liable for indirect, incidental, or consequential damages nor shall the liability of NuFlo Technologies, Inc. arising in connection with any products sold hereunder (whether such liability arises from a claim based on contract, warranty, tort, or otherwise) exceed the actual amount paid by Buyer to NuFlo Technologies, Inc. for the products delivered hereunder."
- (4) The warranty does not extend to any product manufactured by NuFlo Technologies, Inc. which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by NuFlo Technologies, Inc.
- (5) The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than at NuFlo Technologies, Inc.'s factory or service locations by persons not expressly approved by NuFlo Technologies, Inc.



## **NuFlo Measurement Systems**

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PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL INSTRUMENTS (DISPLACER OR FLOAT)				SHEET 1 OF 2	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : LEVEL CONTROLLERS				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.L
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
								BY	CHK'D
1	TAG NO.	LC-610		LC-620A		LC-620B		LC-630	
2	SERVICE	CHILLER		LTS		LTS		DEETHANIZER	
3	LINE NO. / VESSEL NO.	E-610		V-620		V-620		T-630	
B O D Y / C A S E / M O U N T I N G	4	BODY OR CAGE MATERIAL		CS		CS		CS	
		RATING		150 ANSI		600 ANSI		600 ANSI	
	5	CONN. SIZE	LOC. UPPER	48 mm	SIDE	48 mm	SIDE	48 mm	SIDE
		TYPE		NPT		NPT		NPT	
	6	CONN. SIZE	LOC. LOWER	48 mm	BOTTOM	48 mm	BOTTOM	48 mm	BOTTOM
		TYPE		NPT		NPT		NPT	
	7	CASE MOUNTING (RH, LH, TOP)		R.H. MOUNTING		R.H. MOUNTING		R.H. MOUNTING	
		TYPE							
	8	ROTATABLE HEAD							
	9								
	10	ORIENTATION							
	11	COOLING EXTENSION							
12			PSL FAB CAGE		PSL FAB CAGE		PSL FAB CAGE		
D I M E N S I O N S	13	DIMENSIONS		76 OD X 356 mm	76 OD X 356 mm	76 OD X 356 mm	76 OD X 356 mm	76 OD X 356 mm	
	14	INSERTION DEPTH		STD mm	STD mm	STD mm	STD mm	STD mm	
	15	DISPLACER EXTENSION		305 mm	305 mm	305 mm	305 mm	305 mm	
	16	DISP. OR FLOAT MATERIAL		SS		SS		SS	
	17	DISPLACER SPRING/TUBE MTL		STD		STD		STD	
	18								
	19								
X M T R S	20	FUNCTION		CONTROLLER		CONTROLLER		CONTROLLER	
	21	OUTPUT		20-100 KPA		20-100 KPA		20-100 KPA	
	22	CONTROL MODES		PROPORATIONAL ACTION		PROPORATIONAL ACTION		PROPORATIONAL ACTION	
	23	DIFFERENTIAL							
	24	OUTPUT ACTION: LEVEL RISE		OUTPUT DECREASES		OUTPUT INCREASES		OUTPUT INCREASES	
	25	MOUNTING							
	26	ENCLOSURE CLASS							
	27	ELEC. POWER OR AIR SUPPLY							
	28								
S E R V I C E	29	UPPER LIQUID				HC LIQUID			
	30	LOWER LIQUID		PROPANE		HC LIQUID		E GLYCOL	
	31	SP. GR. UPPER	SP. GR. LOWER		0.580		0.467	0.467	1.12
	32	PRES. MAX.	PRES. NORMAL	1724 kPa(g)	100 kPa(g)	8963 kPa(g)	6780 kPa(g)	8963 kPa(g)	6780 kPa(g)
	33	TEMP. MAX.	TEMP. NORM.	66 °C	-26 °C	66 °C	-23 °C	66 °C	-23 °C
34									
35									
O P T I O N S	36	AIRSET	SUPPLY GAGE						
	37	GAGE GLASS CONNECTIONS							
	38	GAGE GLASS MODEL NO.							
	39	CONT:NUM	CONT: FORM						
	40	CONTACT RATING							
	41	ACTION OF CONTACTS							
	42								
43									
44									
45	MANUFACTURER		FISHER		FISHER		FISHER		
46	MODEL NO.		2500-249W (PARTIAL)		2500-249W (PARTIAL)		2500-249W (PARTIAL)		
47	P. O. NUMBER								

NOTES:

AREA. UNIT # :

ISA FORM SM20.26

MLEVEL-INS.XLT

# 2500 and 2503 Series Level-Trol® Controllers and Transmitters

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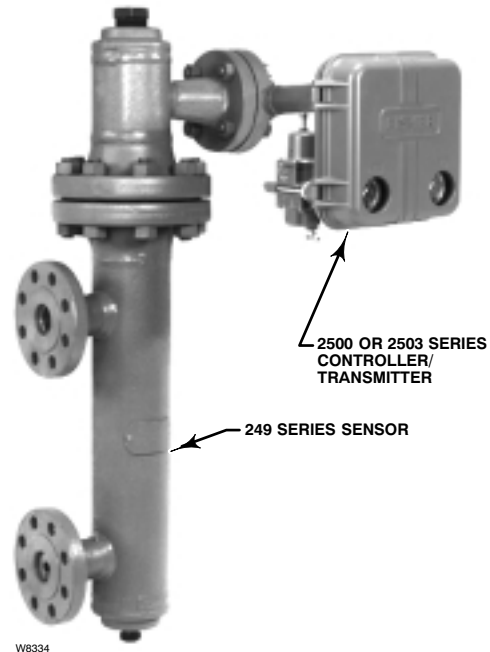


Figure 1. 2500 or 2503 Series Level-Trol® Controller/  
Transmitter on Caged 249 Series Sensor

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# Type 2500

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## Introduction

### Scope of Manual

This manual provides installation, operating, calibration, maintenance, and parts ordering information for the 2500 and 2503 Series pneumatic controllers and transmitters used in combination with 249 Series displacer sensors.

#### Note

**This manual does not include installation or maintenance procedures for the supply pressure regulator, sensor, or other devices. For that information, refer to the appropriate instruction manual for the other device.**

Only qualified personnel should install, operate, and maintain these controller/transmitters. If you have any questions concerning these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

## Description

These instruments control or transmit the fluid level, the level of interface between two fluids, or the density (specific gravity). Each unit consists of a 249 Series displacer-type fluid level sensor and a 2500 or 2503 Series pneumatic controller or transmitter. Figure 1 shows a typical controller-sensor combination.

## Specifications

Refer to table 1 for specifications.

## Installation

The 2500 and 2503 Series controller/transmitters work in combination with 249 Series displacer-type sensors. The factory attaches the controller/transmitter to the sensor, unless it is ordered separately.

## Sensor Assembly

Table 2 lists sensors recommended for use with controller/transmitters. For sensor installation and maintenance, refer to the appropriate sensor instruction manual.

### WARNING

**When replacing the sensor assembly, the displacer may retain process fluid or pressure. Personal injury or property damage may occur due to sudden release of the pressure. Contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor assembly or removing the displacer. Before disassembling the sensor or removing the displacer, observe the more specific warning provided in the sensor instruction manual.**

## Uncrating

Unless ordered separately, the controller/transmitter is attached to the sensor when shipped. Carefully uncrate the assembly.



Table 1. Specifications

<p><b>Available Configurations<sup>(1)</sup></b></p> <p><b>Type 2500</b>—Proportional-Only controller  <b>Type 2500C</b>—Proportional-Only controller with indicator (see figure 10)  <b>Type 2500R</b>—Reverse acting proportional-only controller  <b>Type 2500S</b>—Differential gap (snap acting) controller. See changing controller action procedure and figure 15.  <b>Type 2500T</b>—Transmitter  <b>Type 2503</b>—Differential gap controller without proportional valve; for applications requiring very little adjustment.</p> <p><b>Input Signal<sup>(2)</sup></b></p> <p><b>Fluid Level or Fluid-to-Fluid Interface Level:</b> From 0 to 100% of displacer length—standard lengths for all sensors are 356 mm or 812 mm (14 inches or 32 inches). Other lengths available depending on sensor construction.  <b>Fluid Density:</b> From 0 to 100% of displacement force change obtained with given displacer volume. Standard volume for displacers are listed in table 2.</p> <p><b>Output Signal<sup>(2)</sup></b></p> <p><b>Type 2500 Controller and 2500T Transmitter:</b> 0.2 to 1 bar (3 to 15 psig) or 0.4 to 2 bar (6 to 30 psig)  <b>Type 2500S and 2503 Differential Gap Controllers:</b> 0 bar (0 psig) when switched off and full supply [1.4 or 2.4 bar (20 or 35 psig) nominal depending on controller output pressure range] when switched on.</p> <p><b>Area Ratio of Relay Diaphragms</b></p> <p>3:1</p> <p><b>Supply Pressure Data</b></p> <p>See table 3<sup>(3)</sup></p> <p><b>Maximum Supply Pressure<sup>(3)</sup></b></p> <p>3 bar (45 psig) to the controller or transmitter. If controller or transmitter is equipped with an integrally mounted Type 67FR filter/regulator, typical supply pressure to the regulator is from 2.5 bar (35 psig) to 17 bar (250 psig), maximum. For supply pressures to the filter/regulator, refer to the appropriate regulator instruction manual.</p>	<p><b>Steady-State Air Consumption</b></p> <p><b>2500 Series Controllers and Transmitters (2500, 2500C, 2500R, 2500S, and 2500T):</b> See Table 3.  <b>Type 2503 Controller:</b> Vents only when relay is exhausting.</p> <p><b>Proportional Band<sup>(2)</sup> Adjustment (Proportional-Only Controllers)</b></p> <p>Full output pressure change adjustable over 10 to 100% of displacer length.<sup>(5)</sup></p> <p><b>Differential Gap<sup>(2)</sup> Adjustment (Differential Gap Controllers)</b></p> <p><b>Type 2500S Controller:</b> Full output pressure change adjustable from 20 to 100% of displacer length.<sup>(5)</sup>  <b>Type 2503 Controller:</b> Full output pressure change adjustable over approximately 25 to 40% of displacer length.<sup>(5)</sup></p> <p><b>Span<sup>(2)</sup> Adjustment (Type 2500T Transmitter)</b></p> <p>Full output pressure change adjustable from 20 to 100% of displacer length.<sup>(5)</sup></p> <p><b>Set Point<sup>(2)</sup> (controllers only) or Zero<sup>(2)</sup> (transmitters only) Adjustment</b></p> <p>For proportional-only controllers or transmitters, level adjustment positions the set point or zero for the fluid level, interface level, or displacer force change (density) within the displacer length. For differential gap controllers, level adjustment simultaneously positions both ends of the gap within the displacer length.</p> <p><b>Performance</b></p> <p><b>Independent Linearity<sup>(2)</sup> (transmitters only):</b> 1% of output pressure change for 100% span.  <b>Hysteresis:</b> 0.6% of output pressure change at 100% proportional band, differential gap, or span.  <b>Repeatability<sup>(2)</sup>:</b> 0.2% of displacer length or displacement force change.  <b>Deadband<sup>(2)</sup> (except differential gap controllers<sup>(4)</sup>):</b> 0.05% of proportional band or span.  <b>Typical Frequency Response<sup>(2)</sup>:</b> 4 Hz and 90 degree phase shift at 100% proportional band with output piped to typical instrument bellows using 6.1 meters (20 feet) of 1/4-inch tubing.</p>
--	--

(continued)

Table 1. Specifications (Continued)

<p><b>Ambient Operating Temperature Limits</b></p> <p>For ambient temperature ranges and guidelines for use of the optional heat insulator assembly, see figure 2. Relay temperature limits are:  <b>Standard Construction:</b> -40 to 71°C (-40 to 160°F)  <b>High-Temperature Construction:</b> -18 to 104°C (0 to 220°F)</p> <p><b>Typical Ambient Temperature Operating Influence</b></p> <p>Output pressure changes <math>\pm 1.5\%</math> per 10°C</p>	<p>(50°F) change in temperature at 100% proportional band when using a standard wall torque tube with 249 Series sensors.</p> <p><b>Supply and Output Connections</b></p> <p>1/4-inch NPT female</p> <p><b>Maximum Working Pressure (sensors only)</b></p> <p>Refer to the appropriate sensor instruction manual.</p>
--	---

1. Controllers are field adjustable between direct or reverse action. The letter R in the type number indicates that the controller/transmitter shipped from the factory set for reverse action (see changing controller action procedures). The letter C in the type number indicates that a pointer is attached to the torque tube shaft providing visual monitoring of torque tube motion.
2. This term is defined in ISA Standard S51.1-1979.
3. Control and stability may be impaired if the maximum pressures are exceeded.
4. Adjusting the span of the differential gap controller is equivalent to adjusting the deadband.
5. These statements apply only to units sized to produce a full output change for a 100% level change at the maximum proportional band dial setting.

Table 2. Standard Displacer Volumes

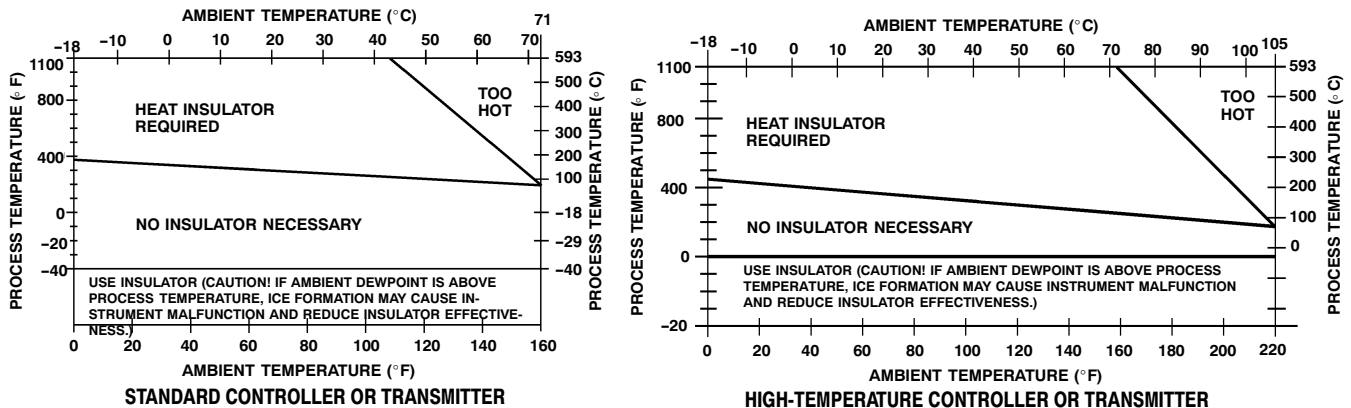
SENSOR TYPE	STANDARD VOLUME, Liters	STANDARD VOLUME, Cubic Inches
249, 249B, 249BP, 249K, 249W	1.6	100 <sup>(1)</sup>
249C, 249CP, 249W	1.0	60 <sup>(2)</sup>
249L	1.9	120
249V	1.3 <sup>(3)</sup>	80 <sup>(3)</sup>

1. For 249W, with standard 812 mm (32-inch) displacer.  
2. For 249W, with standard 356 mm (14-inch) displacer.  
3. With standard 305 mm (12-inch) flange-face-to-displacer centerline dimension only.

Table 3. Supply Pressure Data

OUTPUT SIGNAL RANGE	STANDARD SUPPLY AND OUTPUT PRESSURE GAUGE INDICATIONS <sup>(1)</sup>	NORMAL OPERATING SUPPLY PRESSURE <sup>(2)</sup>		AIR CONSUMPTION AT NORMAL OPERATING SUPPLY PRESSURE		MAXIMUM SUPPLY PRESSURE
		Psig	Bar	Minimum <sup>(3)</sup>	Maximum <sup>(4)</sup>	
0.2 to 1 bar (3 to 15 psig)	0 to 30 psig	20	1.4	4.2 scfh <sup>(5)</sup>	27 scfh <sup>(5)</sup>	3 bar (45 psig)
0.4 to 2 bar (6 to 30 psig)	0 to 60 psig	35	2.4	7 scfh <sup>(5)</sup>	42 scfh <sup>(5)</sup>	3 bar (45 psig)

1. Consult your Fisher Controls representative about gauges in other units.  
2. Control and stability may be impaired if this pressure is exceeded.  
3. At zero or maximum proportional band or specific gravity setting.  
4. At setting in middle of proportional band or specific gravity range.  
5. If air consumption is desired in normal m<sup>3</sup>/hr at 0°C and 1.01325 bar, multiply scfh by 0.0258.



NOTE:  
FOR APPLICATIONS BELOW -29°C (-20°F), BE SURE THE SENSOR MATERIALS OF CONSTRUCTION ARE APPROPRIATE FOR THE SERVICE TEMPERATURE.

CV6190-E  
B1413-3/IL

Figure 2. Guidelines for Use of Optional Heat Insulator Assembly

**CAUTION**

Sensors used for interface or density control may be so large and heavy that the torque tube cannot fully support their weight in air. On the 249V, a travel stop is used to prevent damage. Do not remove this travel stop assembly without first removing the displacer from the displacer rod. Refer to the instruction manual for cageless 249 Series sensors.

**Note**

Caged sensors have rods and blocks installed at each end of the displacers to protect the displacers in shipping. Remove these parts before you install the sensor to allow the displacer to function properly.

Caged sensors come with the displacer installed in the cage. If a tubular gauge glass is ordered with the sensor, the gauge glass is crated separately and must be installed at the site. A damping plate is installed in the lower screwed or flanged connection (see figure 3) to provide more stable operation. Be certain that the cage equalizing connections and the damping plate are not plugged by foreign material.

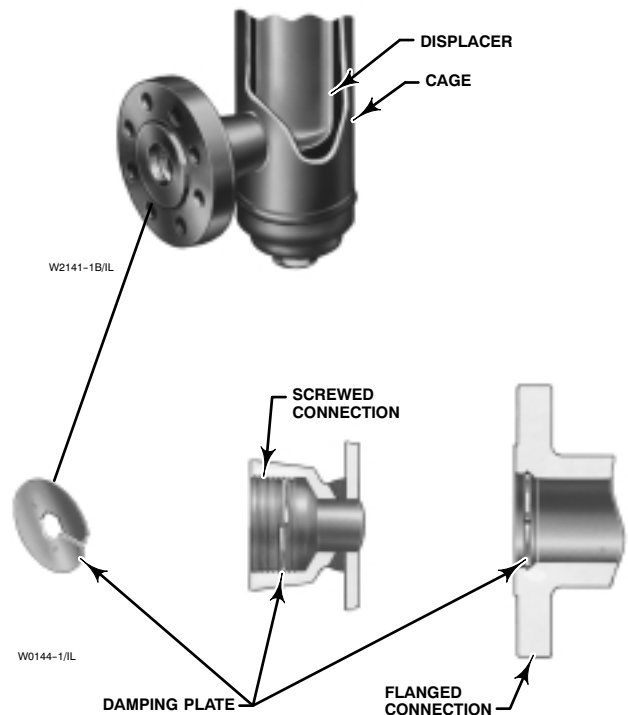


Figure 3. Damping Plate Location

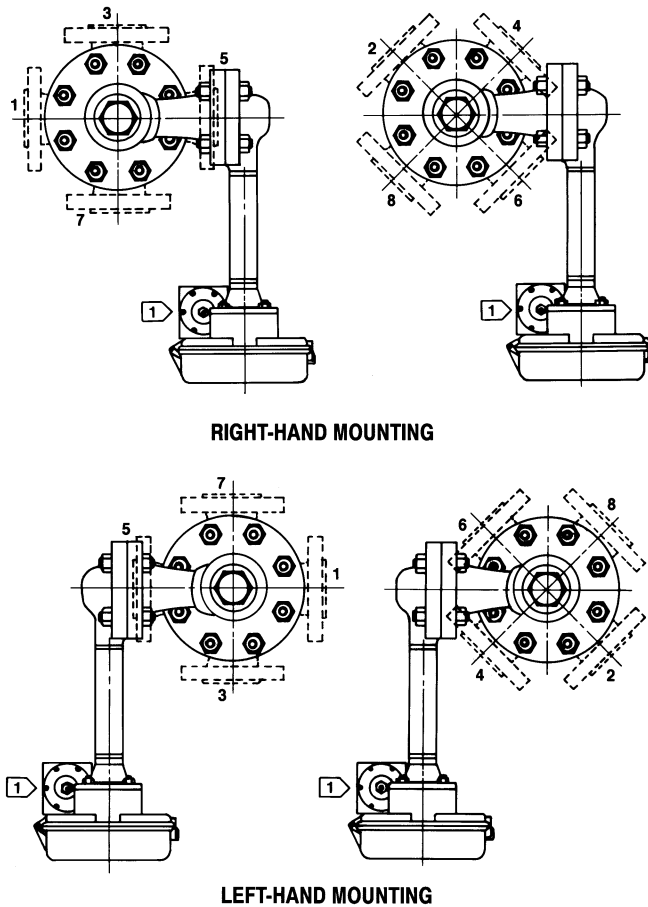


Figure 4. Cage Head Mounting Positions

A cageless sensor comes with its displacer separated from the sensor assembly. Displacers longer than 813 mm (32 inches) come in a separate crate. Shorter displacers come in the same crate as the sensor, but are not attached to their displacer rods. Inspect the displacer to insure it is not dented. A dent may reduce the pressure rating of the displacer. If a displacer is dented, replace it.

### Controller/Transmitter Orientation

The controller/transmitter attaches to the sensor in one of the mounting positions shown in figure 4. Right hand mounting is with the controller or transmitter case to the right of the displacer when you look at the front of the case; left hand mounting is with the case to the left of the displacer. The mounting position can be changed in the field.

Changing this mounting position changes the control action from direct to reverse, or vice versa.

All caged sensors have a rotatable head. That is, the controller/transmitter may be positioned at any of eight alternate positions around the cage as indicated by the numbers 1 through 8 in figure 4. To rotate the head, remove the head flange bolts and nuts and position the head as desired.

### Mounting Caged Sensor

#### CAUTION

Install the cage so that it is plumb; the displacer must not touch the cage wall. If the displacer touches the cage wall, the unit will transmit an erroneous output signal.

#### Note

If the controller/transmitter is not mounted on the sensor, refer to the **Installing Controller/Transmitter on Sensor** procedures in the Maintenance section. That section also provides instructions for adding a heat insulator to a unit.

Cage connections normally are either 1-1/2 or 2-inch, screwed or flanged. Figure 5 shows the combinations. With flanged connections, use standard gaskets or other flat-sheet gaskets compatible with the process fluid. Spiral-wound gaskets without compression-controlling centering rings cannot be used for flange connections.

As shown in figure 6, mount the cage by running equalizing lines between the cage connections and the vessel. A shutoff or hand valve with a 1-1/2 inch diameter or larger port should be installed in each of the equalizing lines. Also install a drain between the cage and shutoff or hand valve whenever the bottom cage line has a fluid-trapping low point.

On fluid or interface level applications, position the sensor so that the center line on the cage (see figure 6) is as close as possible to the center of the fluid level or interface level range being measured. Also consider installing a gauge glass on the vessel, or on the sensor cage (if the cage is tapped for a gauge).

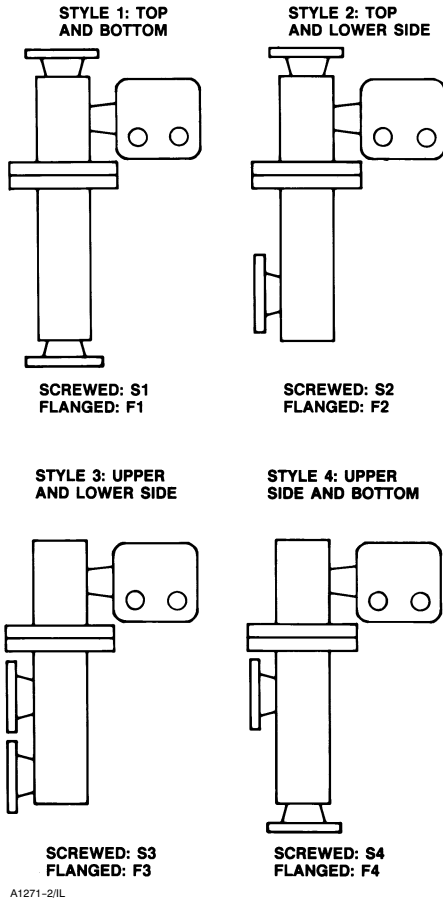


Figure 5. Cage Connection Styles

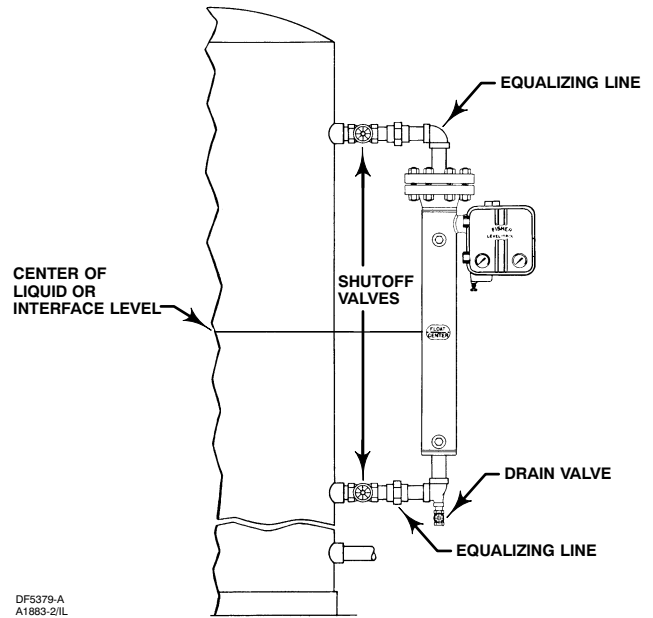


Figure 6. Caged Sensor Mounting

submerged during operation. To obtain the desired controller or transmitter sensitivity may require using either a thin-wall torque tube, an oversized displacer, or both.

**Note**

If the controller/transmitter is not mounted on the sensor, refer to the Installing Controller/Transmitter on Sensor procedures in the Maintenance section. That section also provides instructions for adding a heat insulator to a unit. If the sensor has a temperature-compensated displacer or piezometer ring, refer to the Special Installations procedures in this section before proceeding.

Attach a cageless sensor to a flanged connection on the vessel as shown in figure 7. For interface or fluid level applications, install a gauge glass on the vessel.

**Mounting Cageless Sensor**

**CAUTION**

If a stillwell is used, install it plumb so that the displacer does not touch the wall of the stillwell. If the displacer touches the wall, the unit will transmit an erroneous output signal.

Since the displacer hangs inside the vessel, provide a stillwell around the displacer if the fluid is in a state of continuous agitation to avoid excessive turbulence around the displacer.

**CAUTION**

Displacers used in an interface level application must be completely

**Side-Mounted Sensor**

If a stillwell is required (see figure 7), attach the displacer to the displacer rod from inside the vessel.

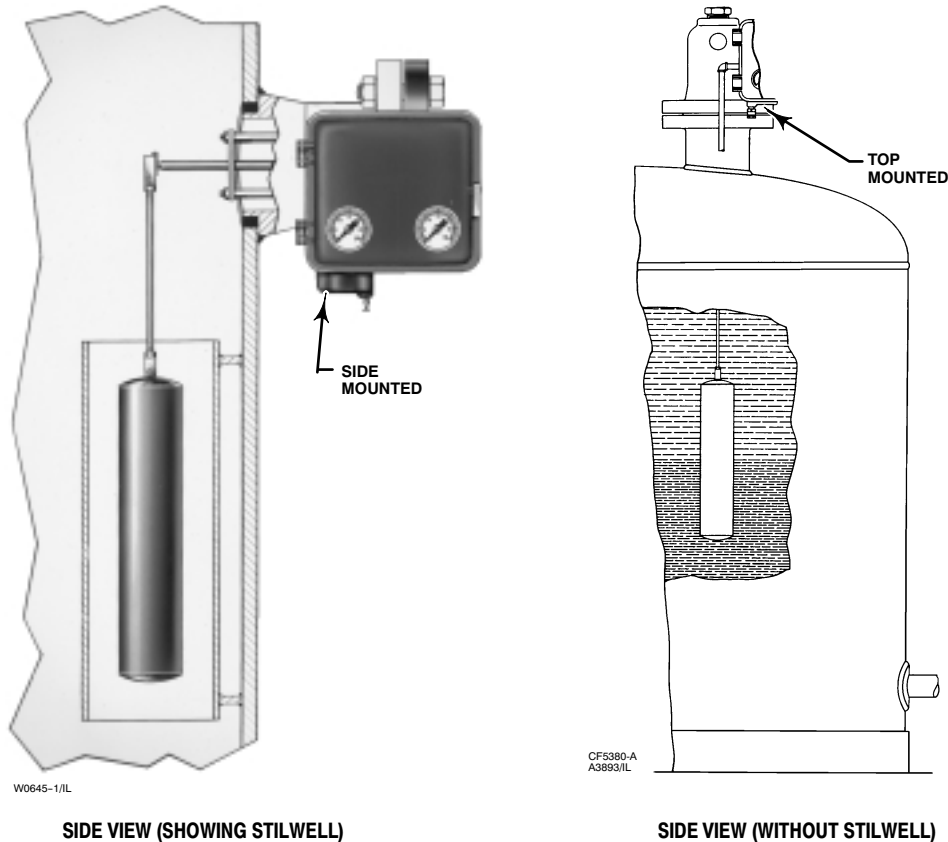


Figure 7. Cageless Sensor Mounting

Connect the displacer as shown in figure 8, locking the assembly with the cotter spring provided. If a stillwell is not required, attach the displacer rod before mounting the sensor on the vessel. Then, you can swing the displacer out horizontally for insertion into the vessel. However, once the sensor is installed and the displacer drops to a vertical position, the displacer may not be capable of being withdrawn for servicing later. Be sure there is another access to the displacer to permit swinging it to a horizontal position or to permit disconnecting it from the displacer rod.

If an extension is used between the displacer spud and the displacer stem end piece, make sure the nuts are tight at each end of the displacer stem extension. Install and tighten suitable bolting or cap screws in the flanged connection to complete the installation.

### Top-Mounted Sensor

#### CAUTION

**If inserting the displacer into the vessel before attaching to the displacer rod, provide a means of supporting the displacer to prevent it from dropping into the vessel and suffering damage.**

Figure 7 shows an example of a top-mounted cageless sensor. You may attach the displacer to the displacer rod before installing the sensor on the vessel. If the displacer diameter is small enough, you may desire to install a long or sectionalized displacer through the sensor head access hole after the sensor is installed on the vessel. Connect the displacer as shown in figure 8, locking the assembly with the cotter springs provided. If a stem extension is used between the displacer spud and the stem end piece, make sure the nuts are tight at each end of the stem. Install and tighten suitable cap screws in the flanged connection to complete the installation.

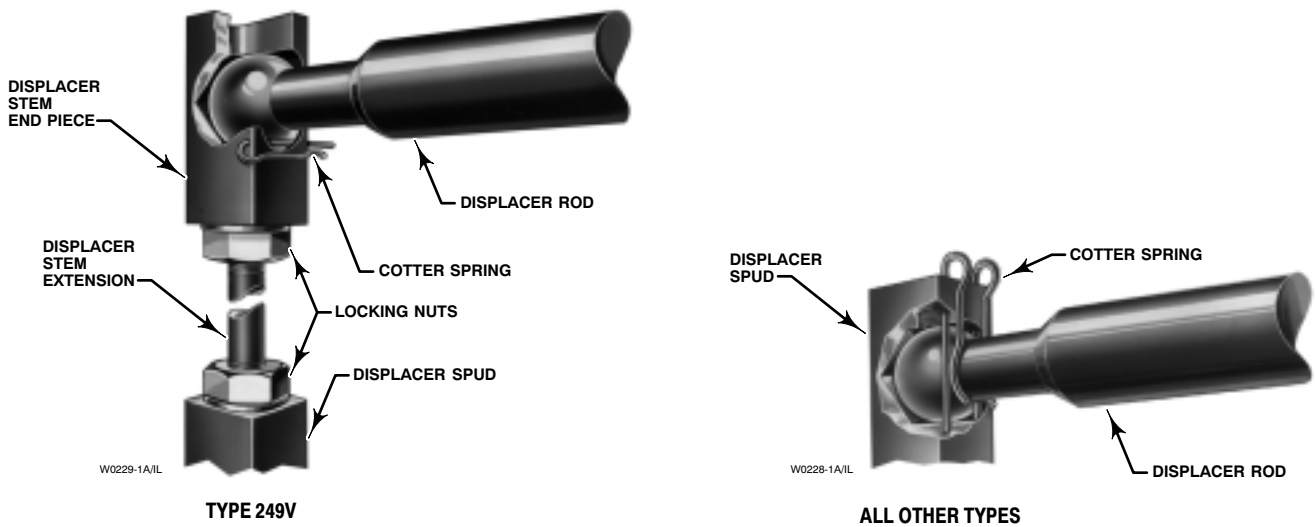


Figure 8. Displacer and Displacer Rod Connections

A special travel stop may be provided on top-mounted sensors to aid in servicing of the sensor. This option prevents dropping the displacer and stem when the displacer rod is disconnected.

### Supply and Output Pressure Connections



To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component where service conditions could exceed the limits given in this manual. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.

Figure 9 shows dimensions, locations, and connections for controller/transmitter installation. All pressure connections to the controller/transmitter are 1/4-inch NPT female.

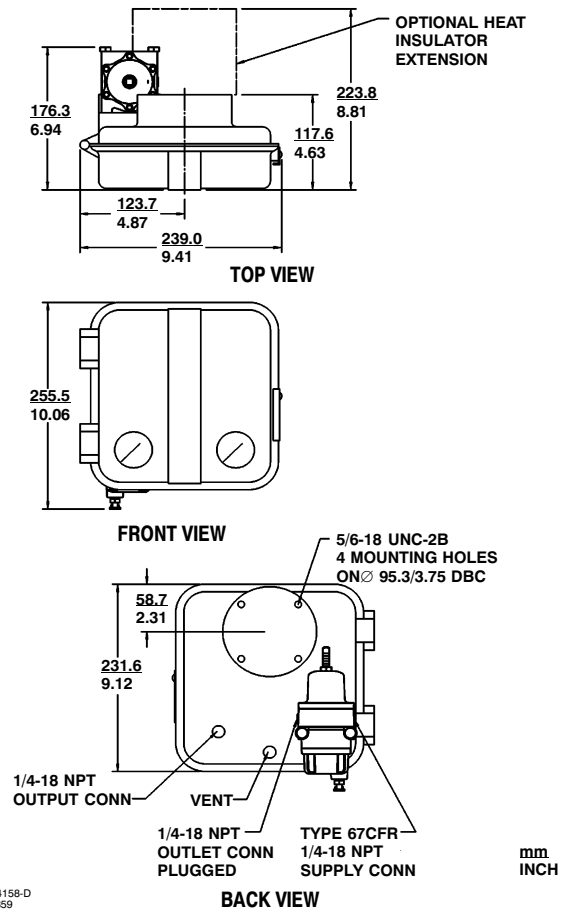


Figure 9. Controller/Transmitter Dimensions and Connections

# Type 2500

## Supply Pressure

### WARNING

**Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free, or a noncorrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend the level of filtration equipment required to prevent performance degradation of pneumatic equipment. A filter or filter regulator capable of removing particles 40-microns in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.**

Supply pressure must be clean, dry air or noncorrosive gas that meets the requirements of ISA Standard S7.3-1975 (R1981). Use a suitable supply pressure regulator to reduce the supply pressure to the normal operating supply pressure shown in table 3. As shown in figure 9, a Type 67FR filter/regulator mounts on the back of the controller/transmitter case and mates with the supply pressure connection on the controller/transmitter case. Pipe the supply pressure to the IN connection of the regulator. Typically, the Type 67FR filter/regulator accepts supply pressures between 2.5 and 17 bar (35 and 250 psig). For specific regulator limits, refer to the appropriate regulator instruction manual.

If operating the controller or transmitter from a high pressure source [up to 138 bar (2000 psig)], use a high pressure regulator system, such as the Type 1367 High Pressure Instrument Supply System. For Type 1367 system installation, adjustment, and maintenance information, see the separate instruction manual.

## Controller/Transmitter Output Connection

As shown in figure 9, the output pressure connection is on the back of the controller/transmitter case. After connecting the output pressure line, turn on the

supply pressure, adjust the filter/regulator to the appropriate supply pressure required for the controller/transmitter and check all connections for leaks.

## Prestartup Checks

Adjustments are shown in figure 10 unless otherwise indicated. Open-loop conditions must exist when performing the prestartup checks. To obtain open-loop conditions:

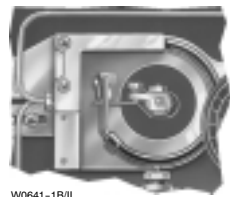
- make sure there is no process flow through the final control element, or
- disconnect the controller/transmitter output signal line and connect it to a pressure gauge.

During prestartup, the displacer must be positioned from its maximum to its minimum range of operation. Provide a means to change the process variable (the process level or interface). If the process variable cannot be varied sufficiently, use the precalibration procedures in the Calibration section to simulate the process variable changes required for these checks.

Make sure the RAISE LEVEL dial on the controller is mounted with the correct side facing out. The dial is marked on both sides with an arrow. The arrow points to the left on one side and to the right on the other. When the sensor is mounted to the left of the controller/transmitter, the arrow on the raise level dial should point to the left, as shown in figure 10. If the sensor is to the right, the arrow should point to the right. If necessary, remove the two mounting screws, turn the dial over so the arrow points correctly, and reinstall the mounting screws. The level directions shown on the dial will be correct for both direct-acting and reverse-acting controllers. For a transmitter, use the same side of the ZERO ADJUSTMENT dial for both right- and left-hand sensor mountings.

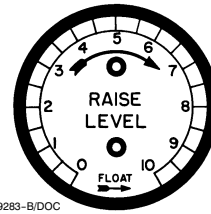
On a controller or transmitter with an optional mechanical indicator assembly, the travel indicator plate is also marked with an arrow on both sides. If the sensor is to the left of the controller/transmitter, the arrow on the plate should point to the left. If the sensor is to the right, the arrow should point to the right. If necessary, reinstall the plate so that the arrow points in the correct direction.





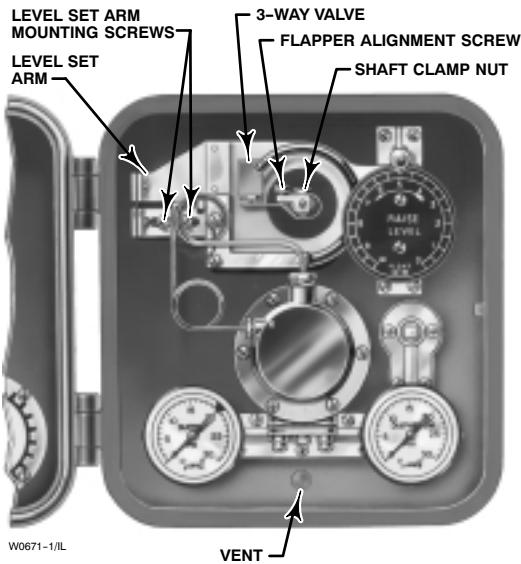
W0641-1B/IL

**BOURDON TUBE DETAIL OF  
TYPE 2500S ON-OFF  
CONTROLLER**



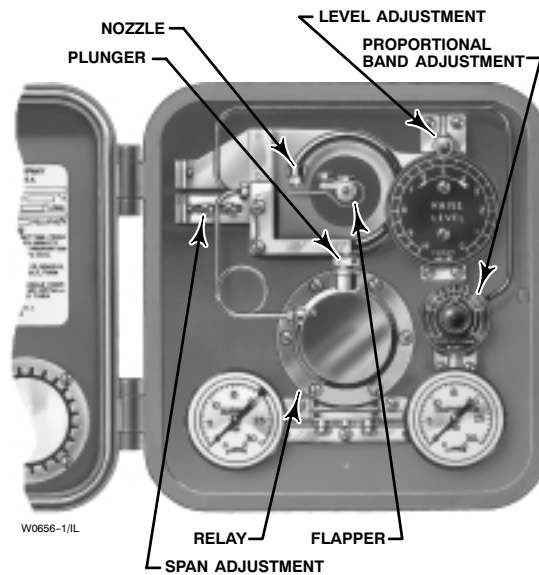
1C9283-B/DOC

**RAISE LEVEL DIAL FOR  
LEFT-HAND MOUNTING**



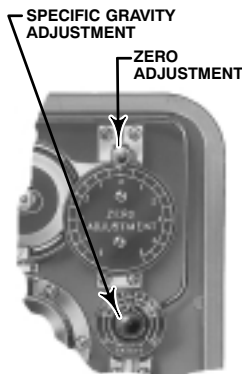
W0671-1/IL

**RIGHT-HAND MOUNTED TYPE 2503R  
ON-OFF CONTROLLER**



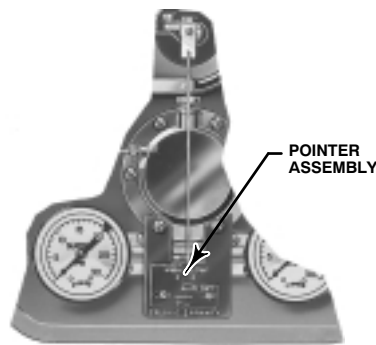
W0656-1/IL

**RIGHT-HAND MOUNTED TYPE 2500  
PROPORTIONAL CONTROLLER**



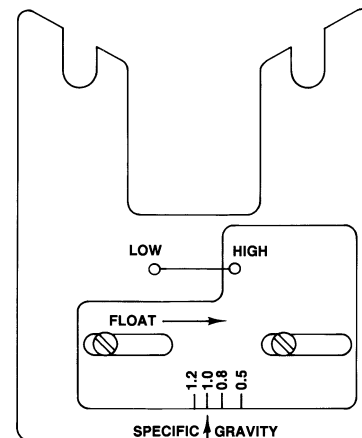
W0647-2B/IL

**DETAIL OF TRANSMITTER  
ADJUSTMENTS**



W0648-1B/IL

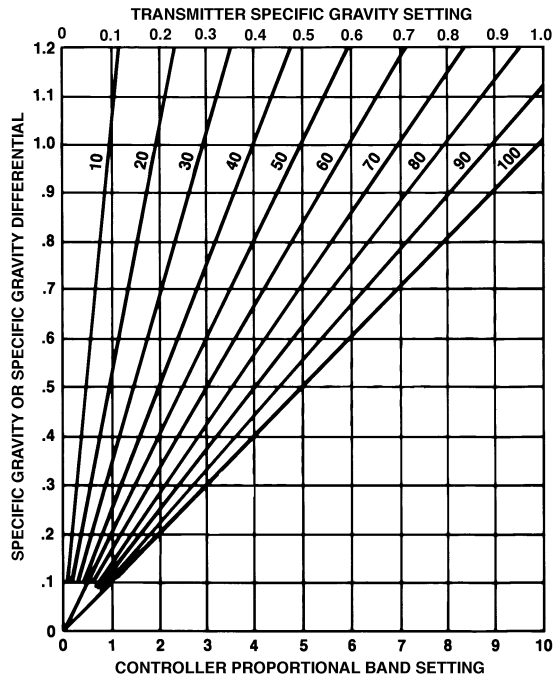
**INDICATOR ASSEMBLY WITH  
RIGHT-HAND MOUNTING**



1E8731  
1E8732  
A1897-1/IL

**TRAVEL INDICATOR PLATE  
FOR LEFT-HAND MOUNTING**

Figure 10. Adjustment Locations



NOTE:  
EACH CURVE MARKED WITH PERCENTAGE OF DISPLACER USED.  
1C9259-G  
A3891-1/IL

Figure 11. Proportional Band and Specific Gravity Setting Chart (chart assumes standard wall torque tube and displacer volume in table 2)

Set the PROPORTIONAL BAND control on a Type 2500 or 2500S controller, or the SPECIFIC GRAVITY control on a Type 2500T transmitter, as follows:

- Sensor with Both Standard Torque Tube and Standard Volume Displacer**—If the torque tube is standard and the displacer volume is close to that listed in table 2, use figure 11 to find the PROPORTIONAL BAND or SPECIFIC GRAVITY setting. Locate the specific gravity of the process fluid on fluid level applications, or the difference between minimum and maximum specific gravity on interface level or density applications, on the vertical axis of the chart. From this location, trace horizontally to the curve with the desired percentage of displacer used, then trace vertically up or down to determine the proper dial setting on the horizontal axis.

- Sensor with Nonstandard Torque Tube and/or Displacer with Other than Standard Volume**—If the construction does not have a standard wall torque tube or has a displacer volume that deviates significantly from the volume listed in table 2, or both, the PROPORTIONAL BAND or SPECIFIC GRAVITY dial setting does not

necessarily indicate the actual proportional band or specific gravity. To determine the correct dial setting, solve the following equation:

$$\text{Corrected Dial Setting} = \left(\frac{L}{100}\right)(\text{SP GR})\left(\frac{V_a}{V_r}\right)(X)$$

Required

where:

L = percentage of displacer length desired for full output pressure change (e.g., if 80% of displacer is used, L = 80)

SP GR = specific gravity of the process fluid (for interface level control, use the difference between the specific gravity of the two fluids; for specific gravity control, use the difference between the upper and lower range limits of specific gravity).

$V_a$  = actual displacer volume, cubic inches listed on the sensor nameplate.

$V_r$  = standard displacer volume, cubic inches, from table 2.

X = torque tube factor (1.0 for standard torque tubes, 2.0 for thin-wall torque tubes, or 0.5 for heavy-wall torque tubes).

### Type 2500 Controller or 2500T Transmitter

#### Note

**In the following steps the output pressure can go as high as the controller supply pressure.**

- Turn on the supply pressure and check that the supply pressure gauge reads 1.4 bar (20 psig) for a 0.2 to 1 bar (3 to 15 psig) or 2.4 bar (35 psig) for a 0.4 to 2 bar (6 to 30 psig) output pressure range. If the pressure is incorrect, loosen the locknut of the Type 67FR filter/regulator (figure 9); turn the adjusting screw clockwise to increase the pressure or, counterclockwise to decrease the pressure. Tighten the locknut after setting the regulator pressure.
- Set the process variable to its minimum value.
- Make sure that the PROPORTIONAL BAND or SPECIFIC GRAVITY control is at the setting

*Table 4. Recommended Settings For Pre-Startup Checks*

MOUNTING	ACTION	RECOMMENDED RAISE LEVEL SETTING FOR TYPE 2500 CONTROLLER		RECOMMENDED ZERO ADJUSTMENT SETTING FOR TYPE 2500T TRANSMITTER	
		For Predetermined PROPORTIONAL BAND Dial Setting of 10	For Predetermined PROPORTIONAL BAND Dial Setting of 0	For Predetermined SPECIFIC GRAVITY Dial Setting of 1.0	For Predetermined SPECIFIC GRAVITY Dial Setting of 0
Right-hand	Direct	3.0 to 3.5	4.0 to 4.5	1.5 to 2.0 to right	0.5 to 1.0 to right
	Reverse	6.5 to 7.0	0.5 to 1.0	1.5 to 2.0 to left	4.0 to 4.5 to right
Left-hand	Direct	3.0 to 3.5	4.0 to 4.5	1.5 to 2.0 to left	0.5 to 1.0 to left
	Reverse	6.5 to 7.0	0.5 to 1.0	1.5 to 2.0 to right	4.0 to 4.5 to left

1. For proportional band dial settings between 10 and 0 or for specific gravity dial settings between 1.0 and 0, interpolate the value.

determined earlier in this section. Then, set the RAISE LEVEL or ZERO ADJUSTMENT control at an appropriate value according to table 4. This table gives recommended settings based on maximum and minimum possible PROPORTIONAL BAND and SPECIFIC GRAVITY settings. If an intermediate PROPORTIONAL BAND or SPECIFIC GRAVITY setting is necessary, extrapolation may be used to determine an appropriate RAISE LEVEL or ZERO ADJUSTMENT setting.

**Note**

**The raise level dial does not reflect actual fluid level in the tank or fluid level position on the displacer.**

4. The OUTPUT gauge on a 0.2 to 1 bar (3 to 15 psig) range should read 0.2 bar (3 psig) for direct or 1 bar (15 psig) for reverse action. On a 0.4 to 2 bar (6 to 30 psig) range the OUTPUT gauge should read 0.4 bar (6 psig) for direct or 2 bar (30 psig) for reverse action.

5. On a controller or transmitter with a mechanical indicator assembly, the pointer should be over the LOW point on the indicator plate. If a slight adjustment is necessary, loosen the side hex clamp nut (key 40, figure 16), shift the pointer, and retighten the nut.

6. Increase the process variable to the level desired for full output change. The OUTPUT gauge on a 0.2 to 1 bar (3 to 15 psig) range should read 1 bar (15 psig) for direct or 0.2 bar (3 psig) for reverse action. On a 0.4 to 2 bar (6 to 30 psig) range the OUTPUT gauge should read 2 bar (30 psig) for direct or 0.4 bar (6 psig) for reverse action. On a controller or transmitter with an indicator assembly, the pointer should be over the HIGH point on the indicator plate; slight plate adjustment may be necessary, as described at the end of step 5.

7. If all prestartup checks are satisfactory, go to the startup procedure. If performance is unsatisfactory, proceed to the Calibration section.

**Type 2500S Controller**

**Note**

**In the following steps the output pressure can go as high as the controller supply pressure.**

1. Turn on the supply pressure and check that the SUPPLY pressure gauge reads 1.4 bar (20 psig) for a 0 to 1.4 bar (0 to 20 psig) output pressure range or 2.4 bar (35 psig) for a 0 to 2.4 bar (0 to 35 psig) output pressure range. If the pressure is incorrect, loosen the locknut of the Type 67FR filter/regulator (figure 9); turn the adjusting screw clockwise to increase the pressure or counterclockwise to decrease pressure. Tighten the locknut after setting the pressure.

2. Set the process variable to its minimum value.

3. On a controller with a mechanical indicator assembly, the pointer should be over the LOW point on the indicator plate. If a slight adjustment is necessary, loosen the hex clamp nut (key 40, figure 16), shift the pointer and retighten the nut.

**Note**

**Adjustment of the RAISE LEVEL control can set the switching points anywhere within the length of the displacer. Be careful not to set the switching points so that one is off the displacer.**

4. Make sure that the PROPORTIONAL BAND control is at the setting determined in the previous procedures. Set the RAISE LEVEL control to 0, then set it to 1.0 for a direct-acting or 4.0 for a reverse-acting controller.

## Type 2500

5. The OUTPUT gauge should read 0 bar (0 psig) for direct or supply pressure for reverse action.
6. Increase the process variable until the OUTPUT gauge changes to either supply pressure for direct or 0 bar (0 psig) for reverse acting. The process variable should be at the desired high trip value. On a controller with an indicator assembly, the pointer should be over the HIGH point on the indicator plate; slight adjustment may be necessary, as described at the end of step 3.
7. Decrease the process variable until the OUTPUT gauge changes to 0 bar (0 psig) for direct or supply pressure for reverse action (depending on controller range). The process variable should be at the desired low trip value.
8. If all prestartup checks are satisfactory, proceed to the Startup section. If performance is unsatisfactory, proceed to the Calibration section.

### Type 2503 Controller

#### Note

**In the following steps the output pressure can go as high as the controller supply pressure.**

#### Note

**Since the Type 2503 controller has no proportional valve, the differential gap between switching points is adjusted by varying the supply pressure. This gap can be varied from approximately a 89 mm (3.5-inch) level change at 1 bar (15 psig) to a 152 mm (6.0-inch) level change at 1.7 bar (25 psig) with a standard volume displacer and a fluid with a specific gravity of 1.0. The gap also varies inversely according to density; a fluid with 0.8 specific gravity produces a 112 mm (4.4-inch) level change at 1 bar (15 psig) to a 191 mm (7.5-inch) change at 1.7 bar (25 psig). Set the gap at a pressure low enough to be compatible with the limitations of the diaphragm control valve or other final control element.**

1. Turn on the supply pressure. If necessary, adjust the Type 67FR regulator to produce the desired differential gap by loosening the locknut (figure 9) and turning the adjusting screw clockwise to

- increase or counterclockwise to decrease pressure. Tighten the locknut.
2. Locate the process variable at its minimum value.

#### Note

**Adjustment of the RAISE LEVEL control can set the switching points anywhere within the length of the displacer. Be careful not to set the switching points so that one is off the displacer.**

3. Set the RAISE LEVEL control to 0 and then reset it as follows:
  - a. For direct-acting controllers, set it between 1.0 and 1.5.
  - b. For reverse-acting controllers, set it between 3.5 and 4.0.
4. The OUTPUT gauge should read 0 bar (0 psig) for direct or full supply pressure for reverse action.
5. Increase the process variable until the OUTPUT gauge changes to full supply pressure for direct or 0 bar (0 psig) for reverse action. The process variable should be at the desired high trip value.
6. Decrease the process variable until the OUTPUT gauge changes to 0 bar (0 psig) for direct or full supply pressure for reverse action. The process variable should be at the desired low trip value.
7. If all prestartup checks are satisfactory, proceed to the Startup section. If performance is unsatisfactory, proceed to the Calibration section.

### Adjustments

This section explains controller/transmitter action and adjustments. Figure 10 shows adjustment locations.

#### Control Action

The following is a definition of control action.

- **Direct Action**—Increasing fluid level, interface level, or density, increases the output signal.
- **Reverse Action**—Increasing fluid level, interface level, or density, decreases the output signal. Controller/transmitters factory-set for reverse-acting have the suffix letter R added to their type number.

The control action is determined by the cage head mounting position and by the Bourdon tube-flapper arrangement in the controller/transmitter. Refer to figure 4 for mounting positions and to figure 15 for Bourdon tube-flapper arrangements. To change the action, refer to the changing action procedure in the Maintenance section.

### ***Level Adjustment (Controllers Only)***

To make a level adjustment, open the controller cover, loosen the knurled adjustment screw, and rotate the adjustment lever around the RAISE LEVEL dial. To raise the fluid or interface level, or increase density, rotate this knob in the direction of the arrows. To lower the level or decrease density, rotate the knob in the opposite direction. This procedure is the same for either direct or reverse action. Tighten the knurled screw.

#### **Note**

**The raise level dial does not reflect actual fluid level in the tank or fluid level position on the displacer.**

### ***Zero Adjustment (Transmitters Only)***

To make a zero adjustment, open the transmitter cover, loosen the adjustment screw and rotate the adjustment lever around the ZERO ADJUSTMENT dial. This adjustment sets the output pressure to correspond to a specific level on the displacer. Tighten the knurled screw.

### ***Proportional Band Adjustment (Except Transmitters and 2503 Series Controllers)***

The proportional band adjustment varies the amount of process variable change required to obtain a full output pressure change. To perform this adjustment, open the controller cover and turn the PROPORTIONAL BAND adjustment (see figure 10). Refer to the prestartup check procedures to determine the proper setting.

### ***Specific Gravity Adjustment (Transmitters Only)***

This adjustment also varies the amount of process variable change required to obtain a full output

pressure change. To perform this adjustment, open the transmitter cover and turn the SPECIFIC GRAVITY adjustment (see figure 10). Refer to the prestartup check procedures to determine the proper setting.

## **Calibration**

### **Precalibration Requirements**

The controller/transmitter can be calibrated in the field, mounted on the vessel containing the process fluid. It may also be done in the shop, but other means of obtaining a displacement force change must be provided. There are wet and dry methods of adapting the calibrating procedure.

#### ***Wet Calibration***

Remove the entire controller/transmitter and sensor assembly from the vessel. For caged sensors, pour the fluid into the cage. For cageless sensors, suspend the displacer to an appropriate depth in a fluid having a specific gravity equal to that of the process fluid.

If necessary, you may use water for wet calibration in the shop. You must compensate for the difference between the specific gravities of water and the process fluid, however. As an example, assume the process fluid has a specific gravity of 0.7. The specific gravity of water is 1.0. To simulate a process level of 50 percent of the input span, would require a water level of 35 percent ( $0.7/1.0 \times 50$  percent = 35 percent).

#### ***Dry Calibration***

Remove the controller/transmitter and torque tube arm, as a single unit, from the cage or vessel. Then, wherever the standard calibration procedures in this manual require a specific process variable input to the sensor, simulate the process variable by suspending the proper weight (such as a can of sand) from the end of the displacer rod. Complete the following procedures (Controller/Transmitter and Torque Tube Arm Disassembly) and (Determining the Amount of Suspended Weight) before proceeding to the Calibrating Procedure.

# Type 2500

## Controller/Transmitter and Torque Tube Arm Disassembly

### WARNING

To avoid personal injury from contact with the process fluid, lower the vessel level below the sensor torque tube arm, or shut off the cage equalizing valves and drain the cage before proceeding. For closed vessels, release any pressure that may be in the vessel before removing the sensor assembly.

When removing the displacer from the displacer rod or removing the controller/transmitter and torque tube arm from the cage or vessel, refer to the appropriate 249 Series instruction manual for assistance. The method of removing the displacer or torque tube arm and attached controller/ transmitter varies with the type of sensor.

For a caged sensor with top equalizing connection, it may be appropriate to remove the entire cage from the vessel before disassembling.

### CAUTION

If the displacer is to be disconnected from the displacer rod before the sensor assembly is removed from the cage or vessel, provide a means of supporting the displacer to prevent it from dropping and suffering damage. The spuds or stem end pieces on all displacers have holes suitable for inserting rods or other supports.

Additionally, a threaded rod may be installed into the 1/4-inch 28 UNF threaded hole in the displacer spud or stem end piece of top-mounted cageless and all caged sensors. For some top-mounted sensors with long displacers, the sensor may be removed through the access hole in the sensor head.

For Type 249BP sensors with travel stop, the stem end piece pins will secure the displacer on the travel stop as long as the travel stop plate is installed and the sensor head is in position.

## Determining the Amount of Suspended Weight

### CAUTION

Avoid overloading a torque tube sized for interface or density applications. Consult your Fisher Controls sales office or sales representative for the maximum allowable substitute weight,  $W_s$ , that may be used with your particular construction.

To determine the total weight that must be suspended from the displacer rod to simulate a certain condition of fluid level or specific gravity, solve the following equation:

$$W_s = W_d - [(0.0361)(V)(SP GR)]$$

where:

$W_s$  = Total suspended weight in pounds (should never be less than 0.5 pounds). For a unit with a horizontal displacer, make sure the center of gravity of the substitute weight is where it would be on the actual displacer.

#### Note

For liquid level control only, simulate the lower range limit of the input span by suspending the displacer from the displacer rod. For other values of input span, remove the displacer and suspend the appropriate weight as determined in the equation above.

$W_d$  = Weight of the displacer, in pounds (determine by weighing displacer).

Table 5. Minimum and Maximum Limits for Setting Process Variables

APPLICATION	MINIMUM LIMIT	MAXIMUM LIMIT
Liquid Level	Displacer must be completely out of liquid	Displacer must be completely submerged in liquid
Interface	Displacer must be completely submerged in lighter of two process liquids	Displacer must be completely submerged in heavier of two process liquids
Density	Displacer must be completely submerged in liquid having specific gravity of lowest range point	Displacer must be completely submerged in liquid having specific gravity of highest range point

0.0361 = Weight of one cubic inch of water (specific gravity = 1.0), in pounds.

V = Volume, in cubic inches, of the portion of the displacer submerged. Or,

$$V = (\pi/4) (\text{displacer diameter})^2 (\text{length of displacer submerged})$$

SP GR = Specific gravity of the process fluid at operating temperature.

For interface level measurement, the equation becomes:

$$W_s = W_d - [(0.0361)(V_l)(SP GR_l) + (0.0361)(V_h)(SP GR_h - SP GR_l)]$$

where:

V<sub>t</sub> = Total volume, in cubic inches, of the displacer.

SP GR<sub>l</sub> = Specific gravity of the lighter of the fluids at operating temperature.

V<sub>h</sub> = Volume, in cubic inches, of the portion of the displacer submerged in the heavier of the fluids.

Or,

$$V = (\pi/4) (\text{displacer diameter})^2 (\text{length of the displacer submerged})$$

SP GR<sub>h</sub> = Specific gravity of the heavier of the fluids at operating temperature.

## Calibration Procedure



### WARNING

**The following calibration procedures require taking the controller/transmitter out of service. To avoid personal injury and property damage caused by an uncontrolled process, provide some temporary means of control for the process before taking the controller/transmitter out of service.**

Figure 10 shows adjustment locations, except as otherwise indicated. In order to calibrate, open-loop conditions must exist. One way to obtain an open loop is to ensure that there is no flow through the final control element. Another way to obtain an open loop is to disconnect the controller/transmitter output signal line and plug the output connection with a test pressure gauge.

Several steps in these calibrating procedures require setting the process variable at its minimum and maximum limits, according to table 5.

### Note

**If the process cannot be varied readily or the Wet Calibration method cannot be used in the following steps, be sure to use the proper sequence of correct weights as found in the Determining Amount of Suspended Weight procedure. Whenever the following steps require particular prestartup checks, refer to the appropriate procedures for: Type 2500 Controller or 2500T Transmitter, Type 2500S Controller, or Type 2503 Controller.**

### Type 2500 Controller and 2500T Transmitter

1. Turn on the supply pressure and check that it is set according to the appropriate prestartup checks procedure.

# Type 2500

2. Make sure that the PROPORTIONAL BAND or SPECIFIC GRAVITY adjustment is at the setting determined according to the appropriate prestartup check procedure.

3. Adjust the RAISE LEVEL (Type 2500) or ZERO ADJUSTMENT (Type 2500T) to the appropriate value per table 4. This table gives recommended settings based on maximum and minimum possible PROPORTIONAL BAND (Type 2500) or SPECIFIC GRAVITY (Type 2500T) settings. If an intermediate PROPORTIONAL BAND or SPECIFIC GRAVITY setting is necessary, extrapolation may be used to determine a new RAISE LEVEL or SPECIFIC GRAVITY setting.

4. Set the process variable to the minimum value of the input range as shown in Table 5. For constructions with an indicator assembly, make sure that the pointer is over the LOW mark.

### Note

**In the following step, the alignment screw (key 33, figure 16) always must remain screwed in far enough to provide spring tension on the underside of the alignment screw head.**

5. Adjust the flapper (key 32, figure 16) to obtain the appropriate pressure listed below. For coarse flapper adjustment, loosen the hex nut (key 40, figure 16) and rotate the flapper assembly about the torque tube shaft. For fine flapper adjustment, turn the flapper alignment screw (key 33, figure 16).

- **For Direct Acting Type 2500, 2500T**, 0.2 bar (3 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 0.4 bar (6 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output.

- **For Reverse Acting Type 2500, 2500T**, 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output.

6. Visually examine the nozzle and flapper to ensure the nozzle is as square as possible with the flapper. The nozzle can be realigned by loosening the Bourdon tube mounting screws (key 45, figure 16) and rotating the Bourdon tube slightly. If the nozzle is realigned, tighten the mounting screws and repeat step 5.

7. Set the process variable to the maximum value of the input range as shown in table 5.

8. The output pressure should be:

- **For Direct Acting Type 2500, 2500T**, 1.0 bar (15 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 2.0 bar (30 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output.

- **For Reverse Acting Type 2500, 2500T**, 0.2 bar (3 psig) for a 0.2 to 1.0 bar (3 to 15 psig) output or 0.4 bar (6 psig) for a 0.4 to 2.0 bar (6 to 30 psig) output.

9. If the output pressure agrees with that shown in step 8, proceed to step 10. If the output pressure does not agree, go to step 11.

10. If the unit does not contain an indicator assembly, go to the Startup section. If the unit contains an indicator assembly, change the pointer span by loosening the indicator plate screws (key 41, figure 16, detail of indicator assembly), slide the plate until the HIGH mark is under the pointer. Tighten the plate screws and go to the Startup section.

### Note

**Any sliding of the level set arm (key 28, figure 16) in the following step changes the zero as well as the output pressure span.**

11. To adjust the output pressure span, loosen the two level set mounting screws (see figure 16) and slide the flexure strip base (key 27) right or left along the elongated slotted hole as follows:

- To **increase** the output pressure span, slide the flexure strip base away from the torque tube shaft.

- To **decrease** the output pressure span, slide the flexure strip base toward the torque tube shaft.

Retighten the screws. If the flexure strip base has been moved as far as possible and the output pressure span is still too large or too small, proceed to step 13.

12. Repeat the procedure from step 4 until the required calibration points are obtained.

### Note

**Any change of the PROPORTIONAL BAND or SPECIFIC GRAVITY adjustment in the following step changes the zero as well as the output pressure span.**

13. If the flexure strip base has been moved as far as possible and the output pressure span is still too



large or too small, slightly adjust the PROPORTIONAL BAND or SPECIFIC GRAVITY adjustment as follows:

- If the output pressure span is too large, slightly increase the PROPORTIONAL BAND or SPECIFIC GRAVITY setting.

- If the output pressure span is too small, slightly decrease the PROPORTIONAL BAND or SPECIFIC GRAVITY setting.

14. Repeat the procedure from step 4 until the required calibration points are obtained.

**Note**

**If you cannot calibrate the controller or transmitter, look for other problems as described in the Troubleshooting procedures, such as leaking connections, or a binding displacer rod. If none of these troubles are apparent, ensure that the displacer is sized correctly for the application.**

**Type 2500S and 2503 Controllers**

1. Turn on the supply pressure and check that it is set according to the appropriate prestartup checks procedure.

2. Make sure that the PROPORTIONAL BAND adjustment (Type 2500S only) is at the setting determined according to the appropriate prestartup check procedure.

3. Perform one or the other of the following:

- **For direct acting controllers**, set the RAISE LEVEL adjustment between 1.0 and 1.5.

- **For reverse acting controllers**, set the RAISE LEVEL adjustment between 3.5 and 4.0.

4. Set the process variable at the minimum value of the input range as shown in table 5. For constructions with an indicator assembly, make sure that the pointer is over the LOW mark.

**Note**

**In the following step, the alignment screw (key 33, figure 16) always must remain screwed in far enough to provide spring tension on the underside of the alignment screw head.**

5. Be sure the flapper is centered over the nozzle. If not, loosen the hex nut (key 40, figure 16) and reposition the flapper, tighten the hex nut.

6. Adjust the flapper (key 32, figure 16) as described below. For coarse flapper adjustment, loosen the hex nut (key 40, figure 16) and rotate the flapper assembly about the torque tube shaft. For fine flapper adjustment, turn the flapper alignment screw (key 33, figure 16).

- **For Direct Acting Controllers**, move the flapper toward the nozzle until the output pressure switches to full supply pressure, then carefully adjust the flapper away from the nozzle until the output pressure switches to 0 bar (0 psig).

- **For Reverse Acting Controllers**, move the flapper away from the nozzle until the output pressure switches to 0 bar (0 psig), then carefully adjust the flapper toward the nozzle until the output pressure switches to full supply pressure.

7. Slowly increase the process variable until the output pressure switches:

- **For Direct Acting Controllers**, slowly increase the process variable until the output pressure switches to full supply pressure. The process variable should be at the maximum value of input range as shown in table 5. If the process variable agrees with table 5, proceed with step 8. If the process variable does not agree with table 5, proceed to step 9.

- **For Reverse Acting Controllers**, slowly increase the process variable until the output pressure switches to 0 bar (0 psig). The process variable should be at the maximum value of input range as shown in table 5. If the process variable agrees with table 5, proceed with step 8. If the process variable does not agree with table 5, proceed to step 9.

8. If the unit does not contain an indicator assembly, go to the startup section. If the unit contains an indicator assembly, change the pointer span by loosening the indicator plate screws (key 41, figure 16, indicator assembly detail), slide the plate until the HIGH mark is under the pointer. Tighten the plate screws and go to the startup section.

**Note**

**Any sliding of the level set arm (key 28, figure 16) in the following step changes the zero as well as the differential gap.**

## Type 2500

9. To adjust the differential gap, loosen the two level set mounting screws (see figure 16) and slide the flexure strip base (key 27) right or left along the elongated slotted hole as follows:

- To **decrease** the differential gap, slide the flexure strip base away from the torque tube shaft.
- To **increase** the differential gap, slide the flexure strip base toward the torque tube shaft.

Retighten the screws. For the Type 2500S only, if the flexure strip base has been moved as far as possible and the differential gap is still too low, proceed to step 11.

10. Repeat the procedure from step 4 until the required calibration points are obtained.

### Note

**Any change in the PROPORTIONAL BAND adjustment in the following step changes the zero as well as the differential gap.**

11. If the flexure strip base has been moved as far as possible and the differential gap is still too large or too small, adjust the PROPORTIONAL BAND as follows:

- If the differential gap is too large, slightly decrease the PROPORTIONAL BAND setting.
- If the differential gap is too small, slightly increase the PROPORTIONAL BAND setting.

12. Repeat the procedure from step 4 until the required calibration points are obtained.

### Note

**If you cannot calibrate the controller, look for other problems as described in the Troubleshooting procedures, such as a nozzle that is not perpendicular to the flapper, leaky connections, or a binding displacer rod. If none of these troubles are apparent, ensure the displacer is sized correctly for the application.**

## Startup

Adjustment locations are shown in figure 10. The pre-startup or calibration procedures must be completed prior to startup.

### Type 2500 Controller

1. Slowly open the upstream and downstream manual control valves in the pipeline. If the pipeline has a bypass valve, close the valve.
2. If desired, adjust the proportional band to the narrowest (lowest) setting that maintains stable control. Proportional band adjustments will affect the process level and may require a level adjustment. If adjusting proportional band, make the adjustments in small increments.
3. To confirm the optimum proportional band setting, momentarily create a load upset. If cycling occurs, broaden (increase) the proportional band until process oscillations diminish rapidly. In general, the narrowest proportional band that does not produce cycling provides the best control.

### Type 2500T Transmitter

1. Make sure that the SPECIFIC GRAVITY and ZERO ADJUSTMENT controls are set according to the Type 2500 Controller or 2500T Transmitter portion of the pre-startup checks procedures.
2. Slowly open the upstream and downstream manual control valves in the pipeline. If the pipeline has a manual bypass valve, close the valve.

### Type 2500S Controller

1. Set the switching points according to the Type 2500S Controller portion of the prestartup checks procedures.
2. Slowly open the upstream and downstream manual control valves in the pipeline. If the pipeline has a manual bypass valve, close the valve.
3. If necessary, the proportional band may be adjusted to increase or decrease the differential gap. Adjust the RAISE LEVEL adjustment to reposition the differential gap. After readjustment, confirm the controller is still switching correctly at both switching points.

### Type 2503 Controller

1. Set the switching points according to the Type 2503 Controller portion of the prestartup checks procedures.

2. Slowly open the upstream and downstream manual control valves in the pipeline. If the pipeline has a manual bypass valve, close the valve.
3. If necessary, reposition the switching points by adjusting the RAISE LEVEL control. For example, if the differential gap is set for 102 mm (4-inches) of level change, this 102 mm (4-inches) can be set anywhere within the length of the displacer. After readjustment, confirm the controller is still switching correctly at both switching points.

## Principle of Operation

The controller/transmitter receives the change in fluid level, fluid-to-fluid interface level, or density from the change in the buoyant force the fluid exerts on the sensor displacer. The displacer, through a mechanical linkage, imparts a rotary motion to the torque tube shaft. This rotary motion positions the flapper according to the level position of the displacer; the nozzle/Bourdon tube arrangement sends a pneumatic signal to the relay valve.

All 2500 and 2503 Series controller/transmitters use the same basic pressure-balanced relay assembly. The following descriptions explain how the relay action produces the output signal with the various controller/transmitter constructions.

### Type 2500 Controller or 2500T Transmitter

Full supply pressure comes to the relay from the regulator, as shown in figure 12. The relay has a fixed restriction through which supply pressure bleeds before entering the large diaphragm area and the inner Bourdon tube channel. In a steady-state condition, the process level holds the torque tube and attached flapper steady in relation to the nozzle. This allows pressure to escape between the nozzle and flapper at the same rate it bleeds into the large diaphragm area. The large diaphragm holds the inlet end of the relay valve slightly open to compensate for the venting of output pressure through the proportional valve as it maintains a steady-state position of the final control element. The output pressure, through the three-way proportional valve, affects the Bourdon tube outer channel, holding the Bourdon tube in a steady-state position.

A process level change raises or lowers the displacer, moving the flapper with respect to the

nozzle. If the process level change increases nozzle pressure, the large diaphragm moves down; this closes the exhaust end and opens the inlet end of the relay valve (see figure 12). This action of the relay valve increases the output pressure to the final control element. Since the area ratio of the large diaphragm to the small diaphragm is three-to-one, the small diaphragm action amplifies the output pressure change. The three-way proportional valve lets the increase in output pressure apply to the Bourdon tube outer channel. The expansion of the Bourdon tube moves the nozzle away from the flapper slowing the response of the pneumatic circuit.

If the process level change decreases the nozzle pressure, the large diaphragm moves up. This action closes the inlet end and opens the exhaust end of the relay valve which allows output pressure to exhaust. This relay valve action reduces the output pressure to the final control element and is the reverse of the previous explanation.

The proportional valve varies the reaction of the Bourdon tube to changes in the output pressure. For additional information on the proportional valve action, refer to the following proportional valve subsection.

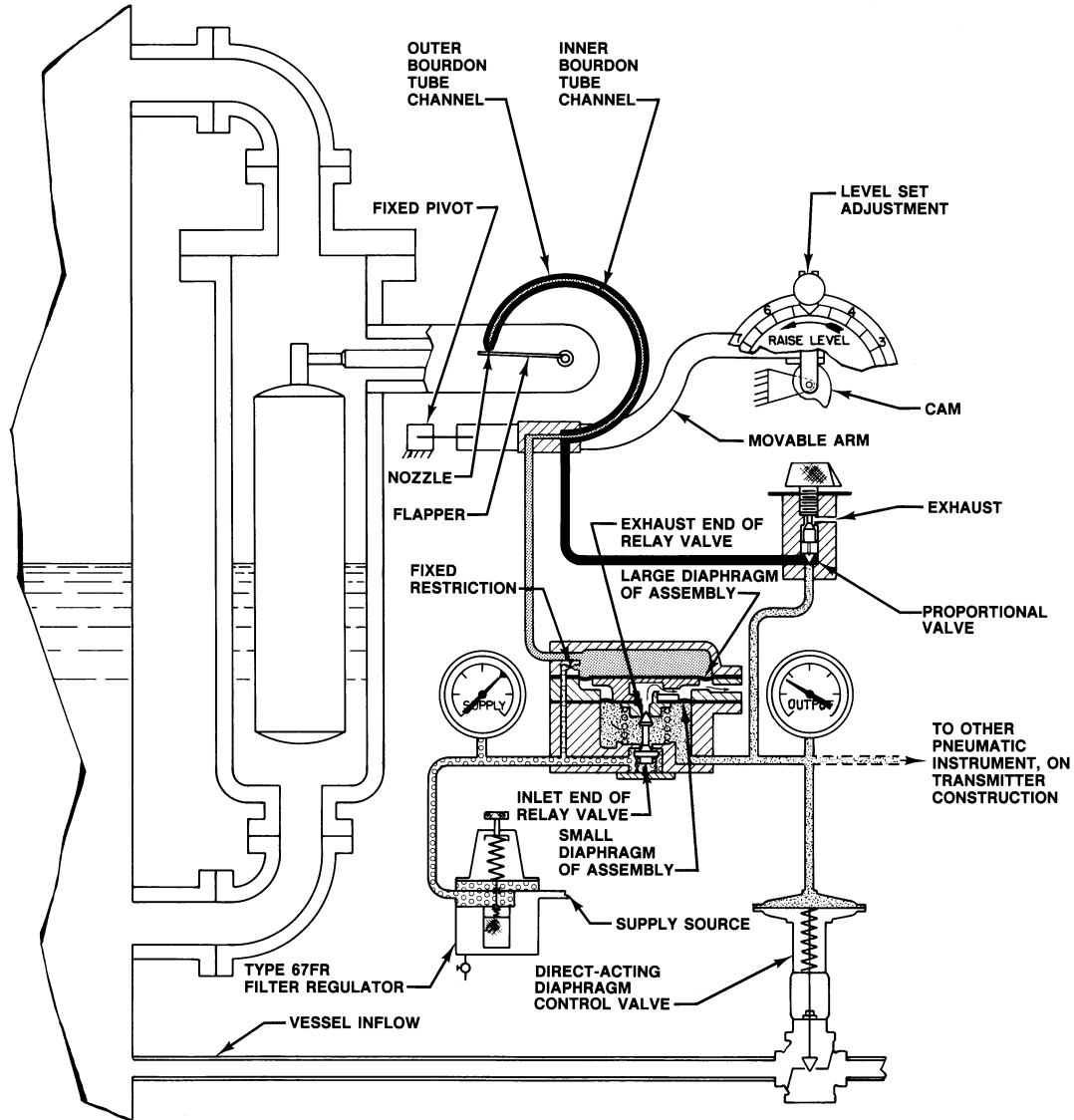
### Proportional Valve






The three-way proportional valve is adjustable to allow some or all of the output pressure change to feed back to the Bourdon tube outer channel, providing proportional band control (see figure 12). The Bourdon tube moves to counteract the pressure changes in the nozzle, equaling the relay diaphragm pressure differential. The relay valve maintains a new output pressure according to the change in the process variable.

A wide-open proportional valve (fully counterclockwise) permits feedback of the output pressure signal change and produces 100 percent proportional response. A closed (fully clockwise) proportional valve produces smaller proportional responses, because part of the output pressure change vents through the proportional valve exhaust.

### Type 2500S Controller

This construction has the same flapper, relay, and proportional valve as the Type 2500 controller. However, the nozzle is connected (figure 12) in such a way that output pressure feedback (from the



-  SUPPLY PRESSURE
-  OUTPUT PRESSURE
-  NOZZLE PRESSURE
-  PROPORTIONAL PRESSURE
-  EXHAUST

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BO998-1/L

Figure 12. Direct-Acting, Right-Hand-Mounted 2500-249 Series Controller/Transmitter

movement of the Bourdon tube) moves the nozzle in the opposite direction of the flapper. This action completely opens the relay valve for full output pressure or completely closes the relay valve for full exhaust of the output pressure, allowing no in-between throttling.

### Type 2503 Controller

This construction has the same flapper and sensor arrangement as the Type 2500 controller, but its Bourdon tube has a three way valve operated by a plunger (see figure 13). Note that the switch point adjustment changes the position of the moveable

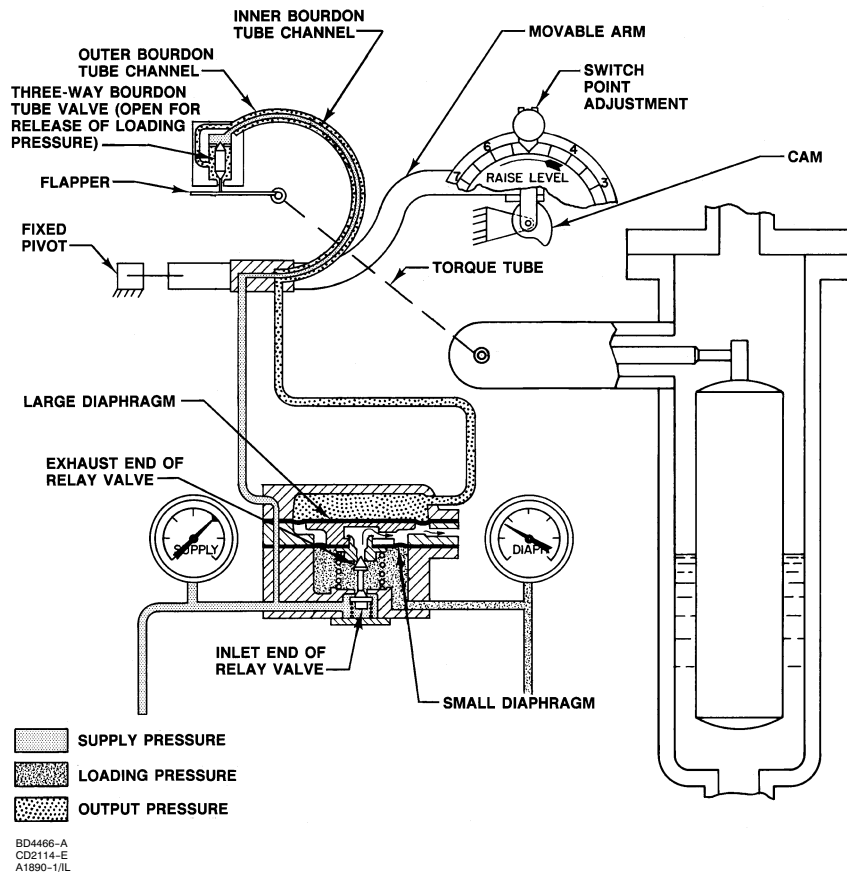


Figure 13. Direct-Acting Left-Hand-Mounted Type 2503 Controller

arm and attached Bourdon tube assembly; this in turn changes the switch point in relationship to the process level. The differential gap of the 2503 either completely opens the relay valve for full output pressure or completely closes the relay valve for full exhaust of the output pressure, allowing no in-between throttling.

For a direct-acting controller, as long as the process variable remains above the switch point, the flapper does not depress the plunger of the Bourdon tube valve. In this condition, the Bourdon tube valve remains closed, providing full loading pressure to the Bourdon tube. This loading pressure moves the Bourdon tube away from the flapper. Also, in this condition, full loading pressure is on the upper diaphragm of the relay. The loading pressure moves the diaphragm down, closing the exhaust end and opening the inlet end of the relay valve, allowing full output pressure.

When the process level sufficiently decreases, the flapper pushes in the plunger of the Bourdon tube

valve enough to release the loading pressure and seal the inner Bourdon tube channel (see figure 13). This decrease in the loading pressure moves the Bourdon tube toward the flapper, producing the snap action. Also, this decrease in loading pressure allows relay spring pressure to move the large diaphragm up, closing the inlet end and opening the exhaust end of the relay valve,

allowing full exhaust of the output pressure. This control action continues until a sensor level change moves the flapper away from the plunger, permitting the Bourdon tube valve to close, restoring loading pressure to the pneumatic circuit. Reverse-acting controllers produce the opposite effect.

## Maintenance

The 2500 and 2503 Series controllers/transmitters work in combination with 249 Series displacers. Refer to figure 16 for key number locations, unless otherwise indicated.

# Type 2500

Due to the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher Controls.

## WARNING

**When replacing the sensor assembly, the displacer may retain process fluid or pressure. Personal injury or property damage may occur due to sudden release of the pressure. Contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor assembly or removing the displacer. Before disassembling the sensor or removing the displacer, observe the more specific warning provided in the sensor instruction manual.**

## Troubleshooting

When troubleshooting, open loop conditions must exist unless otherwise stated. When monitoring the process variable, use the most accurate level indicating device available. The output signal measuring device should have corresponding accuracy.

Table 6 lists some common operating faults, their probable causes, and corrective action.

## Removing Controller/Transmitter from Sensor

### WARNING

**To avoid injury in the following steps, turn off the supply pressure and carefully release any pressure trapped in the controller/transmitter before breaking any pressure connection. Provide a bypass for the control device if continuous operation is required during maintenance.**

1. Disconnect the supply and output pressure tubing from the controller or transmitter. For a controller/transmitter with an indicator, remove the pointer assembly by referring to the section entitled Replacing the Bourdon Tube.
2. Loosen the top hex clamp nut (key 40, figure 16) and remove the flapper base (key 30, figure 16) from the torque tube rotary shaft.

## CAUTION

**If the hex clamp nut has not been loosened or the pointer removed according to step 2, attempting to remove the controller/transmitter from the sensor may bend the flapper or rotary shaft. Be careful that the back of the controller/transmitter case or the heat insulator does not drop down and bend the rotary shaft or shaft extension.**

3. Remove any insulating tape from the joint between the controller/transmitter case and the torque tube arm. Remove the four cap screws (key 39, figure 14) that hold the controller/transmitter or heat insulator to the torque tube arm. Pull the case straight out from the torque tube arm, easing it over the shaft coupling (key 36, figure 14) if one is installed.
4. If the controller/transmitter has a heat insulator, remove the four button head cap screws and washers (keys 40 and 53, figure 14) and remove the insulator assembly.

## Changing Mounting Methods

### WARNING

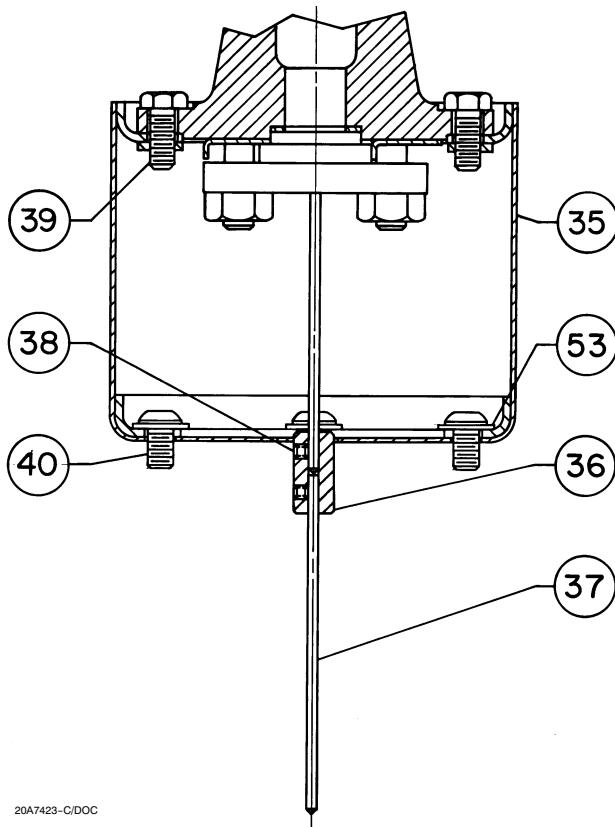
**To avoid personal injury from contact with the process fluid, lower the vessel fluid level below the torque-tube arm before proceeding. For closed vessels, release any pressure that may be above the fluid. Also, be careful to avoid overloading a thin-wall torque tube with an overweight displacer.**

Refer to figure 16 for key number locations.

1. Remove the controller/transmitter as described previously.

*Table 6. Troubleshooting Chart for 2500 Series Controller/Transmitters*

<b>FAULT</b>	<b>POSSIBLE CAUSE</b>	<b>CHECK</b>	<b>CORRECTION</b>
1. Process wanders or cycles around set point.	1.1 Proportional band or specific gravity adjustment incorrect or improperly tuned control loop.	Ensure the prestartup procedures are completed correctly. Tune control loop.	If stable control cannot be attained and all other elements are functionally correct, examine other possible causes related to the controller/transmitter.
	1.2 Supply pressure varying or incorrect supply pressure setting.	Use input pressure gauge to monitor stability. Make sure regulator IN supply pressure is within limits.	Apply correct supply pressure. Use one regulator per instrument.
	1.3 Sensor not plumb and is in contact with sidewall or leak in displacer.	Check cage vessel and stillwell installation, or for leaking displacer.	Make sure the displacer and displacer rod hangs freely. Make sure linkage is tight. Replace displacer if leaking.
	1.4 Relay malfunction.	Check for relay malfunction by using the testing relay deadband procedure.	Depress plunger to clean out the fixed restriction. Replace relay using the procedure in the Maintenance section.
2. Controller/transmitter controlling off set point or switching point.	2.1 Supply pressure not set correctly.	Make sure regulator supply pressure is set correctly. Make sure regulator IN supply pressure is within limits.	Reset the supply regulator pressure. If the condition occurs again, rebuild or replace regulator. Provide a regulator input pressure within regulator limits.
	2.2 Leak in the controller/transmitter loop.	Use soap and water to check for internal and external leaks.	Replace or repair leaking parts as necessary.
	2.3 Leaking displacer.	Ensure the displacer is not filling with process fluid.	Refer to sensor maintenance procedures in the appropriate sensor instruction manual.
	2.4 Flapper adjustment.	Ensure the flapper is not loose on the torque tube shaft and is centered on the nozzle.	Replace or tighten flapper assembly as necessary and/or center flapper on nozzle.
	2.5 Process variable changed.	Ensure the process variable has not changed from original calibration settings, or displacer not designed for specific gravity of process.	Change process variable back to original specification or recalibrate. If necessary, provide replacement displacer of correct size and recalibrate.
3. Controller/transmitter cannot attain full output range.	3.1 Supply pressure not set correctly.	Make sure supply pressure is set correctly. Make sure regulator IN supply pressure is within limits.	Reset the regulator pressure. If problem reoccurs, replace or rebuild the regulator. Ensure regulator IN supply pressure is within limits at all operating levels.
	3.2 Flapper adjustment.	Ensure the flapper is not loose on the torque tube shaft and is centered on the nozzle.	Replace or tighten flapper assembly as necessary and/or center flapper on nozzle.
	3.3 Process variable changed.	Ensure the process variable has not changed from original calibration settings, or from displacer's designed specific gravity.	Change process variable back to original specification or recalibrate. If necessary, provide replacement displacer of correct size and recalibrate.
	3.4 Relay malfunction	Check for relay malfunction by using the testing relay deadband procedure.	Depress plunger to clean out the fixed restriction. Replace relay using the procedure in the Maintenance section.
	3.5 Leak in the controller/transmitter loop.	Use soap and water to check for internal and external leaks.	Replace or repair leaking parts as necessary.
4. Controller/transmitter remains at full or zero output pressure.	4.1 Supply or output pressure gauge malfunction.	Ensure the pressure gauges are registering correctly.	Replace pressure gauges. Use corrective action given in section 3 of this table.
	4.2 Flapper adjustment.	Ensure the flapper is not loose on the torque tube shaft and is centered on the nozzle.	Replace or tighten flapper assembly as necessary and/or center flapper on nozzle.



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Figure 14. Heat Insulator for 249 Series Sensor

2. A controller/transmitter is attached to the sensor in one of the mounting positions shown in figure 4. Right-hand mounting is with the controller/transmitter case (key 1) to the right of the displacer (FLOAT), as you look at the front of the case, left-hand mounting is with the case to the left of the displacer. For a 249 Series sensor, remove the torque tube arm from the sensor or vessel and reinstall the torque tube arm in the opposite position according to the appropriate instruction manual. Note that the term FLOAT is marked on the RAISE LEVEL dial and the indicator plate, if one is used.

3. Check the desired control action. If the control action is not correct, refer to the changing action procedures to change it. Mount the Bourdon tube in one of the positions shown in figure 15.

4. The arrow on the RAISE LEVEL dial under the word FLOAT should point toward the displacer. If not, remove the dial from the controller, turn it over, and install it in the correct position.

5. For a controller/transmitter with an indicator assembly, the arrow near the word FLOAT on the

indicator plate should point toward the displacer. If it does not, remove the two screws (key 41, see detail of indicator assembly in figure 16), turn the front plate (key 54) to the side with the FLOAT arrow pointing toward the displacer, and secure the plate with the screws.

6. Install the controller/transmitter according to the next section.

### Installing Controller/Transmitter on Sensor

#### Note

If the installation is in a location that is not readily accessible and shop calibration is required, remove the torque tube arm from the cage or vessel before installing the controller or transmitter to the sensor. Install the controller/transmitter on the torque tube arm in the shop; then calibrate and return the controller/transmitter with the torque tube arm assembly attached for installation.

Perform step 1 only if adding a heat insulator to a unit that does not have one. Key numbers in this step are shown in figure 14.

1. To install the heat insulator, secure the shaft extension (key 37) to the torque tube assembly rotary shaft with the shaft coupling (key 36). Tighten both set screws (key 38), with the coupling centered as shown in figure 14. Then mount the insulator assembly (key 35) on the controller/transmitter case with four button head cap screws and washers (keys 40 and 53). Tighten the screws.

### CAUTION

In the following step, avoid bending the rotary shaft of the torque tube assembly. Bending or side loading of this shaft could cause erroneous readings. Additionally, make sure the ball bearing assembly (key 12, figure 16) is removed from the case (key 1, figure 16) to provide clearance when installing the case on the sensor.

2. Remove the bearing assembly (key 12, figure 16) from the case (key 1, figure 16).

3. Carefully slide the controller/transmitter case straight in. Secure the case on the torque arm or insulator with the four cap screws (key 39).



**Note**

**If a heat insulator is used, do not insulate its exterior.**

4. Slide the bearing assembly (key 12, figure 16) onto the shaft or shaft extension of the insulator, and install the bearing assembly (key 12, figure 16) into the case (key 1, figure 16).
5. Install the flapper base (key 30, figure 16) on the torque tube rotary shaft, making sure the flapper is centered over the nozzle or Bourdon tube valve. Secure the base with the hex nut (key 40, figure 16). For a controller/transmitter with an indicator assembly, install the pointer assembly according to the section entitled Replacing the Bourdon Tube.
6. Connect the supply and output pressure tubing and perform the calibration procedure.

**Replacing the Bourdon Tube**

Refer to figure 16 for key number locations.

1. Disconnect the tubing (key 10 for Type 2503 and key 11 for Type 2500) from the Bourdon tube base. For a controller/transmitter with indicator assembly, loosen the side hex clamp nut (key 40) and remove the pointer assembly (key 51) from the torque tube rotary shaft.
2. Remove the mounting screws (key 45) and Bourdon tube assembly (key 16).
3. Inspect the Bourdon tube. Replace it if necessary, using a tube with a black color code for a 0.2 to 1 bar or 0 to 1.4 bar (3 to 15 psig or 0 to 20 psig) range. Use a tube with a red color code for a 0.4 to 2 bar or 0 to 2.4 bar (6 to 30 psig or 0 to 35 psig) range. The range is stamped at the Bourdon tube base.
4. Mount the Bourdon tube on the level set arm (key 28). Secure it with the mounting screws, using the proper orientation as shown in figure 15. Connect the tubing to the tube base, with tubing from the R connection on the relay (key 34) going to the marked base connection. The other tubing goes to the unmarked base connection. With an indicator assembly, install the pointer assembly on the rotary shaft and tighten the hex nut.
5. Perform the calibration procedure.

**Changing Action**

**Note**

**The following procedure is necessary to restore previous action if the mounting method has been changed. Figure 16 shows key numbers.**

1. Reposition the Bourdon tube (and indicator assembly, if used) according to steps 1 through 4 of the section entitled Replacing the Bourdon Tube.
2. Loosen the hex nut (key 40) and remove the flapper base (key 30) from the torque tube rotary shaft. Turn the flapper base over and install it on the rotary shaft, using the proper orientation as shown in figure 15 and making sure the flapper is centered over the nozzle or Bourdon tube valve.
3. Perform the calibration procedure.

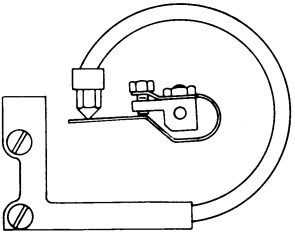
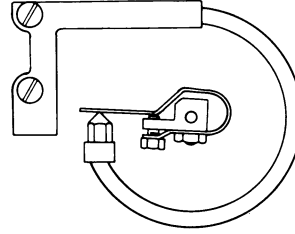
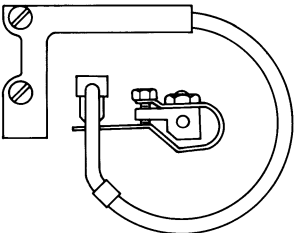
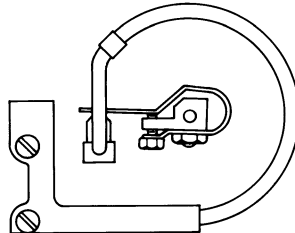
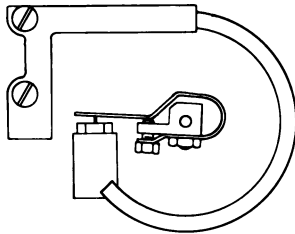
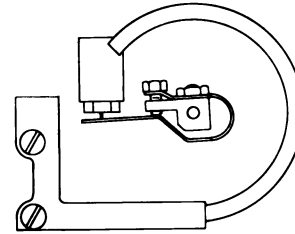
**Relay Deadband Testing (Type 2500 Controller or 2500T Transmitter Only)**

1. Replace the appropriate (proportional or specific gravity) adjustment assembly with the 1/8-inch NPT pipe plug according to the section entitled Replacing the Proportional Valve.
2. Turn on the supply pressure and set it to 1.4 to 2.4 bar (20 or 35 psig), depending on the controller/transmitter operating range.
3. By changing the process variable and adjusting the RAISE LEVEL or ZERO ADJUSTMENT control, set the output pressure to 1.0 or 2.0 bar (15 or 30 psig). While monitoring the output pressure, slowly change the process variable until the output pressure just changes, and record the value of the process variable at the detection point.
4. Change the process variable in the opposite direction until the output pressure just changes and again record the value of the process variable. If the difference between the two recorded values (the deadband) is more than 0.2% of the maximum displacer length, the relay must be replaced or repaired according to the Changing Relay section.
5. Turn off the supply pressure, remove the pipe plug, and install the appropriate adjustment assembly.

**Replacing the Proportional Valve**

**Note**

**The following procedure, to convert to or from the pipe plug or the desired**

CONSTRUCTION	DIRECT ACTING—RIGHT HAND MOUNTING REVERSE ACTING—LEFT HAND MOUNTING	REVERSE ACTING—RIGHT HAND MOUNTING DIRECT ACTING—LEFT HAND MOUNTING
TYPE 2500 OR 2500T (INCLUDING C VERSIONS)		
TYPE 2500S (INCLUDING C VERSIONS)		
TYPE 2503		

AC9554  
AR8148  
BO996-1/IL

Figure 15. Bourdon Tube-Flapper Arrangements for Various Actions and Mountings

**adjustment assembly, can be used for any type number covered in this manual.**

1. Remove the tubing (key 10) from the proportional band valve assembly.
2. Unscrew the base of the PROPORTIONAL BAND or SPECIFIC GRAVITY adjustment assembly (key 36 or 90, figure 16), or the 1/8-inch NPT pipe plug (key 73, not shown), from the relay base (key 23, figure 16).
3. Install the pipe plug or the desired adjustment assembly into the relay base.
4. Replace the tubing (key 10) to the proportional band valve assembly.

## Changing Relay

The relay may be removed for cleaning or replacement.

### Removal

1. For a controller or transmitter with indicator assembly, loosen the two lower relay screws (key 96) and slide out the indicator base plate (key 53).
2. Disconnect the tubing (key 10 or 11) from the relay.
3. Remove both mounting screws, relay, and relay gasket (keys 43, 34, and 22).

### Replacement

1. Install a new gasket (key 22), the replacement relay (key 34), and secure with two mounting screws (key 43). On a controller or transmitter with an

indicator assembly, slide the base plate under the two lower screws of the relay case, align the plate so the pointer will read properly, and tighten the screws.

2. Connect the tubing (key 10 or 11) to the relay.
3. Test the relay deadband, according to the Relay Deadband Testing procedure in this section.
4. If the deadband is within tolerance, go to the Calibration section.

## Parts Ordering

Whenever corresponding with the sales representative about this equipment, use the controller/transmitter type number and the serial number. The serial number is found on the nameplate (key 215, figure 16). When ordering replacement parts, also state the complete 11-character part number of each part required as found in the following parts list.

## Parts List

Key	Description	Part Number
-----	-------------	-------------

### Controller Parts Kits

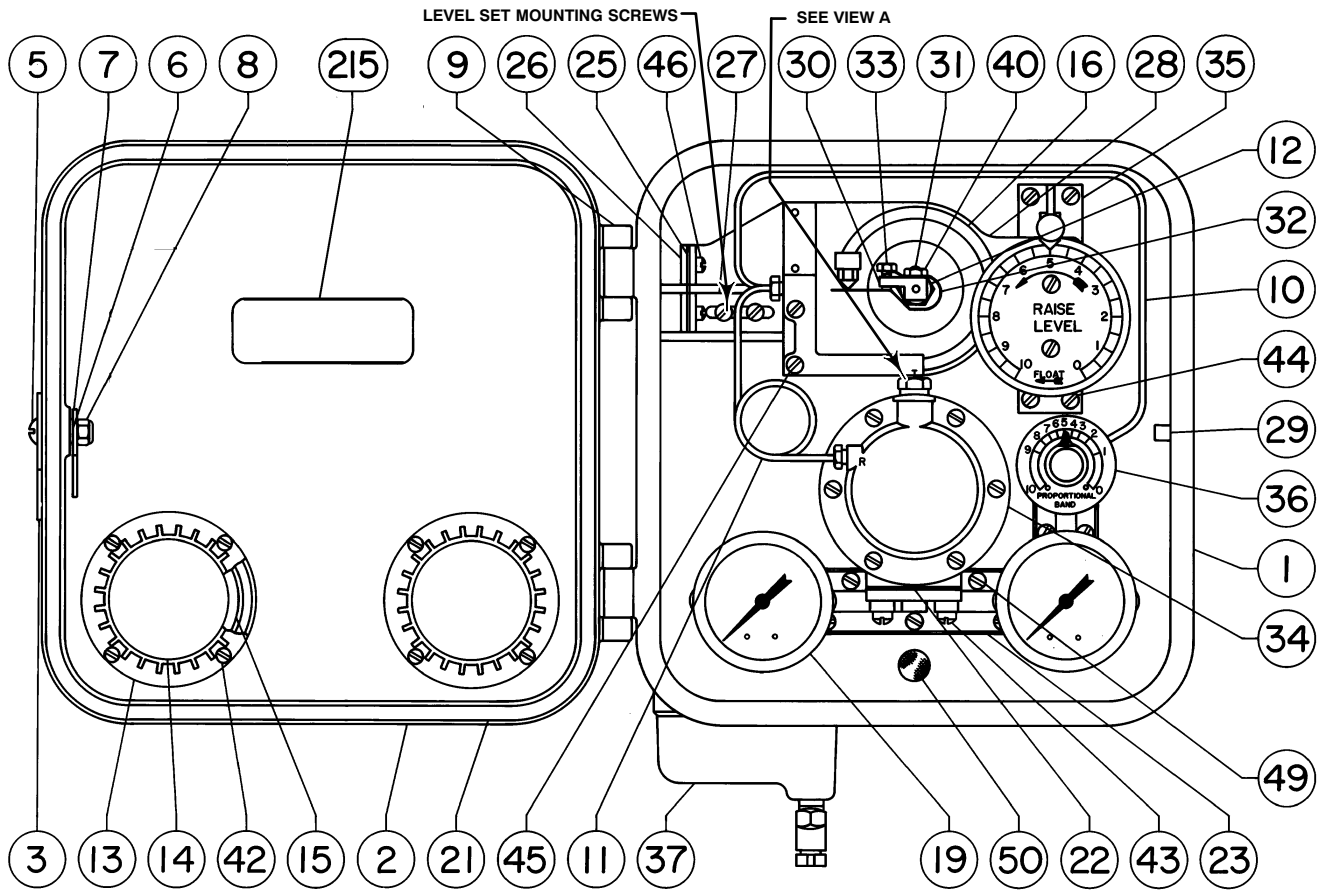
Type 2500 Controller Repair Kits		
Contains keys 12, 15, 21, 24, 38, and the flapper assembly		
	Standard temperature	R2500 X00L32
	High temperature	R2500 X00H32
Type 2503 Controller Repair Kit		
Standard temperature only		
The kit contains		
	keys 12, 21, 22, 24, 38, and the flapper assembly.	R2503 X00022

Key	Description	Part Number
	Relay Replacement Kit	
	Contains keys 22, 43, and the relay assembly	
	Standard temperature	RRELAYX0L22
	High temperature	RRELAYX0H22
	Heat Insulator Retrofit Kit	
	Contains the heat insulator parts shown in figure 14 and listed under Heat Insulator in this parts list	
		R2500XH0012

## Common Controller/Transmitter Parts (figure 16)

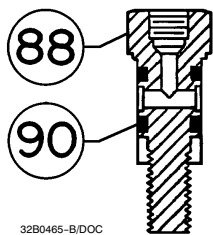
Key	Description	Part Number
1	Case back	57A0953 X012
2	Case cover, aluminum	50B9454 X012
3	Door handle, pl steel	1C8972 25082
4	Door handle shaft (not shown), brass	1C8984 14012
5	Machine screw, steel	1C8958 X0022
6	Spring washer, stainless steel	1C8970 36032
7	Door hook, pl steel	1C8971 25082
8	Stop nut, pl steel	1C8959 X0012
9	Drive-lock pin, (2 req'd)	1C8991 X0022
10	Tubing assembly, stainless steel	
	For all 2500 Series except Type 2503	1N7983 X0012
	For Type 2503 only	1H3093 X0012
11	Relay tubing, stainless steel	1N7984 X0012
12	Ball bearing assembly, Brass, pl	1C8983 000A2
13	Retaining ring, pl steel (2 req'd)	1A4658 28992
14	Gauge glass (2 req'd)	0T0192 06042
15	Gauge glass gasket, neoprene (2 req'd)	0T0191 04082
16*	Bourdon tube assembly, Brass	
	Type 2500 and 2500T	
	3 to 15 psig	32B1231 X012
	6 to 30 psig	32B1231 X022
	Type 2500S	
	0 to 20 psig	32B1233 X012
	0 to 35 psig	32B1233 X022
	Type 2503	
	0 to 20 psig	32B1234 X012
	0 to 35 psig	32B1234 X022
	Stainless steel	
	Type 2500 and 2500T	
	3 to 15 psig	32B1232 X032
	6 to 30 psig	32B1232 X042

# Type 2500



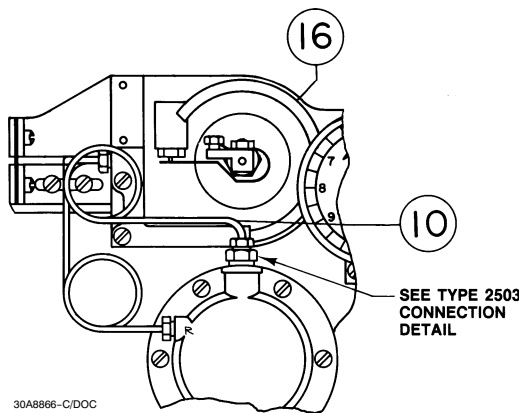
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TYPICAL CONTROLLER



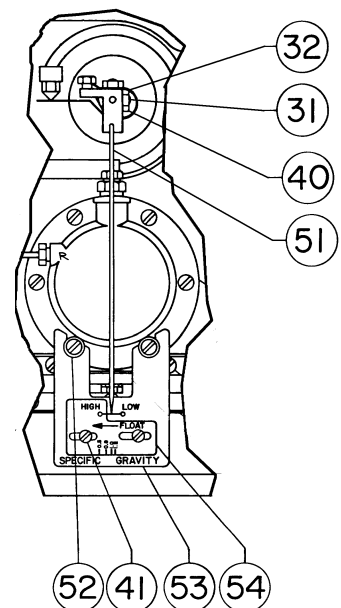
32B0465-B/DOC

TYPE 2503 CONNECTOR DETAIL  
ORIFICE ASSEMBLY  
(SEE FIGURE 21)



30A8866-C/DOC

VIEW A  
TYPE 2503R CONTROLLER  
CONSTRUCTION



30A8869-D/DOC

DETAIL OF INDICATOR  
ASSEMBLY ON C VERSIONS

**NOTE:**

PARTS NOT SHOWN 4, 24, 38, 39, 47, AND 48.

Figure 16. 2500 Series Controller / Transmitter Constructions



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## Cageless 249 Series Sensors

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### Introduction

#### Scope of Manual

This instruction manual includes maintenance, and parts ordering information for the cageless 249 Series sensors.

Although a Type 249 sensor is usually shipped with attached controller or transmitter, this manual does not include operation, installation, calibration, maintenance, and parts ordering information for the controller/transmitter or for the complete unit. For this information, refer to the appropriate controller/transmitter instruction manual.

Only personnel qualified through training or experience should install, operate, and maintain the sensor and attached controller or transmitter. If there are any

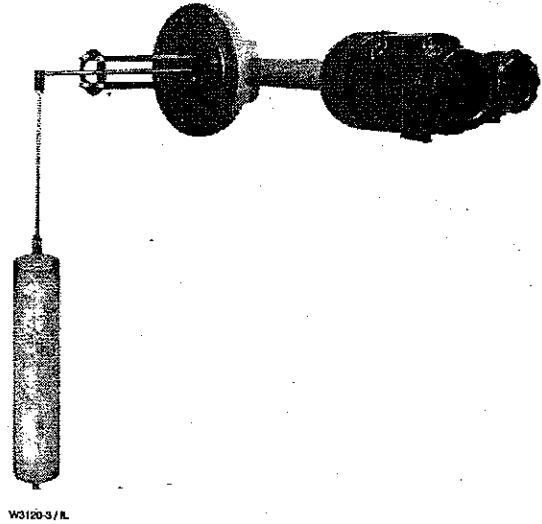


Figure 1. Type 249V Sensor with DLC3000 Series Digital Level Controller

questions concerning these instructions, contact your Fisher Controls sales office or representative before proceeding.

#### Description

The 249 Series sensors are designed to measure liquid level, interface level, or density/specific gravity inside a process vessel.

A torque tube assembly (figure 2) and displacer provide an indication of liquid level, interface level, or density/specific gravity. The torque tube assembly consists of a hollow torque tube with a shaft welded inside it at one end and protruding from it at the other end.

The unconnected end of the tube is sealed by a gasket and clamped rigidly to the torque tube arm, permitting the protruding end of the shaft to twist and therefore transmit rotary motion. This allows the interior of the torque tube to remain at atmospheric pressure, thus eliminating packing and the disadvantages of packing friction.

The displacer always exerts a downward force on one end of the displacer rod. The other end of the displacer rod rests on the knife-edge of the driver bearing. A



FISHER-ROSEMOUNT™

# Cageless 249 Series

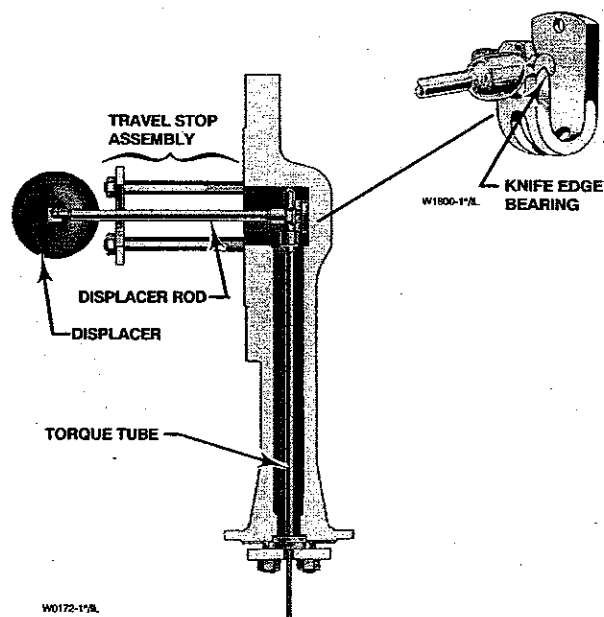


Figure 2. Typical Side-Mounted Cageless Displacer

keyed shaft on the bearing end of the displacer fits into a socket on the outside of the welded end of the torque tube assembly.

A change in liquid level, interface level, or density/specific gravity buoys up the displacer by a force equal to the weight of the liquid displaced. Corresponding vertical movement of the displacer rod results in angular movement of the displacer rod around the knife edge. Since the torque tube assembly is a torsional spring which supports the displacer and determines the amount of movement of the displacer rod for a given displacement change, it will twist a specific amount for each increment of buoyancy change. This rotation is brought through the torque tube arm by the protruding rotary shaft. A controller or transmitter attached to the end of the rotary shaft converts the rotary motion into varying pneumatic or electric signals.

## Type Number Description

- **Type 249BP**—ANSI Class 150, 300, 600 steel top-mounted sensor.
- **Type 249CP**—ANSI class 150, 300, 600 stainless steel top-mounted sensor.
- **Type 249P**—ANSI class 900 and 1500 steel top-mounted sensor
- **Type 249V**—ANSI Class 125 or 250 cast iron or Class 150, 300, 600, 900, or 1500 steel side-mounted sensor.

All cageless 249 Series sensors have flanged connections.

The Parts List section shows some Type 249 sizes by construction, standard displacer lengths, and standard materials. However, Type 249 parts are available in a wide variety of materials of construction, part dimensions, and other specifications. Contact your Fisher Controls sales office or representative for assistance in selection of specific materials, dimensions, and specifications.

## Maintenance

### WARNING

**Avoid personal injury or property damage resulting from the sudden release of pressure. Before performing any maintenance procedure, relieve any process pressure in the process vessel where the Type 249 sensor is installed. Drain the process liquid from the process vessel. Shut off any electrical or pneumatic input to the controller or transmitter attached to the Type 249 sensor and vent any pneumatic supply pressure. Use caution when loosening flange bolting or pipe plugs (key 26).**

**Remove the controller or transmitter from the torque tube arm (key 3).**

**Before performing any maintenance procedure requiring the handling of the displacer, inspect the displacer (key 10) to make sure process pressure or liquids have not penetrated the displacer.**

**The displacer in this unit is a sealed container. If penetrated by process pressure or liquid, the displacer may hold pressure or hazardous liquid for an extended period. A displacer that has been penetrated by process pressure or liquid may contain:**

- pressure as a result of being in a pressurized vessel
- liquid that becomes pressurized due to a change in temperature
- liquid that is flammable, toxic, corrosive, or reactive

**Sudden release of pressure, contact with hazardous liquid, fire, or explosion, which might result in personal injury or property damage, can occur if a displacer that is retaining pressure or process**



liquid is punctured, subjected to heat, or repaired.

Handle the displacer with care. Consider the characteristics of the specific process liquid in use.

### Note

Except for gaskets (keys 13, 14), trouble symptoms peculiar to specific parts are discussed in the following sections. Each section is specific to these parts. Regardless of location, gasket failure is indicated by leakage in the gasket area. Every time a gasket is removed, replace it with a new one upon reassembly.

The procedures below apply to all sensor types except where indicated. Key numbers used are shown in the following illustrations:

- Type 249BP—figure 5
- Type 249CP—figure 6
- Type 249P—figure 7
- Type 249V—figure 8

Sensor parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions.

Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, materials of construction, and other product characteristics specified by Fisher Controls), use only replacement parts manufactured or furnished by Fisher Controls.

## Removing the Displacer and Stem

The displacer (key 10) is a sealed container. If the displacer has been penetrated by process pressure or liquid, it may hold pressure or hazardous liquid for an extended period.

Process residue buildup on the displacer and stem (key 24) may change displacer weight or displacement. A bent stem or a dented or corroded displacer can impair performance.

If the displacer rests against the travel stop, appears to be overweight, or causes output drift or other output inaccuracies, it may have been penetrated by process pressure or liquid. Such a displacer may contain pressure because it was in a pressurized vessel, may contain process liquid that becomes pressurized due to a change in temperature, and may contain process liquid

that is flammable, toxic, corrosive, or reactive. Sudden release of pressure, contact with hazardous liquid, fire, or explosion, which may result in personal injury or property damage, can occur if a displacer that is retaining pressure or process liquid is punctured, subjected to heat, or repaired.

Handle the displacer with care.

### Note

On the Types 249V, 249P, and 249BP with travel stop, the displacer must come out with the sensor head (key 2) or torque tube arm (key 3) before being completely disconnected from the displacer rod (key 7). If separating the displacer and displacer rod, remove the cotter spring (key 11).

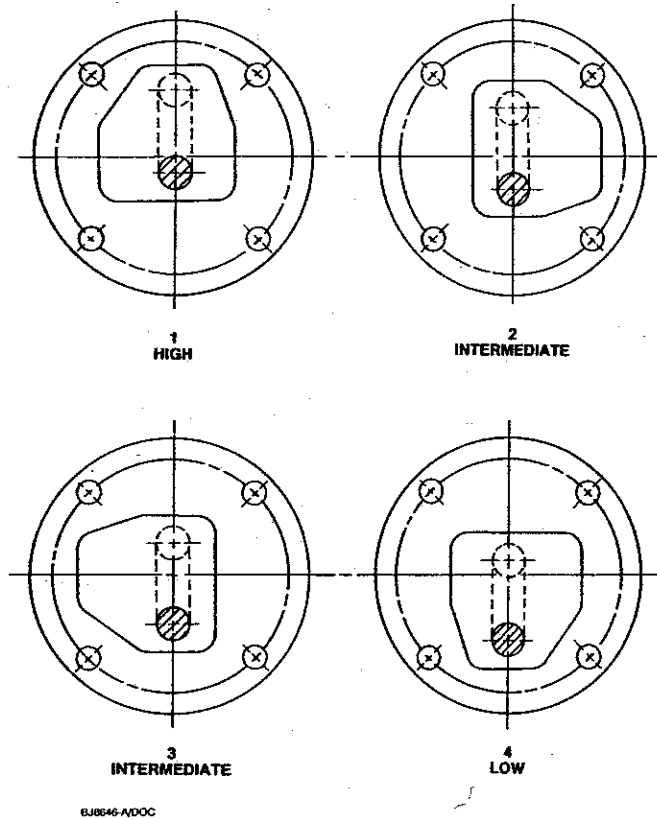
Be careful not to let the displacer slip and drop into the bottom of the process vessel, as displacer damage could result.

1. Before starting any maintenance procedure, be sure the following safety actions are completed.
  - Relieve process pressure in the process vessel where the Type 249 sensor is installed.
  - Drain the process liquid from the process vessel.
  - Shut off any electrical or pneumatic input to the controller or transmitter attached to the Type 249 sensor and vent any pneumatic supply pressure. Remove the controller or transmitter from the torque tube arm.
  - Use caution when loosening flange bolting or pipe plugs.
  - Be sure process pressure or liquids have not penetrated the displacer.
2. Support the sensor head (key 2) and the torque tube arm (key 3). Remove the bolting that holds the sensor head to the process vessel.

## CAUTION

When removing a sensor from a process vessel, the displacer may remain attached to the displacer rod and be lifted out with the sensor head (key 2) when the sensor head is removed. If separating the displacer and displacer rod before removing the sensor head, remove the cotter spring (key 11). Be careful not to let the displacer slip and drop into the bottom of the process vessel, as displacer damage could result.

# Cageless 249 Series



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Figure 3. Type 249V Travel Stop Plate Positions

3. Carefully remove the sensor head or torque tube arm. If the displacer comes out with the head or torque tube arm, be careful not to damage the displacer or bend the stem when setting the head or arm down.

4. On the Type 249V, the travel stop plate can be located in one of four positions as shown in figure 3. With a standard or thin-walled displacer hanging free on the displacer rod, the rod should not touch the plate. If it does, remove the plate and choose a position where the rod will not touch the plate.

5. Follow the procedure for replacing the displacer, displacer rod assembly, cotter spring, stem end piece, and displacer spud as necessary.

## Replacing the Displacer, Cotter Spring, Stem End Piece, and Displacer Spud

The cotter spring (key 11), the ball on the displacer rod/driver assembly (key 7), and the stem end piece or displacer stem connector (key 23) may be either too worn for a secure connection or so clogged or corroded that the displacer does not pivot properly. Replace these parts, as necessary.

## CAUTION

If the displacer is to be disconnected from the displacer rod before being removed from the process vessel, provide a suitable means of supporting the displacer to prevent it from dropping into the process vessel and being damaged.

1. After following the proper procedure to remove the sensor head and the displacer from the process vessel, move the sensor assembly to a suitable maintenance area. Support the assembly to avoid damage to the displacer, displacer stem, displacer rod/driver assembly, and associated parts.

2. To help support the displacer on a unit without travel stop (Type 249BP, 249P, 249CP), install the stem and stem end piece (or a threaded rod) into the 1/4 inch-28 UNF threaded hole in the displacer spud or stem connector. On the Types 249BP with travel stop, the groove pin (key 42) will secure the displacer as long as the travel stop plate (key 41) is installed and the sensor head (key 2) is in position.

3. Reach the cotter spring, displacer spud, ball end of the displacer rod/driver assembly, stem end piece, or displacer stem connector as follows:

- **Top-Mounted Type 249BP, 249CP, and 249P Sensors**—By removing the pipe plug (key 26).

- **Side-Mounted Type 249V Sensor**—By removing the process vessel bolting and pulling out the torque tube arm (key 3). The inside of the process vessel wall will cause the displacer to swing up so it can be pulled out through the vessel opening.

4. Remove the cotter spring to free the displacer or stem end piece from the ball end of the displacer rod/driver assembly. Lift the displacer or stem end piece from the ball.

5. Replace worn or damaged parts as necessary. Return the displacer or stem end piece to the displacer rod/driver assembly. Install the cotter spring.

6. Install the sensor head and controller/transmitter. Calibrate the controller/transmitter following the procedures given in the controller/transmitter instruction manual.

## Replacing the Displacer Rod/Driver Assembly

The ball on the displacer rod/driver assembly (key 7) may be either too worn for a secure connection or so corroded that the displacer does not pivot properly. Replace the displacer rod/driver assembly, if necessary.

## CAUTION

**If the displacer is to be disconnected from the displacer rod/driver assembly before being removed from the process vessel, provide a suitable means of supporting the displacer to prevent it from dropping into the process vessel and being damaged.**

1. After following the proper procedure to remove the sensor head and the displacer from the process vessel, move the sensor assembly to a suitable maintenance area. Support the assembly to avoid damage to the displacer, displacer stem, displacer rod assembly, and associated parts.
2. Remove the controller/transmitter and displacer (key 10). Then, remove the hex nuts (key 20) that hold the torque tube arm (key 3) to the sensor head (key 2). Separate the torque tube arm from the sensor head.
3. Using the proper tool, loosen and then remove the upper bearing driver bolt (key 5). Lift the displacer rod/driver assembly from the knife edge of the driver bearing (key 4). Separate the displacer rod/driver assembly from the end of the torque tube assembly (key 9).
4. If necessary, remove the bearing driver by removing the lower bearing driver bolt. Install a new bearing driver and bolts.
5. If necessary, replace the displacer rod/driver assembly and install it on the knife edge of the bearing driver. Carefully fit the keyed shaft on the bearing end of the displacer rod into a socket on the outside of the welded end of the torque tube assembly.
6. Install the sensor head and controller/transmitter. Calibrate the controller/transmitter following the procedures given in the controller/transmitter instruction manual.

## Replacing the Torque Tube

Corrosion or leakage through the outer end of the torque tube is evidence of deterioration in the torque tube assembly (key 9) or torque tube end gasket (key 14). Erratic or nonexistent rotary shaft output may occur if the socket on the inner end of the torque tube assembly does not engage the bearing end of the displacer rod assembly (key 7).

1. After following the proper procedure to remove the sensor head and the displacer from the process vessel, move the sensor assembly to a suitable maintenance area. Support the assembly to avoid damage to the displacer, displacer stem, displacer rod assembly, and associated parts.

2. Remove the controller/transmitter and displacer (key 10). Then, remove the hex nuts (key 20) that hold the torque tube arm (key 3) to the sensor head (key 2). Separate the torque tube arm from the sensor head.
3. Remove the nuts (key 18) and retaining flange (key 6) holding the positioning plate (key 8) at the end of the torque tube arm.

## CAUTION

**If the displacer is still attached to the displacer rod at this point, be careful not to let the torque tube assembly slip when using the screwdriver leverage procedure in steps 4 and 6. Sudden release of the displacer would cause damage.**

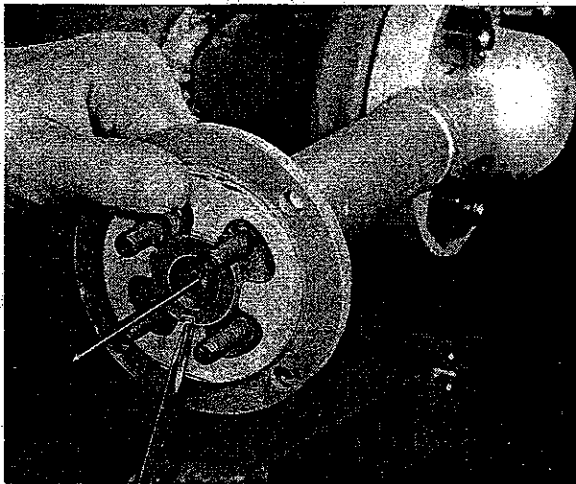
4. Remove the positioning plate (key 8) by freeing its two lugs.

The vertical lug fits into a hole in the flange of the torque tube arm (top of figure 4). The horizontal lug (hidden behind the screwdriver at the bottom of figure 4) fits into a slot in the outer tube end of the torque tube assembly (the figure 4 exploded view shows this lug to the right of the outer tube end).

The positioning plate may be pried away from the torque tube arm and outer tube end if the displacer already has been disconnected from the displacer rod. However, if the displacer is still connected to the displacer rod, place a screwdriver blade in the slots of the positioning plate and outer tube end as shown in figure 4. Slowly turn the positioning plate to release its lug from the torque tube arm. Then, carefully turn the plate back to allow the displacer to come to rest and slip the other lug of the plate from its slot in the outer tube end.

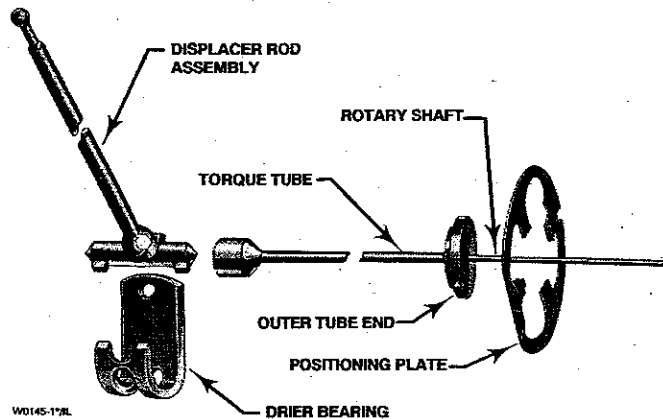
5. Pull the torque tube assembly and tube end gasket out of the torque tube arm.
6. Install a new tube end gasket and insert the torque tube assembly into the torque tube arm as shown in figure 4. Rotate the torque tube assembly until its socket mates with the driver member on the displacer rod assembly and so the outer tube flange rests against the gasket. With a thumb on the upper portion of the positioning plate and a screwdriver in the slots as shown in figure 4, rotate the plate and press the lug on the plate into the hole in the torque tube arm.
7. Install the retaining flange and secure it with four nuts (key 18), being sure to tighten all nuts evenly.
8. Install the sensor head and controller/transmitter. Calibrate the controller/transmitter following the procedures given in the controller/transmitter instruction manual.

# Cageless 249 Series



W0854-1/RL

REMOVAL OR INSTALLATION OF POSITIONING PLATE



EXPLODED VIEW OF TORQUE TUBE AND DISPLACER ROD ASSEMBLY

Figure 4. Torque Tube and Displacer Rod Assemblies

## Replacing the Torque Tube Arm and Changing the Mounting

Looseness of the driver bearing (key 4), wear on its knife-edged surface, or a bent, worn, or corroded displacer rod assembly (key 7) may impair performance. Be especially sure to check the ball on the displacer rod.

1. After following the proper procedure to remove the sensor head and the displacer from the process vessel, move the sensor assembly to a suitable maintenance area. Support the assembly to avoid damage to the displacer, displacer stem, displacer rod assembly, and associated parts.
2. Remove the controller/transmitter and displacer (key 10). Then, remove the hex nuts (key 20) that hold the torque tube arm (key 3) to the sensor head (key 2). Separate the torque tube arm from the sensor head.
3. Follow the proper procedure to remove the torque tube assembly (key 9).
4. Remove the bearing bolts (key 5), displacer rod assembly, and driver bearing.

### Note

Be sure to install the driver bearing so its knife edge is pointing up when the torque tube arm is mounted in the desired orientation. Since changing the mounting position of the torque tube arm by 180° will change controller or transmitter action from direct to reverse or vice versa, controller/transmitter action must be reversed from what it was before the mounting method was changed.

5. Install the driver bearing, displacer rod assembly, and bearing bolts (key 5) into the torque tube arm. Install a new arm gasket. Install the torque tube arm on the sensor head or process vessel and secure it with the proper bolting (keys 19 and 20).
6. Install the torque tube assembly. Install the displacer.
7. Install the sensor head and controller/transmitter. Calibrate the controller/transmitter following the procedures given in the controller/transmitter instruction manual.

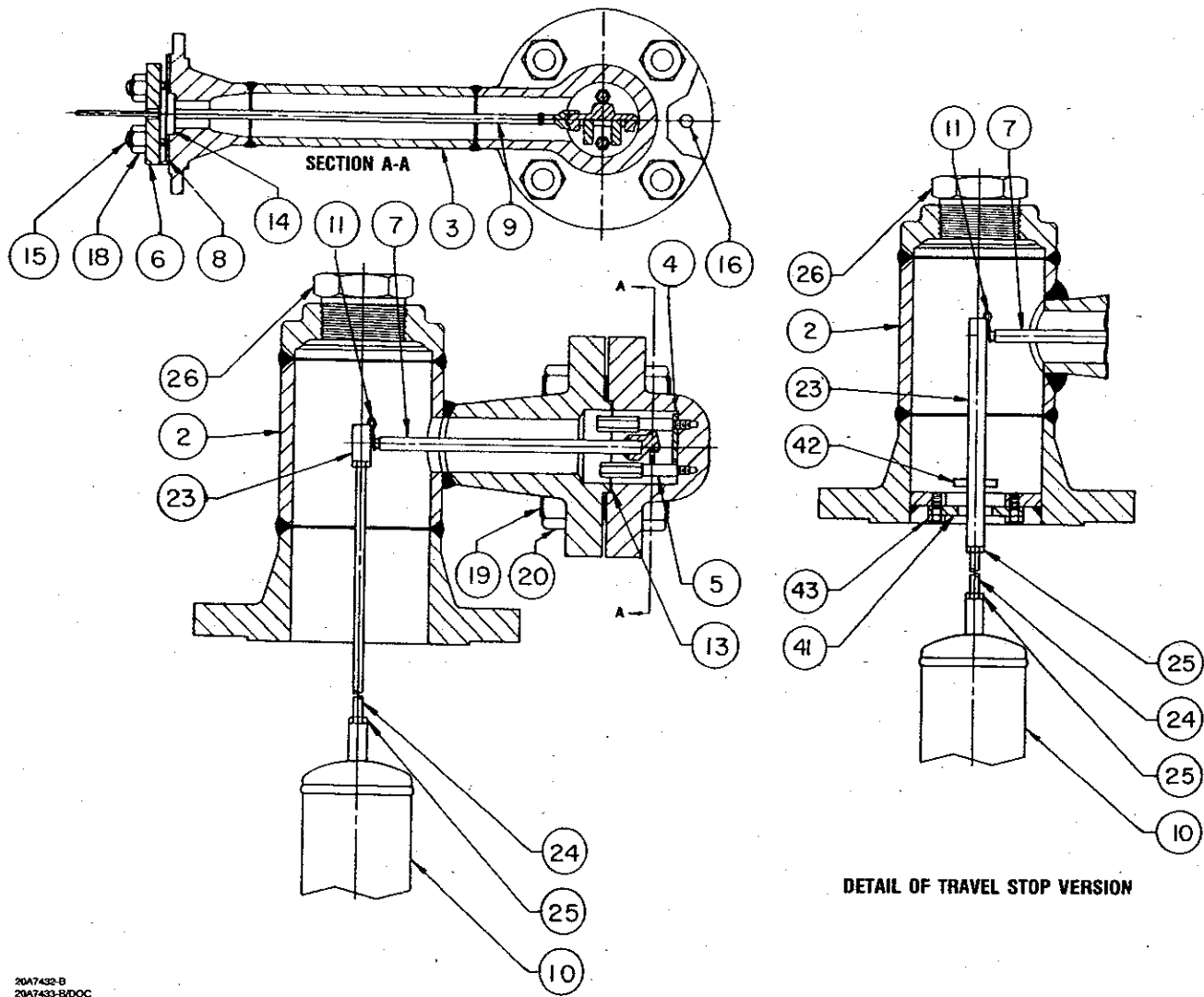
## Parts Ordering

Whenever corresponding with your Fisher Controls sales office or representative about this equipment, always mention the sensor serial number. Each sensor is assigned a serial number which is stamped on a nameplate (key 54, not shown) attached to the torque tube arm. This same number also appears on the controller/transmitter nameplate when a complete controller/transmitter-sensor unit is shipped from the factory. When ordering a replacement part, be sure to include the 11-character part number from the following parts list.

## Parts Kits

Key	Description	Part Number
	<b>SENSOR PARTS KIT.</b>	
	Kit contains keys 9, 11, 13, 14	
	For Type 249BP	R249X000012

# Cageless 249 Series



20A7432-B  
20A7433-B/DOC

Figure 5. Type 249BP Sensor Construction

## Parts List

Key Description

Part Number

### Sensor Common Parts

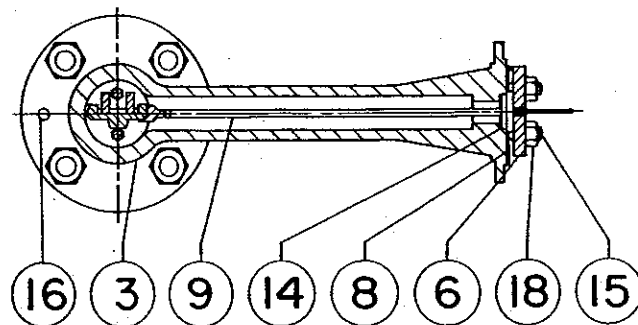
2	Sensor Head For 249BP, 249CP, 249P (If a part number is required, contact your Fisher Controls sales office or representative.) Not req'd for 249V	
3	Torque Tube Arm For 249V (If a part number is required, contact your Fisher Controls sales office or representative.)	
4	Driver Bearing, S31600	1K5395 36042
5	Driver Bearing Bolt, S31600 (2 req'd)	1K5394 35072

Key	Description	Part Number
6	Retaining Flange (If a part number is required, contact your Fisher Controls sales office or representative.)	
7	Rod/Driver Assy, S31600 For 249BP S31600 For 249CP For 249P For 249V	1B5461 000A2 1F9579 000A2 1B5698 000A2 1B5787 000A2
8	Positioning Plate, S31600	1B8123 25082
9*	Torque Tube Assy <sup>(1)</sup> For 249BP N05500 (Nickel Alloy, K-Monel) Std wall Heavy wall Thin wall	1K4493 X0012 1K4497 X0012 1K4495 X0012

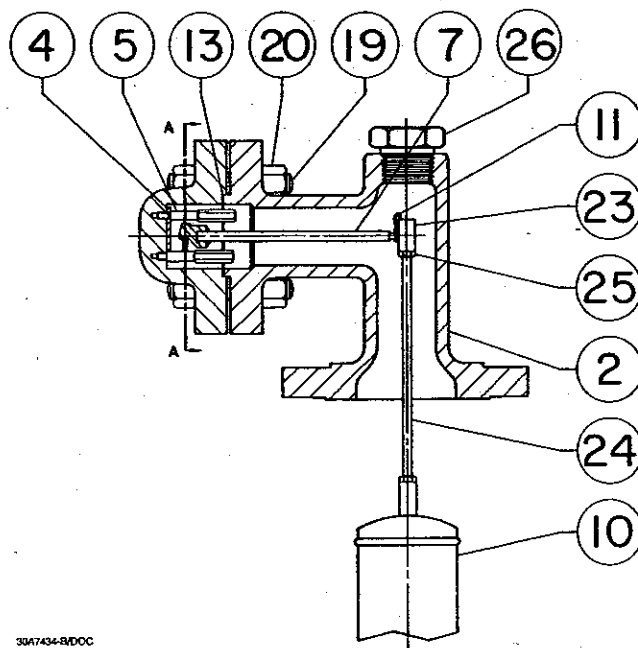
\*Recommended spare parts

1. This part is available in a wide variety of materials of construction, part dimensions, or other specifications. Listed here are standard or typical materials, dimensions, or specifications. Contact your Fisher Controls sales office or representative for assistance in selection of specific materials, dimensions, or specifications.

# Cageless 249 Series



SECTION A-A



3347434-BDDC

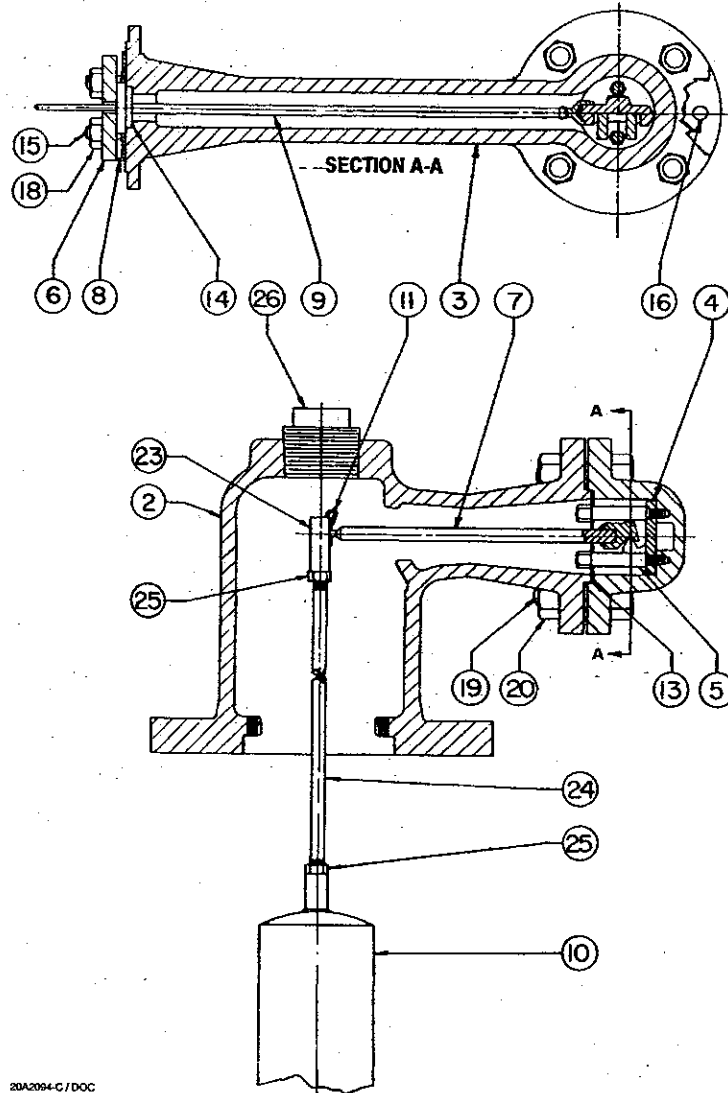
Figure 6. Type 249CP Sensor Construction

Key	Description	Part Number	Key	Description	Part Number
9*	Torque Tube Assy <sup>(1)</sup> (cont'd)		10	Displacer <sup>(1)</sup>	
	<b>For 249CP</b>			<b>For 249BP, 249CP</b>	
	S31600			3 inch X 14 inches (1600 psi), S30400	15A3848 X012
	Std wall	1K4505 000A2		3 inch x 14 inches (1600 psi), S31600	15A3848 X022
	Heavy wall	1K4503 000A2		2 inch x 32 inches (1500 psi), S30400	15A4586 X012
	<b>For 249P</b>			2 inch x 32 inches (1500 psi), S31600	15A4586 X022
	N05500			1-1/2 inch x 60 inches (1800 psi), S30400	15A5017 X042
	Std wall	1K4499 X0012		1-3/8 inch x 72 inches (1400 psi), S30400	1C1685 000A2
	Thin wall	1K4501 X0012		<b>For 249P</b>	
	<b>For 249V</b>			2-3/4 inch x 14 inches (6000 psi) S30400	1L7548 000A2
	N05500			2-3/4 inch x 14 inches (6000 psi) S31600	1L7548 X0012
	Std wall	1K4499 X0012		2-7/8 inch x 14 inches (4000 psi) S30400	1L9152 000A2
	Thin wall	1K4501 X0012		2-7/8 inch x 14 inches (4000 psi) S31600	1L9152 X0012

\*Recommended spare parts

1. This part is available in a wide variety of materials of construction, part dimensions, or other specifications. Listed here are standard or typical materials, dimensions, or specifications. Contact your Fisher Controls sales office or representative for assistance in selection of specific materials, dimensions, or specifications.

# Cageless 249 Series



20A2094-C/DOC

Figure 7. Type 249P Sensor Construction

Key	Description	Part Number	Key	Description	Part Number
10	Displacer <sup>(1)</sup> (cont'd)		10	Displacer <sup>(1)</sup> (cont'd)	
	<b>For 249P (cont'd)</b>			<b>For 249V (cont'd)</b>	
	1-3/4 inch x 32 inches (4200 psi) S30400	15A4666 X032		3 inch x 14 inches (1500 psi), S31603 (NACE)	15A3848 X312
	1-3/4 inch x 32 inches (4200 psi) S31600	15A4666 X022		2 inch x 32 inches (1500 psi), S30400	15A4586 X012
	1-29/32 inch x 32 inches (3400 psi) S30400	15A4581 X042		2 inch x 32 inches (1500 psi), S31600	15A4586 X022
	1-29/32 inch x 32 inches (3400 psi) S31600	15A4581 X012		2 inch x 32 inches (1500 psi), S31603 (NACE)	15A4586 X162
	<b>For 249V</b>			1-5/8 inch x 48 inches (1800 psi), S30400	15A5007 X022
	3 inch x 10 inches (1600 psi), S30400			1-1/2 inch x 60 inches (1800 psi), S30400	15A5017 X042
	(vertical or horizontal mounting)	1J7062 000A2	11*	Cotter Spring <sup>(1)</sup> , N04400 (Monel) (2 req'd)	1A5179 42022
	3 inch x 10 inches (1600 psi), S31603 (NACE)	1J7062 X0022	13*	Arm Gasket <sup>(1)</sup>	
	(vertical or horizontal mounting)			<b>For 249BP, 249CP</b>	
	3 inch x 14 inches (1600 psi), S30400	15A3848 X012		thru Class 600, graphite/SST	1E5629 X0072
	3 inch x 14 inches (1600 psi), S31600	15A3848 X022		<b>For 249P</b>	
				Class 900 & 1500 graphite/SST	1A1297 X0022

\*Recommended spare parts

1. This part is available in a wide variety of materials of construction, part dimensions, or other specifications. Listed here are standard or typical materials, dimensions, or specifications. Contact your Fisher Controls sales office or representative for assistance in selection of specific materials, dimensions, or specifications.

# Cageless 249 Series

Key	Description	Part Number	Key	Description	Part Number
14*	Tube End Gasket <sup>(1)</sup> For 249BP, 249CP, or 249V thru Class 600, graphite/SST For 249P Class 900 & 1500 graphite/SST	0Y0876 X0052 0Y0876 X0022	25	Hex Nut <sup>(1)</sup> , B8M (2 req'd)	1A3915 35252
15	Stud Bolt <sup>(1)</sup> , steel B7 (4 req'd) For 249BP, 249CP, 249V (249V thru Class 600) For 249P Class 900 & 1500	12A8835 X132 1K6235 X0152	26	Pipe Plug <sup>(1)</sup> , steel For 249BP For 249CP For 249P	1A3985 24182 1B7656 38992 1A4442 28992
16	Groove Pin, S31600 For 249BP, 249CP, 249P	1A3618 28992	35	Heat Insulator Ass'y (use only when specified)	22A0033 X012
18	Hex Nut <sup>(1)</sup> , steel B7 (4 req'd) For 249BP, 249CP, and 249V thru Class 600 For 249P Class 900 & 1500	1A3773 24072 1A3772 X0892	36	Shaft Coupling (for heat insulator ass'y) Use only when specified	1A5779 35032
19	Bolt Stud <sup>(1)</sup> , steel B7 (4 req'd) For 249B, 249CP thru Class 600 For 249P Class 900 & 1500	1A3544 31012 1A4212 X0042	37	Shaft Extension (for heat insulator ass'y) Use only when specified	1B6815 40022
20	Hex Nut <sup>(1)</sup> , steel (8 req'd) For 249BP, 249CP thru Class 600 For 249P Class 900 & 1500	1A3760 24072 1C1727 X0592	38	Set Screw (for heat insulator ass'y) (2 req'd) Use only when specified	1E6234 X0022
23	Displacer Stem End Piece <sup>(1)</sup> , S31600 For 249BP, 249CP w/out travel stop For 249BP w/travel stop For 249P w/out travel stop For 249V Stem End Piece Rod Connector	1A3933 35072 1E9202 35072 1A3933 35072 1A9436 35072 1A9431 35072	39	Cap Screw (for heat insulator ass'y) (4 req'd) Use only when specified	1A3816 K0012
24	Displacer Stem <sup>(1)</sup> When ordering a replacement displacer stem, specify length and desired material.		40	Cap Screw (for heat insulator ass'y) (4 req'd) Use only when specified	1V2395 28982
			41	Travel Stop Plate, steel For 249V For 249BP	1J7310 28992 1E9131 36072
			42	Groove Pin (travel stop pin), SST For 249BP not req'd for 249V	1A5246 35032
			43	Cap Screw, hex head, steel (2 req'd) For 249BP	1A3917 24052
			44	Stud Bolt <sup>(1)</sup> , steel B7 For 249BP w/2-inch top flange, Class 150 (4 req'd) w/2-inch top flange, Class 300 (8 req'd)	1J6981 31012 1L5151 31012
			45	Hex Nut <sup>(1)</sup> , steel For 249BP w/2-inch top flange, Class 150 (8 req'd) w/2-inch top flange, Class 300, 600 (16 req'd)	1A3760 24072 1A3760 24072
			46	Hex Nut, steel (4 req'd) For 249V	1A3457 35252
			52	Travel Stop Post, S31600 (4 req'd) For 249V	1C1185 35072
			53	Washer (for heat insulator ass'y) (4 req'd) Use only when specified	1B8659 28982
			54	Nameplate	
			55	Drive Screw	
			56	NACE Tag	
			57	Wire	

\*Recommended spare parts

1. This part is available in a wide variety of materials of construction, part dimensions, or other specifications. Listed here are standard or typical materials, dimensions, or specifications. Contact your Fisher Controls sales office or representative for assistance in selection of specific materials, dimensions, or specifications.



# Cageless 249 Series

Key	Description	Part Number
	<b>Indicating Gauge</b>	
	*Gauge, steel/brass (0-100%) (3-15 psi)	21B9701 X012
	Mounting Bracket, steel	21B9696 X012
	Hex Nut, SA194-2H/zn pl (2 req'd)	1E9440 24112
	Lock Washer, plated carbon steel (2 req'd)	1C2257 28982
	Connector Tube, brass	15A6002 X212
	Pipe Tee, A197 malleable iron, galvanized	1C5975 47362
	Pipe Plug, C36000 (brass, B16)	1A6495 X0052
	Pipe Nipple, SA106-B/galv/zn	1C6789 26232
	Machine Screw, plated carbon steel (3 req'd)	1K4336 28992
	U-bolt, steel	
	For use w/fabricated arm	1D7642 24092
	For use w/cast arm	1N6419 24092

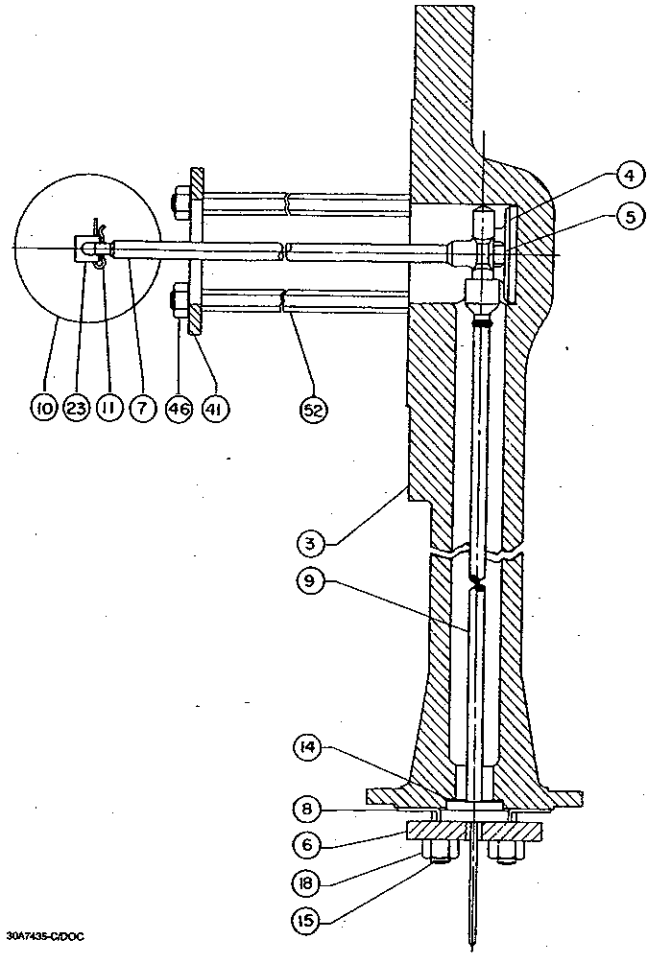


Figure 8. Type 249V Sensor Construction

\*Recommended spare parts

# Cageless 249 Series

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PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL INSTRUMENTS (DISPLACER OR FLOAT)				SHEET 2 OF 2	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : LEVEL CONTROLLERS				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.L
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
								DATE	03/11/2005
								REQ.	
								BY	CHK'D
1	TAG NO.		LC-640		LC-690				
2	SERVICE		GLYCOL FLASH TANK		FUEL GAS SCRUBBER				
3	LINE NO. / VESSEL NO.		V-640		V-690				
B O D Y / C A S E / R O T A T I O N	4 BODY OR CAGE MATERIAL		CS		CS				
	RATING		150 ANSI		150				
	5	CONN. SIZE	LOC. UPPER	60 mm	SIDE	60 mm	SIDE	mm	
	TYPE		NPT		NPT				
	6	CONN. SIZE	LOC. LOWER	mm		mm		mm	
	TYPE								
	7 CASE MOUNTING (RH, LH, TOP)								
	TYPE								
	8 ROTATABLE HEAD								
	10 ORIENTATION		INTERNAL FLOAT		INTERNAL FLOAT				
	11 COOLING EXTENSION								
	12								
D I M E N S I O N	13 DIMENSIONS		48 OD X 305 mm		48 OD X 305 mm		mm	mm	
	14 INSERTION DEPTH		mm		mm		mm	mm	
	15 DISPLACER EXTENSION		mm		mm		mm	mm	
	16 DISP. OR FLOAT MATERIAL		PVC		PVC				
	17 DISPLACER SPRING/TUBE MTL		STD		STD				
	18								
19									
F U N C T I O N	20 FUNCTION		CONTROLLER		CONTROLLER				
	21 OUTPUT		20-100 KPA		20-100 KPA				
	22 CONTROL MODES		PROPORATIONAL ACTION		PROPORATIONAL ACTION				
	23 DIFFERENTIAL								
	24 OUTPUT ACTION: LEVEL RISE		OUTPUT INCREASES		OUTPUT INCREASES				
	25 MOUNTING								
	26 ENCLOSURE CLASS								
	27 ELEC. POWER OR AIR SUPPLY								
28									
S E N S I T I V I T Y	29 UPPER LIQUID								
	30 LOWER LIQUID		E-GLYCOL		HC LIQUID				
	31	SP. GR. UPPER	SP. GR. LOWER	1.10		0.5			
	32	PRES. MAX.	PRES. NORMAL	1724 kPa(g)	420 kPa(g)	1034 kPa(g)	700 kPa(g)	kPa(g) kPa(g) kPa(g) kPa(g)	
C O N T A C T	33	TEMP. MAX.	TEMP. NORM.	79 °C	54 °C	66 °C	20 °C	°C °C °C °C	
	34								
	35								
O P E R I N G	36 AIRSET		SUPPLY GAGE						
	37 GAGE GLASS CONNECTIONS								
	38 GAGE GLASS MODEL NO.								
	39 CONT:NUM		CONT: FORM						
	40 CONTACT RATING								
	41 ACTION OF CONTACTS								
	42								
	43								
44									
M A N U F A C T U R E R	45 MANUFACTURER		FISHER		FISHER				
	46 MODEL NO.		L2		L2				
	47 P. O. NUMBER								

NOTES:

AREA. UNIT # :

# 2680-268T Series

## 2680-268T Series Liquid Level Controllers

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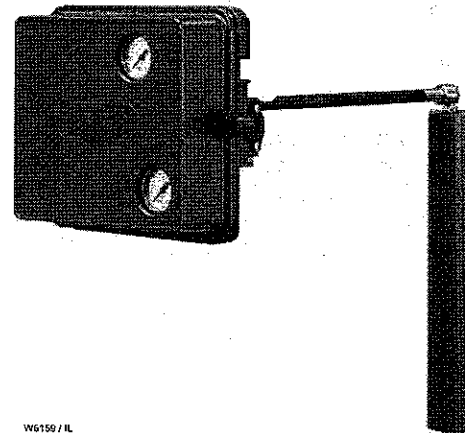


Figure 1. 2680 Series Controller with Type 268T Sensor

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### Introduction

#### Scope of Manual

This instruction manual includes installation, adjustment, maintenance, and parts ordering information for 2680 Series liquid level controllers and Type 268T displacer-type sensors.

Only personnel qualified through training or experience should install, operate and maintain this controller. If there are any questions regarding the instructions in this manual, contact your Fisher Controls sales office or sales representative before proceeding.

#### Description

These rugged 2680 Series liquid level controllers use a Type 268T displacer type sensor (see figure 1) to detect liquid level or the interface of two liquids of different specific gravities.



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**FISHER-ROSEMOUNT™ Managing The Process Better™**

# 2680-268T Series

Table 1. Specifications

## Available Configurations

**Controllers:** See table 2

**Type 268T Sensor:** Displacer-type liquid level sensor for mounting to side of tank. Displacer travel is transmitted to controller by pivotal movement of displacer rod

## Input Signal<sup>(1)</sup>

**Type:** Liquid level or liquid-to-liquid interface

**Level Change Required for Full Change in Output Signal in 1.0 Specific Gravity Liquid with 20 Psig (1.4 Bar) Supply, Direct Action, and Standard 1-7/8 X 12-Inch (48 x 305 mm) Vertical Displacer with Standard Lever Arm Length:**

Type	Control Mode	Maximum Proportional Band Level Change, Inches (mm)	Minimum Proportional Band Level Change, Inches (mm)
2680	Throttling	4 (102)	12 (305)
	On-off	5 (127)	12 (305)
2680A	Snap-acting	0.5 (13)	0.8 (20)

## Minimum Specific Gravity<sup>(2)</sup>

**Type 2680:** Minimum specific gravity, or specific gravity differential for interface applications, is 0.4

**Type 2680A:** Minimum specific gravity, or specific gravity differential for interface applications, is 0.1

**Type 2680E:** Minimum specific gravity, or specific gravity differential for interface applications, is 0.3

## Output Signal<sup>(1)</sup>

**Type 2680 and 2680A:** Pneumatic ■ on-off or ■ proportional pressure signal

### Ranges:

**On-Off:** 0 (off) or full supply pressure (on)

**Throttling:** ■ 3 to 15 psig (0.2 to 1.0 bar) or ■ 6 to 30 psig (0.4 to 2.0 bar)

**Action:** Field-reversible between direct (increasing level increases output signal) and reverse (increasing level decreases output signal)

**Type 2680E:** Same as signal to switch (see electrical rating)

## Electrical Rating

**Type 2680E:** Single-pole, double-throw (SPDT) or double-pole, double throw (DPDT) switch: 11 amperes, 1/4 horsepower at 125/250 volts ac; 5 amperes resistive, 3 amperes inductive at 28 volts dc; 2 amperes resistive, 1 ampere inductive at 48 volts dc

## Supply Pressure Requirements

**Type 2680 Controller**

**On-Off:** Any desired pressure between 20 and 50

psig (1.4 and 3.4 bar).

**Throttling:** 20 psig for 3 to 15 psig output signal (1.4 bar for 0.2 to 1.0 bar output signal) and 35 psig for 6 to 30 psig output signal (2.4 bar for 0.4 to 2.0 bar output signal)

**Type 2680A Controller:** Any desired pressure between 20 and 50 psig (1.4 and 5.2 bar)

Do not use supply pressure below 20 psig (1.4 bar)

## Steady-State Air Consumption<sup>(4)</sup>

**Type 2680:** ≤1.0 scfh (0.03 normal m<sup>3</sup>/hr) at 20 psig (1.4 bar) supply pressure

**Type 2680A:** ≤1.0 scfh at 20 psig (1.4 bar) or 35 psig (2.4 bar) supply pressure in tripped condition; air consumption increases during trip

## Nominal Displacer Sizes

■ 1-7/8 x 12 inches (48 x 305 mm) or ■ 2-3/4 x 8 inches (70 x 203 mm)

## Maximum Displacer Working Pressure<sup>(3)</sup>

**Polyvinylchloride (PVC) Displacer:** 3750 psig (258.5 bar)

**Stainless Steel Displacer:** 1440 psig (99 bar) cold working pressure. 1330 psig (92 bar) at 400°F (204°C)

## Maximum Displacer Insertion Length

**Horizontal Displacers:** 1-7/8 x 12-inch PVC, standard lever arm length plus one 6-inch extension  
1-7/8 x 12-inch SST and all standard 2-3/4 x 8-inch, standard lever arm length

**Vertical Displacers:** All standard 1-7/8 x 12-inch, standard lever arm length plus one 6-inch extension  
All standard 2-3/4 x 8-inch, standard lever arm length

## Maximum Sensor Working Pressure<sup>(3)</sup>

See table 3

## Operative Ambient Temperature Limits<sup>(1)(3)</sup>

**Controller:** -20 to 160°F (-29 to 71°C)

**PVC Displacer:** -20 to 175°F (-29 to 79°C)

**Stainless Steel Displacer:** -20 to 200°F (-29 to 93°C)

## Process Temperature Limits<sup>(1)(3)</sup>

**PVC Displacer and Highly Saturated Nitrile O-Rings:** -20 to 175°F (-29 to 79°C)

**Stainless Steel Displacer and Highly Saturated Nitrile O-Rings:** -20 to 200°F (-29 to 93°C)

**Stainless Steel Displacer and Fluoroelastomer O-Rings:** 0 to 400°F (-18 to 204°C)

-continued-

# 2680-268T Series

Table 1. Specifications (continued)

## Standard Supply, and Output Pressure Gauge Indications

Triple scale gauges in 0 to 60 psig/0 to 0.4 MPa/0 to 4.0 bar

## Hazardous Area Classification

The 2680 Series controllers have no hazardous area approvals. For approvals on the electrical switch component of the Type 2680E, see Hazardous Area Classifications bulletin

## Controller Connections

**Supply:** 1/4 in. NPT female located on the bottom of the case

**Output:** 1/4 in. NPT female located on the top of the case

**Case Vent:**  
1/4 in. NPT female with vent screen assembly located on the back of the case

## Type 2680E Electrical Connection Size

1/2-inch (12.7 mm) NPT male

1. This term is defined in ISA Standard S51.1-1979.
2. Depends on float rod/displacer orientation and length. Contact your Fisher Controls sales office or sales representative for further information.
3. The pressure and temperature limits in this document and any applicable code limitations should not be exceeded.
4. Scfh—Standard cubic feet per hour (60°F and 14.7 psia). Normal m<sup>3</sup>/hr—Normal cubic meters per hour (0°C and 1.01325 bar, absolute)

Table 2. Available Controller Configurations

TYPE NUMBER	CONTROL MODE	CONTROL ACTION
2680	On-off	Direct
		Reverse
	Throttling	Direct
		Reverse
2680A and 2680E	Snap acting	Direct
		Reverse

The Type 2680 and 2680A low-bleed controllers use a single four-mode relay to provide the applicable control and action. The device delivers a pneumatic output signal to a control valve.

The Type 2680E electrical controller is similar except it opens and closes an electrical switch in response to rising or falling levels.

## Specifications

Specifications for these controllers and sensors are listed in table 1.

## Installation

### WARNING

To avoid personal injury or property damage caused by the sudden release of process fluid, be certain the service conditions do not exceed the sensor pressure limits listed in table 3. Use pressure-limiting or pressure-relieving devices to prevent service conditions from exceeding these limits.

Table 3. Sensor Connection Types and Maximum Working Pressure

CONNECTION SIZE	CONNECTION TYPE <sup>(1)</sup>	MAXIMUM WORKING PRESSURE
2-inch	Screwed (NPT)	Consistent with Class 1500 pressure temperature ratings per ASME/ANSI B16.34-1988 up to maximum pressure of 3750 psig (258.5 bar)
	Slip-on flange	Consistent with pressure temperature ratings of coupling used per ASME/ANSI B16.34-1988 up to maximum pressure of 3750 psig (258.5 bar)

1. All connection types available in NACE materials.

### CAUTION

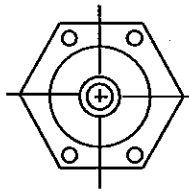
If the Type 2680-268T level controller is installed on a vessel that is to be shipped to a different location (e.g. skid mounted units), remove the displacer and displacer rod extensions before shipment. Failure to do so could result in damage to the displacer rod due to vibration and impact loading during shipment. After the vessel is installed at its final location, reassemble the displacer and displacer rod extension.

1. Be sure there are no obstructions inside the tank that will interfere with displacer installation or operation.
2. Provide the appropriate connection in the tank wall to match the sensor connection. Locate the tank wall connection such that the displacer will be at the desired control level.
3. If necessary, reinforce the tank connection so that it will be capable of supporting the sensor and controller.

## Welding Information

When installed, the controller case must be plumb and level to allow proper operation. To ensure proper posi-

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**CORRECT CONTROLLER MOUNTING  
HOLE ORIENTATION WHEN  
MOUNTED ON VESSEL**

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Figure 2. Sensor Orientation for Flange Welding

tioning, observe the following before welding a flange to the Type 268T sensor. Refer to figure 7 for key number locations.

1. For proper operation, the arms of the sensor pivot base (key 12) and pivot body (key 11), shown in figure 7, must be horizontal when the sensor is mounted on the tank. Mounting the sensor connection on the vessel so that the controller mounting hole pattern is as shown in

2. figure 2 assures that these arms are horizontal.

3. Before welding on the sensor connection (key 4), the pivot base (key 12) (see figure 7) must be removed to prevent subjecting the O-rings and anti-extrusion rings to excessive heat. To remove the pivot base, unscrew the hex nut (key 6) and remove the spacer (key 5) and spring (key 7). After removing the spring, replace the spacer (key 5) and hex nut (key 6) on the displacer rod.

From the displacer end, pull the displacer rod away from the sensor connection (key 4) to pull the pivot base (key 12) loose from the sensor connection. Remove the hex nut (key 6) to permit removing the displacer rod, pivot base, pivot body, and spacer from the sensor connection.

4. Place a shield in the bore of the sensor connection (key 4) to prevent weld splatter from getting into the pivot base and O-ring areas.

5. Before welding the welded-on flange to the sensor connection (key 4), be sure that the sensor connection is positioned so that the controller mounting hole pattern will be as shown in figure 2 when the flange is bolted to the vessel.

## Attaching a Vertical Displacer

Refer to figure 7 for part locations.

1. Thread jam nut (key 2) all the way onto the threaded portion of the universal joint assembly (key 8).

2. Thread the displacer (key 1) all the way onto the threaded portion of the universal joint assembly.

3. Tighten the jam nut (key 2) against the displacer (key 1).

## Attaching a Horizontal Displacer

Refer to figure 7 for part locations. Thread the displacer (key 1) all the way onto the displacer rod (key 3) or extension (key 20).

## Screwed Connections

Insert the displacer end of the controller-sensor assembly into the tank connection, and screw the sensor threads into the tank connection. Tighten sufficiently to seal the threads. Make sure that the controller case is level.

## Flanged Connections

Perform the below listed steps. Refer to figure 7 for key number locations.

1. Orient the controller so that the case is level.

### CAUTION

**Do not pick up the controller/sensor by lifting the displacer rod (key 3). This action could place excessive stress on the displacer rod and cause the unit to malfunction.**

2. Install a suitable flange gasket.

3. Insert the displacer end of the sensor into the tank connection. Position the sensor flange so it can be bolted to the tank flange.

4. Complete the sensor flange to tank flange connection.

## Pressure Connections

### WARNING

**Personal injury or property damage may result from an uncontrolled process if the supply medium is not clean, dry, oil-free, or non-corrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend the level of filtration**

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equipment required to prevent performance degradation of pneumatic equipment. A filter or filter regulator capable of removing particles 40 microns in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.

1. Provide a source of clean, dry air that meets the requirements of ISA Standard S7.3-1975 (R1981) as the operating medium. Refer to table 1 to determine supply pressure.
2. Connect the supply pressure to the 1/4-inch NPT female connection on the bottom of the controller case.
3. Connect the output signal line to the equipment being operated and to the 1/4-inch NPT output connection on the top of the controller case.

## Vent

### WARNING

If a flammable, toxic, corrosive, or reactive gas is to be used as the supply pressure medium, personal injury or property damage could result from fire or explosion of accumulated gas or from contact with toxic, corrosive, or reactive gas. The controller/actuator assembly does not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used. A remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.

The vent opening or the end of the remote vent pipe, if one is required, must be protected against the entrance of all foreign matter that could plug the vent. Use 1/2-inch (13 mm) diameter pipe for the remote vent pipe. Check the vent periodically to be certain it is free of any obstructions.

## Type 2680E Electrical Connection

For standard action, connect electrical wires as shown in table 4. To reverse the action, refer to table 4 and reverse wiring for normally open (NO) switches and normally closed (NC) switches.

Table 4. Type 2680E Wiring Codes

Wire Color	SPDT	DPDT Switch 1	DPDT Switch 2
Red	Normally Closed	Normally Closed	
Brown	Common	Common	
Blue	Normally Open	Normally Open	
Green	Ground	Ground	Ground
Black			Normally Closed
Yellow			Common
Purple			Normally Open

## Changing Controller Action or Mode

### WARNING

To avoid personal injury caused by a sudden release of pressure, shut off the supply pressure and bleed pressure from the supply lines before performing any procedure in this section.

## Type 2680

The action of a Type 2680 controller may be changed between either direct or reverse, and the control mode may be changed between either on-off or throttling.

Refer to figure 3. Loosen the four switch retention screws on the relay. Move the switches to the control action and control mode required by the application. Tighten the four switch retention screws.

## Type 2680A

The action of a Type 2680A controller may be changed between either direct or reverse. The control mode is always snap acting.

Refer to figure 4. Loosen the four switch retention screws on the relay. Move the switches to the control action required by the application. Tighten the four switch retention screws.

## Type 2680E

For standard action, connect electrical wires as shown in table 4.

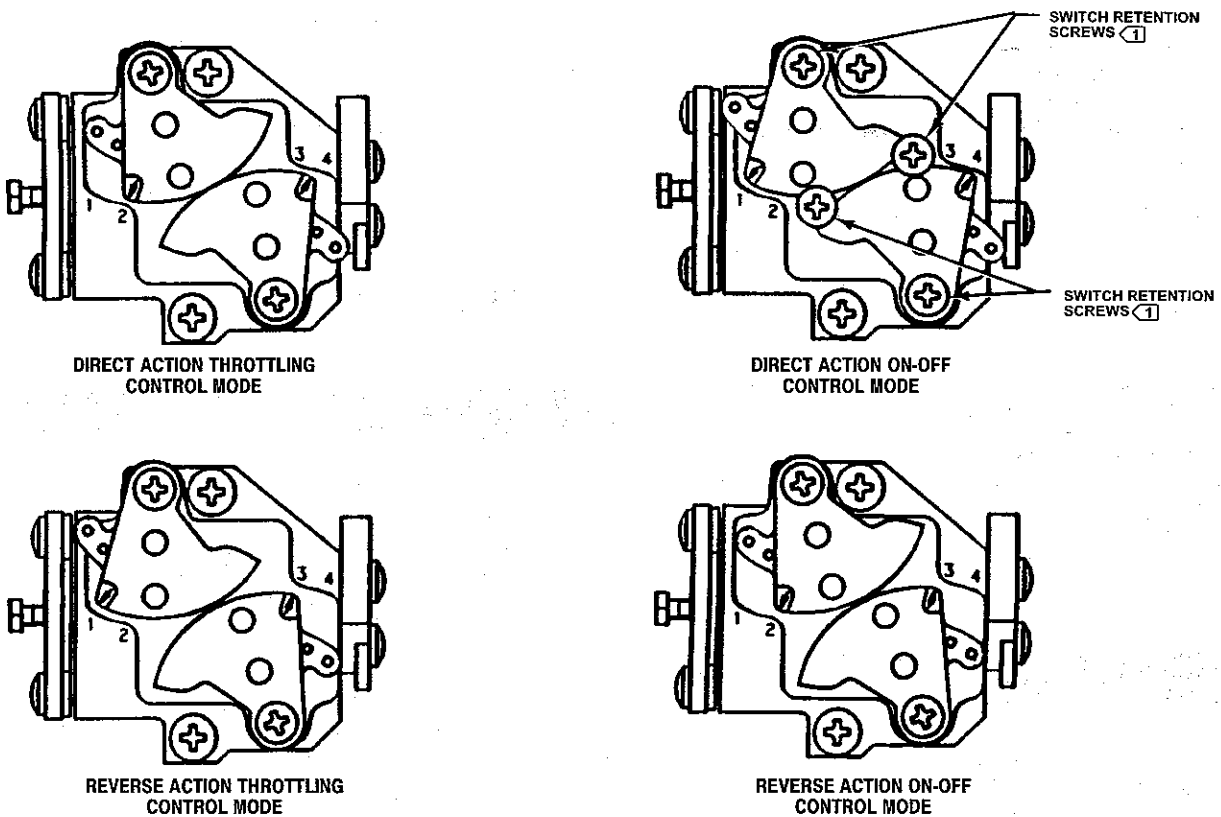
To reverse the action, refer to table 4 and reverse wiring for normally open (NO) switches and normally closed (NC) switches.

## Proportional Band Adjustment

Except where indicated, key numbers referenced in the following procedures are shown in figure 8. The span levers and other proportional band information are shown in figure 5.



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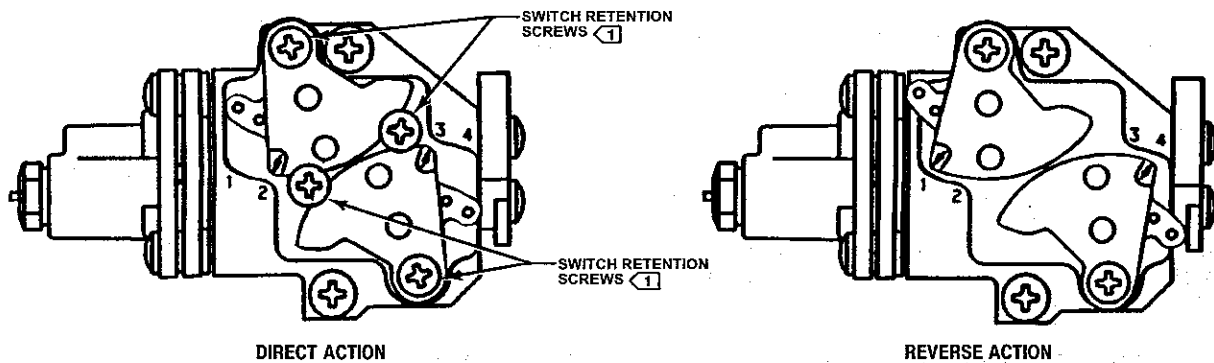


NOTE:

- ① ALL FOUR SWITCH RETENTION SCREWS SHOWN ONLY ON THIS VIEW. OTHER VIEWS SHOW ONLY TWO SWITCH RETENTION SCREWS IN ORDER TO ILLUSTRATE THE SWITCH CONFIGURATION.

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Figure 3. Type 2680 Controller Switch Positions for Changing Action and Control Mode



NOTE:

- ① ALL FOUR SWITCH RETENTION SCREWS SHOWN ONLY ON THIS VIEW. OTHER VIEWS SHOW ONLY TWO SWITCH RETENTION SCREWS IN ORDER TO ILLUSTRATE THE SWITCH CONFIGURATION.

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Figure 4. Type 2680A Controller Switch Positions for Changing Action

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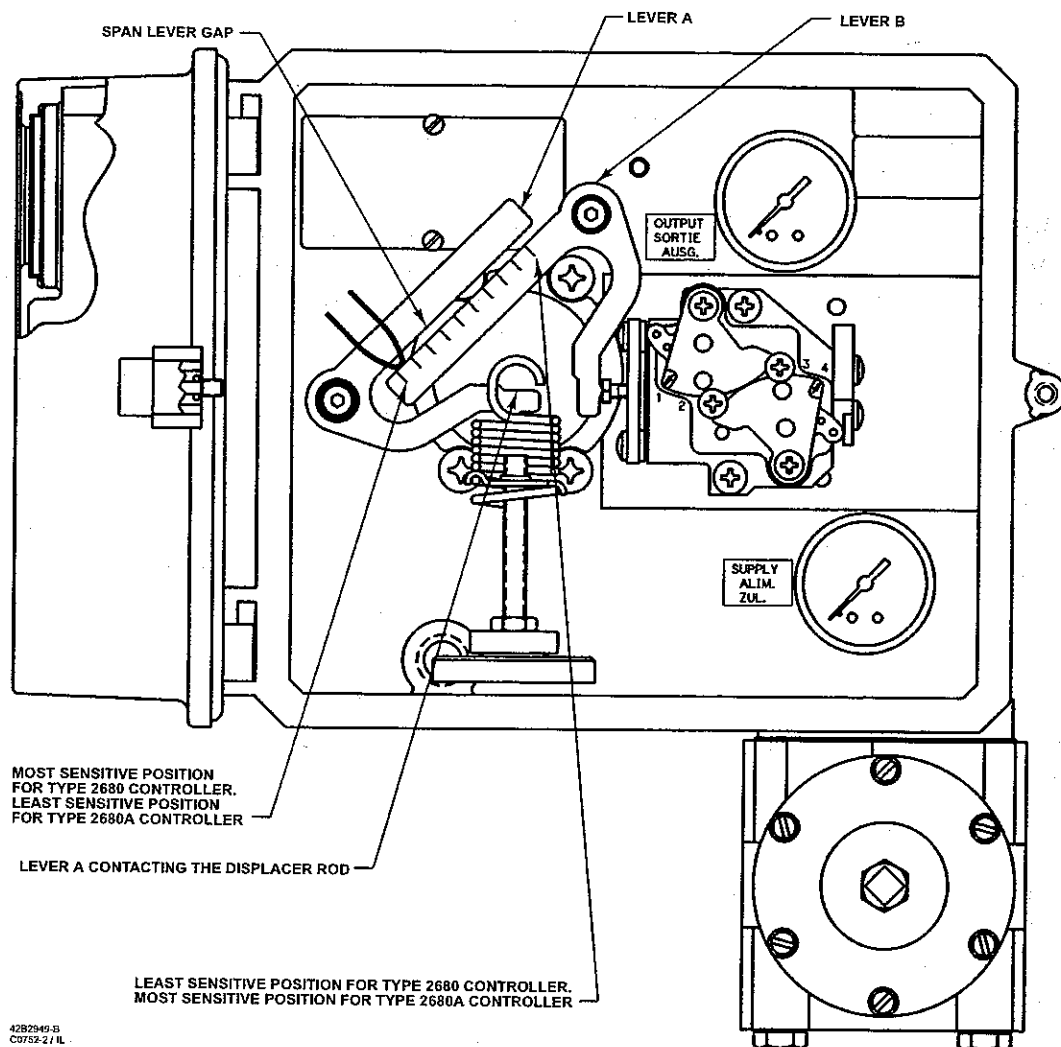


Figure 5. Proportional Band Adjustments

## Preliminary Checks

1. Check the supply pressure gauge (key 10) to be certain that the supply pressure is at the desired value. Adjust the supply pressure as required.
2. Adjust the displacer rod to the horizontal position with the spring adjustment (key 4).
3. Bounce the end of the displacer rod (key 3, figure 7) up and down to check that the sensor is operating freely.
4. Place the span adjuster (key 9) at the desired position (see figure 5).
5. Check figures 3 and 4 for correct control action and control mode.

6. Adjust the relay adjustment screw (key 51, Type 2680) or the valve assembly (key 53, Type 2680A) so that the gap between the span levers (see figure 5) is equal when lever A is contacting the displacer rod.

## Type 2680 Direct-Acting Throttling Controllers

1. Make certain the Preliminary Checks procedure at the start of this section has been completed.
2. Lower the liquid level so that it is below the bottom of the displacer or at the lowest desired operating point on the displacer. For interface applications, completely cover the displacer with the lighter fluid. The heavier fluid should be below the bottom of the dis-

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placer or at the lowest desired operating point on the displacer.

3. Adjust the spring adjustment (key 4) until the output pressure is 1 to 2 psig for a 3 to 15 psig output range, or 2 to 4 psig for a 6 to 30 psig output range.

## Type 2680 Reverse-Acting Throttling Controllers

1. Make certain the Preliminary Checks procedure at the start of this section has been completed.

2. Lower the liquid level so that it is below the bottom of the displacer or at the lowest desired operating point on the displacer. For interface applications, completely cover the displacer with the lighter fluid. The heavier fluid should be below the bottom of the displacer or at the lowest desired operating point on the displacer.

3. Adjust the spring adjustment (key 4) until the output is 16 to 17 psig for a 3 to 15 psig output range, or 31 to 34 psig for a 6 to 30 psig output range.

## Type 2680 Direct-Acting On-Off and Type 2680A Direct-Acting Snap Acting Controllers

1. Make certain the Preliminary Checks procedure at the start of this section has been completed.

2. Lower the liquid level so that it is below the bottom of the displacer or at the lowest desired operating point on the displacer. For interface applications, completely cover the displacer with the lighter fluid. The heavier fluid should be below the bottom of the displacer or at the lowest desired operating point on the displacer.

3. Adjust the spring adjustment (key 4) until the output pressure is at full supply pressure.

4. Readjust the spring adjustment (key 4) until the output pressure goes to zero psig.

## Type 2680 Reverse-Acting On-Off and Type 2680A Reverse-Acting Snap Acting Controllers

1. Make certain the Preliminary Checks procedure at the start of this section has been completed.

2. Lower the liquid level so that it is below the bottom of the displacer or at the lowest desired operating point on the displacer. For interface applications, completely cover the displacer with the lighter fluid. The heavier fluid should be below the bottom of the displacer or at the lowest desired operating point on the displacer.

3. Adjust the spring adjustment (key 4) until the output pressure goes to zero psig.

4. Readjust the spring adjustment (key 4) until the output pressure goes to full supply pressure.

## Principle of Operation

The operation of the Type 2680 and 2680A controllers in combination with the Type 268T sensor is based on Archimedes Principle, which states that a body immersed in a liquid will be buoyed up by a force equal to the weight of the liquid displaced. The buoyant force and resultant movement of the displacer in the liquid is transmitted to the controller which delivers a pneumatic signal to a control valve.

Figure 6 shows a simple schematic of the controller and sensor. In its normal position, the counterclockwise moment due to the weight of the displacer about pivot point O is balanced by the clockwise zero spring moment and the counterclockwise relay zero force moment applied through lever A to the displacer rod. The weight of the displacer decreases when the liquid level increases and the subsequent buoyant force increases causing a force imbalance between the zero spring, relay, and displacer forces. This force imbalance is transmitted to the relay by levers A and B. The relay compensates for the force imbalance by converting it to a pressure output to a control valve and bringing the forces back into equilibrium.

For throttling control, the relay pressure output will be proportional to the buoyant force. For on-off control, the relay pressure output will be either zero or equal to the supply pressure over the range of liquid level change. The liquid level change required to fully operate the relay is adjusted by sliding the proportional band adjustment along lever A to vary the lever ratio between levers A and B.

With reverse-acting proportional control, the principle of operation remains the same as that for direct action; however, the controller delivers an increasing pneumatic signal to the control valve when the liquid level falls.

Operation of the Type 2680E is similar, except rising or falling levels opens or closes the electrical switch.

## Maintenance

Parts are subject to normal wear and must be inspected periodically and replaced as necessary. The frequency of parts inspection and replacement depends upon the severity of service conditions. When inspection or repairs are required, disassemble only those parts necessary to accomplish the task.

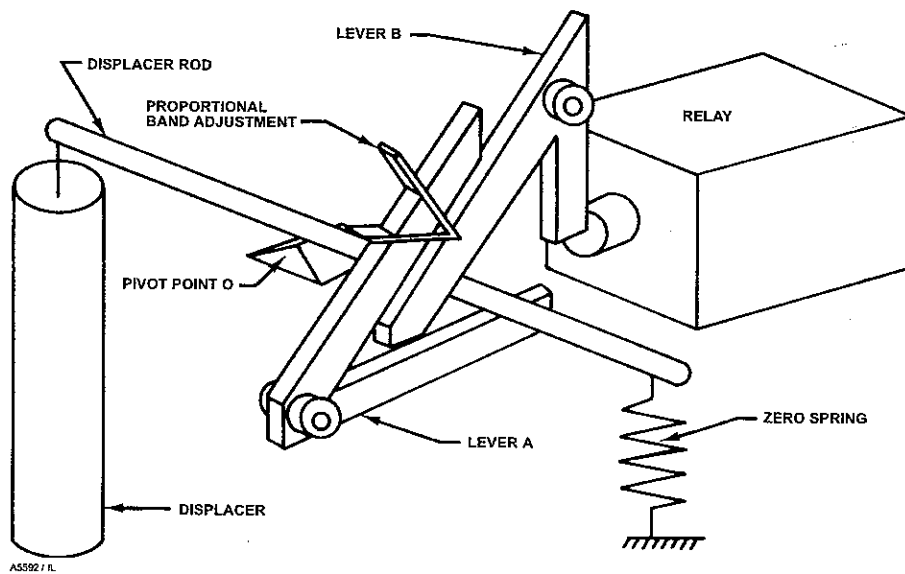


Figure 6. Operational Schematic

Due to the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher.

## WARNING

To avoid personal injury or property damage caused by the release of pressure or process fluid, observe the following before starting maintenance:

- Provide some temporary means of control for the process before taking the controller out of service.
- Provide a means of containing the process fluid before removing any measurement devices from the process.
- Vent any trapped process pressure.
- Shut off electrical power to Type 2680E.

### Removing the Controller From the Sensor

Observe the warning given at the start of the Maintenance section.

1. Disconnect the supply and output pressure lines.

2. Slide the hook end of the zero spring (key 5, figure 8) over and off the controller end of the displacer rod (key 3, figure 7).

3. Remove the four controller mounting screws (key 11, figure 8), and pull the controller straight away from the sensor.

### Replacing the Sensor O-Rings

Observe the warning given at the start of the Maintenance section. Refer to figure 7 for key number locations unless otherwise indicated.

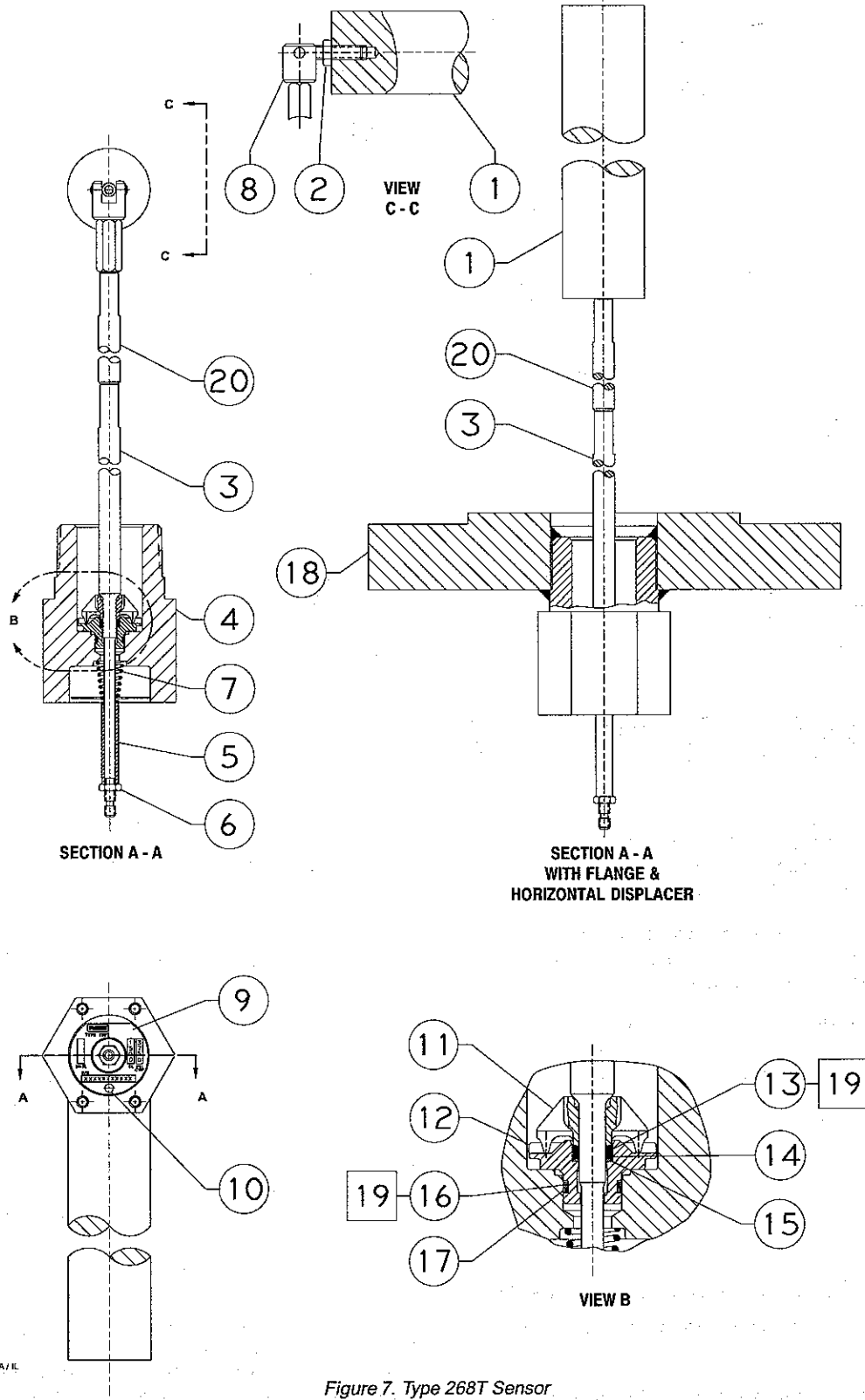
#### Disassembly

1. Remove the controller from the sensor by following the procedure outlined in the previous section.
2. Remove the sensor from the tank.
3. Unscrew the hex nut (key 6) and removing the spacer (key 5) and spring (key 7). After removing the spring, replace the spacer (key 5) and hex nut (key 6) on the displacer rod.

From the displacer end, pull the displacer rod away from the sensor connection (key 4) to pull the pivot base (key 12) loose from the sensor connection. Remove the hex nut (key 6) to permit removing the displacer rod, pivot base, pivot body, and spacer from the sensor connection.

4. Slide the pivot base (key 12), retaining ring (key 15), anti-extrusion ring (key 14), and O-ring (key 13) off the displacer rod. Remove the O-ring (key 16) and backup ring (key 17) from the pivot base.

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Figure 7. Type 268T Sensor

## Assembly

### WARNING

**Improper assembly of the O-rings, anti-extrusion ring, and backup ring could result in O-ring extrusion and permit leakage of process fluids. To avoid personal injury or property damage from leaking process fluid, be sure the O-rings, anti-extrusion ring and backup ring are assembled in the order shown in figure 7.**

1. Place the pivot body (key 11) on the displacer rod (key 3) so that it is positioned as shown in figure 7.
2. Slide the O ring (key 13), anti-extrusion ring (key 14) and retaining ring (key 15) onto the displacer rod assembly (key 3). Be sure the O-ring, anti-extrusion ring, and retaining ring are in the order shown in figure 7. Slide the pivot base onto the displacer rod so that the points of the pivot body (key 11) will engage the slots in the pivot base (key 12).
3. Install the O-ring (key 16) and backup ring (key 17) into the groove on the pivot base (key 12). Be sure the backup ring is on the downstream pressure side of the O-ring as shown in figure 7.
4. Insert the displacer rod (key 3) into the vessel side of the sensor connection (key 4).
5. The pivot base must seat in the slots cast in the sensor connection. These slots will be horizontal when the sensor connection (key 4) is oriented as shown in figure 2.
6. To reduce the possibility of nicking the O-ring (key 16) on the pivot base, keep the displacer rod centered in the sensor connection as much as possible while pushing the pivot base into the sensor connection. Be sure the pivot base seats in the slots cast in the sensor connection.
7. Slide the spring (key 7) and spacer (key 5) onto the displacer rod and secure with the hex nut (key 6). Fully tighten the hex nut (key 6).
8. View the sensor connection from the vessel side. Ensure that the pivot body arms remain aligned with the pivot base arms (the two pivot body points are seated in the pivot base slots).
9. Install the sensor on the tank.

### Replacing the Controller Relay

Observe the warning given at the start of the Maintenance section. Refer to figure 8 for key number locations unless otherwise indicated.

1. Disconnect the supply and output pressure lines.
2. Remove the two relay mounting screws (key 34), and pull the relay away from the controller base (key 1).
3. Install the new relay using two relay mounting screws (key 34). Make certain that the relay mounting O-rings (keys 45 and 46, not shown) are completely in their mounting bosses before installing the relay. Make certain span lever B (see figure 5) is in line with and pushing in on the end of either the relay adjustment screw (key 51, Type 2680) or the pilot valve plug of the valve assembly (key 53, Type 2680A).

### Replacing the Controller Supply Filter

Observe the warning given at the start of the Maintenance section. Refer to figure 8 for key number locations unless otherwise indicated.

1. Disconnect the supply and output pressure lines.
2. Loosen the filter cap screws (key 15), and rotate the filter cap (key 14) to the side to uncover the supply filter (key 16).
3. Remove the old filter (key 16), and remove any debris from the filter boss.
4. Install a new supply filter. Reinstall the filter cap (key 14), and tighten the filter cap screws (key 15).

### Removing Switch from Type 2680E

Observe the warning given at the start of the Maintenance section. Refer to figure 9 for key number locations unless otherwise indicated.

1. Disconnect conduit and wires from the controller.
2. On the back of the controller (outside the switch, key 62) is a set screw. This set screw retains the spacer (key 64). Loosen the set screw.
3. Open the controller, and remove the spacer (key 64).
4. Push the switch down into the housing far enough to remove two C-rings (key 63).
5. Pull the switch out through the top of the controller.
6. Reverse the steps to install a new switch.

### Parts Ordering

When corresponding with the Fisher Controls sales office or sales representative about this equipment, always mention the serial number of the controller. The serial number can be found on the nameplate (key 56, figure 8). When ordering replacement parts, also specify the complete 11-character part number of each part required as found in the following parts list.

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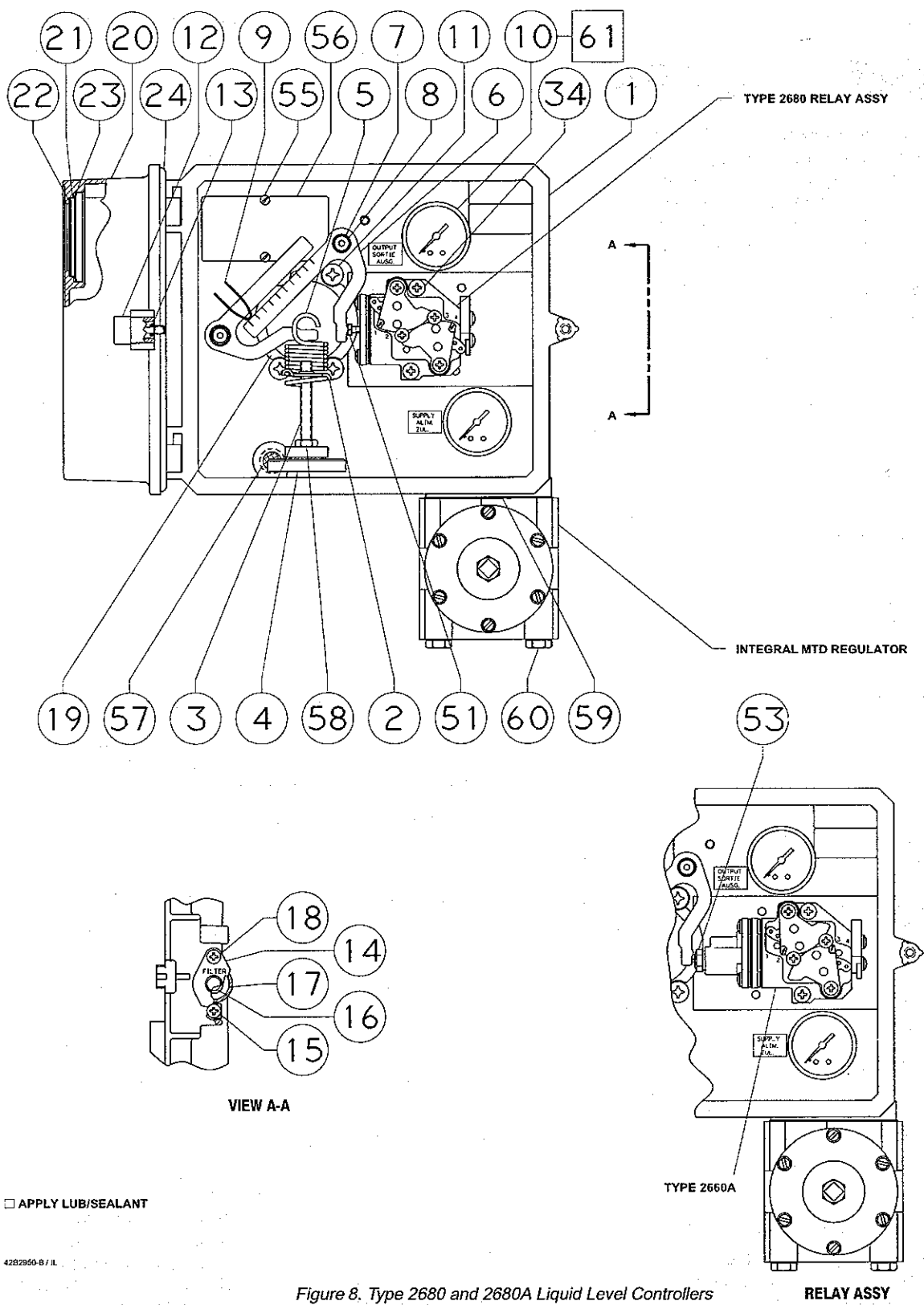


Figure 8. Type 2680 and 2680A Liquid Level Controllers

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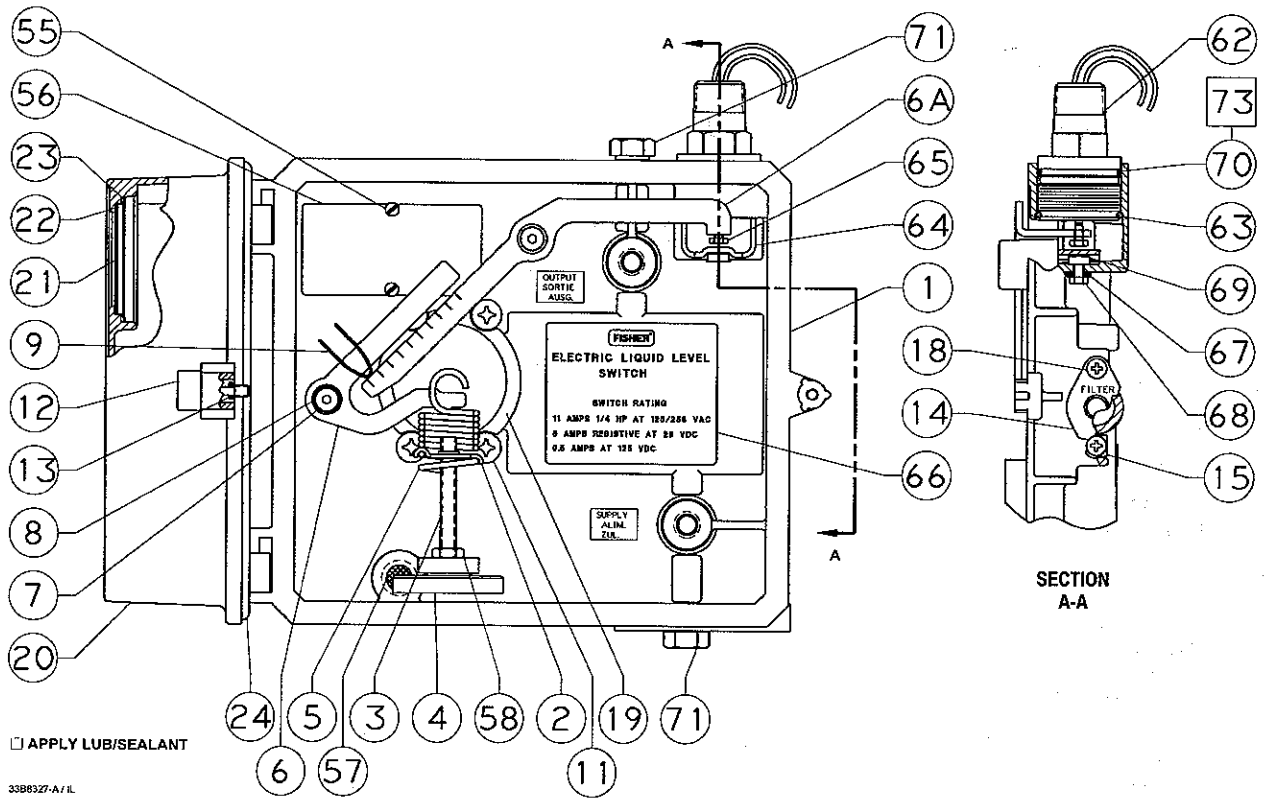


Figure 9. Type 2680E Liquid Level Controller

## Parts Kits

Key	Description	Part Number
<b>Controller</b>		
Repair kits include relay assembly and O-rings (keys 34, 45, and 46 relay mounting screw and O-rings)		
	Type 2680	
	Low temperature	R2660XRLY12
	High temperature	32B2951X022
	Type 2680A	
	Low temperature	R2660XRLY22
	High temperature	32B2951X042
<b>Sensor</b>		
Repair kit includes keys 13, 14, 15, 16, and 17 (highly saturated nitrile O-rings, retaining ring, anti-extrusion ring, and nitrile backup ring)		
		R268TX00012

## Parts List

### Controller

1	Controller Base, marine grade aluminum	
	Type 2680/2680A	42B2894 X012
	Type 2680E	33B8086 X012

Key	Description	Part Number
2	Zero Spring Seat, S31600 (316 SST)	22B2904 X012
3	Zero Adjustment Bolt, stainless steel	12B2907 X012
4	Spring Adjustment, S31600	22B2896 X012
5	Zero Spring, (17-7PH SST)	
	Type 2680/2680A (25 lb. spring)	12B2893 X012
	Type 2680A (5 lb. spring)	12B2957 X012
	Type 2680E (5 lb. spring)	12B2957 X012
6	Span Lever Assembly, stainless steel (2 req'd for Type 2680 & 2680A) (1 req'd for Type 2680E)	12B2897 X012
6A	Span Lever Assembly, stainless steel Type 2680E	22B8033 X012
7	Shoulder Screw, stainless steel (2 req'd)	12B2900 X012
8	Flanged Bearing, nylon (2 req'd)	12B2901 X012
9	Span Adjustor, stainless steel	22B2902 X012
10*	Pressure Gauge (2 req'd) (Type 2680/2680A)	11B4036 X022
11	Mounting Screw, stainless steel (4 req'd)	12B2903 X012
12	Case Cover Screw, stainless steel	18A1080 X012
13*	O-Ring, nitrile	1D1346 06992
14	Filter Cap, reinforced plexiglass	22B2898 X012
15	Cap Screw, stainless steel (2 req'd)	16A6711 X022



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Key	Description	Part Number	Key	Description	Part Number
16*	Filter (Type 2680/2680A)	11B2307 X012	<b>Sensor</b>		
17*	O-Ring, nitrile (Type 2680/2680A)	14A1968 X012	1	Displacer	
18	Machine Screw, stainless steel (2 req'd)	5908124 X012		1-7/8x12-inches	
19*	Sensor Gasket, composition	12B2933 X012		PVC	12B2936 X032
				S31603 (316L SST)	12B2956 X032
20	Cover, marine grade aluminum	42B2895 X012		2-3/4x8-inches	
21	Cover Lens, plexiglass (2 req'd)			PVC	12B2958 X032
	Type 2680/2680A	1R1922 05032		S31603	12B2959 X032
	Type 2680E	1R1922 X0022	2	Hex Nut, S31600 (vertical displacer only)	1A3421 X0042
22*	Gasket, neoprene (2 req'd)	1V5521 06992	3	Displacer Rod, S17400 (17-4PH SST)	14B5018 X012
23	Retaining Ring, steel (2 req'd)	11A6502 X012	4	Sensor Connection	
				2-inch NPT Connection	34B4962 X012
24*	Cover Gasket, nitrile	12B2905 X012		2-inch slip-on Connection	34B5019 X012
34	Relay Mounting Screw, stainless steel (2 req'd) (Type 2680/2680A)	12B2921 X012	5	Spacer, S30400 (304 SST)	12B2945 X012
45*	Relay Mounting O-Ring, nitrile (not shown)		6	Hex Nut, S31600	1A4117 X0022
	Type 2680/2680A	10A3804 X012	7	Conical Spring, S31600	12B2931 X012
46*	Relay Mounting O-Ring, nitrile (not shown)		8	Universal Joint, S31600 (vert displ only)	13B8749 X012
	Type 2680/2680A	10A8217 X042			
51	Relay Adjustment Screw	Incl in Parts Kits	9	Nameplate	---
53	Valve Assembly	Incl in Parts Kits	10	Drive Screw, stainless steel	1A3682 28982
54	Valve Assembly O-Ring	Incl in Parts Kits	11	Pivot Body, CB7CU-1 (17-4PH SST)	24B4960 X012
			12	Pivot Base, CF8M (316 SST)	24B4967 X012
55	Self-Tapping Screw, stainless steel (2 req'd)	1P4269 28982	13*	O-Ring,	
56	Nameplate	---		Highly Saturated Nitrile	11B2308 X022
57	Screen, stainless steel	0L0783 43062		Fluoroelastomer	11B2308 X032
58	Hex Nut, stainless steel	1A4117 X0012	14*	Anti-Extrusion Ring, PTFE	14B4964 X012
			15*	Retaining Ring, S30400 (304 SST)	14B4965 X012
59*	Filter Gasket, neoprene (Type 2680/2680A)	1C8986 03012	16*	O-Ring	
60	Cap Screw, stainless steel (2 req'd)			Highly Saturated Nitrile	10A3716 X062
	Type 2680/2680A	1C3988 X0022		Fluoroelastomer	10A3716 X022
61	Sealant Zinc-plate No. 770 (not furnished with controller) (Type 2680/2680A)		17*	Backup Ring	
				Nitrile	14B4940 X012
				Fluoroelastomer	14B5017 X012
<b>The following part numbers are for the Type 2680E only.</b>			18	Flange Assembly, steel (includes flange and 2-inch slip-on sensor connection, key 4)	
62*	Switch, stainless steel			W/2x2 Flange	
	SPDT	20B5075 X012		Class 150 RF	34B5013 X012
	DPDT	20B5076 X012		Class 300 RF	34B5013 X022
63	Split Ring, steel/zn pl (2 req'd)	13B8088 X012		Class 600 RF	34B5013 X032
64	Spacer, S31600	23B8089 X012		Class 600 RTJ	34B5013 X042
65	Self Tap Screw, stainless steel	13B8090 X012		Class 1500 RF	34B5013 X052
				Class 1500 RTJ	34B5013 X062
66	Label, alum	13B8091 X012		W/4x2 Flange	
67*	O-Ring, nitrile	13B8326 X012		Class 150 RF	34B5013 X072
68	Machine Screw, stainless steel	16A6935 X022		Class 300 RF	34B5013 X082
69	Square Nut, stainless steel	16A6711 X022		Class 600 RF	34B5013 X092
				Class 600 RTJ	34B5013 X102
70*	O-Ring, nitrile	1U8790 06562		Class 900 RF	34B5013 X112
71	Pipe Plug, S31600, (2 req'd)	1A7675 35072		Class 900 RTJ	34B5013 X122
73	Lubricant	T13078 T0012		Class 1500 RF	34B5013 X132
				Class 1500 RTJ	34B5013 X142
			19	Lubricant, Lubriplate Mag-1 (not furnished with sensor)	
			20	Extension, S31600	12B2953 X022

\*Recommended spare part

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For information, contact Fisher Controls:  
 Marshalltown, Iowa 50158 USA  
 Cernay 68700 France  
 Sao Paulo 05424 Brazil  
 Singapore 0512





## Installation and Maintenance

### INSTALLATION AND MAINTENANCE ARMSTRONG 11-LD LIQUID DRAINER FOR DRAINING LIQUIDS FROM GASES UNDER PRESSURE

This bulletin should be used by experienced personnel as a guide to the installation and maintenance of 11-LD liquid drainers. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Armstrong or its local representative if further information is required.

Armstrong 11-LD Liquid Drainers are made entirely of stainless steel and are available in two pressure ranges. The maximum operating pressure of the drainer depends on the internal orifice size and the specific gravity of the liquid. Table 1 shows the maximum operating pressures for the two orifice sizes at different specific gravities. **DO NOT EXCEED THE MAXIMUM OPERATING PRESSURE.** For identification, the orifice size is stamped on the discharge fitting of the drainer.

TABLE 1

Orifice Dia.	Specific Gravity of Liquid										
	1.00	.95	.90	.85	.80	.75	.70	.65	.60	.55	.50
#38	275	256	232	207	184	160	136	113	90	65	41
5/64	400	400	400	400	371	323	273	228	182	131	85

NOTE: If specific gravity falls between those shown above, use the next lower gravity. For example, if specific gravity is 0.73, use 0.70 gravity data.

NOTE: The maximum pressure vessel rating for the 11-LD is 400 psig at 500°F.

NOTE: Float type drainers are not recommended where heavy oil, sludge, or considerable dirt are encountered in the system piping. Dirt can prevent the valve from seating tightly. Cold oil can prevent drainers from opening. Armstrong inverted bucket BSW traps are ideal where these conditions exist.

#### INSTALLATION

1. Install the 11-LD at the low points of the system to be drained. Typical installations are shown in the accompanying illustrations. Follow good piping practices.



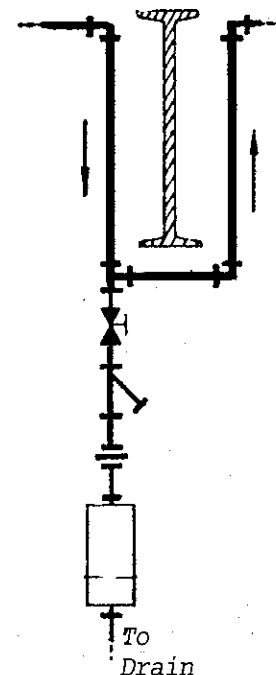
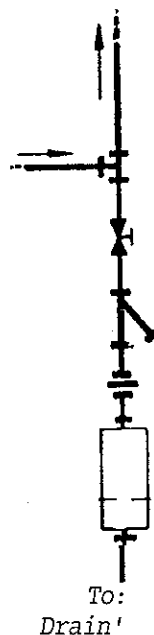
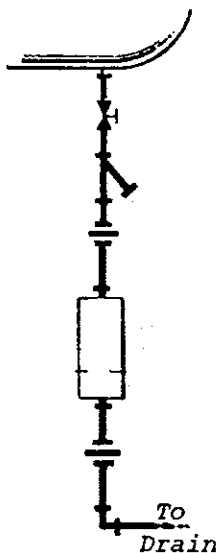
**Armstrong**

INSTALLATION AND MAINTENANCE OF ARMSTRONG 11-LD  
LIQUID DRAINER

2. Install the inlet piping (from the equipment being drained to the drainer), then blow down the piping at full line pressure to remove loose dirt and scale. NOTE: THE DRAINER HACK-VENTS THROUGH THE INLET PIPING, SO USE FULL 3/4" PIPING BETWEEN THE EQUIPMENT AND THE DRAINER INLET. Use a full ported valve. Avoid horizontal piping with sags and dips between the equipment and the drainer inlet.
3. Install the drainer as shown in the accompanying diagrams, below and close to the equipment to be drained.
4. When tightening a pipe into either the inlet or discharge fitting, use the hex-shaped fitting as a wrenching surface. Using other parts of the drainer for wrenching may place unnecessary stress on the drainer body.

**MAINTENANCE**

1. To check the operation of the 11-LD, disconnect the outlet piping and observe the discharge from the unit. It should release water or other fluid, but should close tightly to gases.
2. When an 11-LD is not operating properly, remove it from the piping and force water or air in through the **discharge** fitting. Back-flushing to remove scale and dirt often restores the drainer to normal operating condition.
3. When an 11-LD cannot be made to operate properly, remove it and install a new one with the same orifice size.





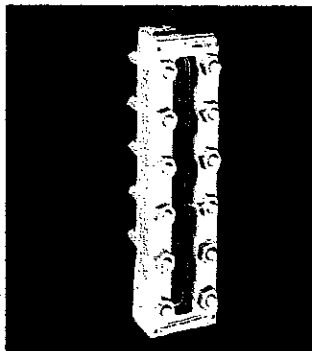
# TECHNICAL DATA direct reading flat glass liquid level gage model RL (REFLEX-L SERIES)

Section 2000  
Bulletin 2210  
Issued 5/87  
Replaces 4/86



Approved Models Available

Pressures to 2400 psi @ + 100F (16500 kPa @ + 38C)  
Temperature range - 20F to + 600F (- 29C to + 316C)



### Quality construction

All materials conform to AISI or ASTM Specifications.

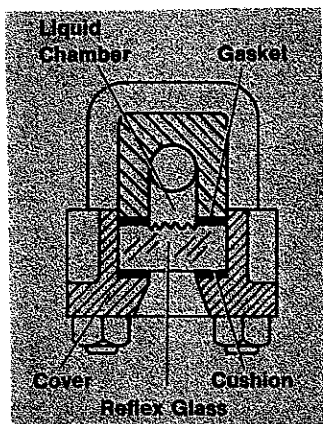
- **Liquid chamber** — one piece steel regardless of number of gage sections — optional materials available.
- **Cover** — encloses glass to reduce stress and resist glass breakage
- **Boils and nuts** — alloy steel for high temperature service
- **Glass** — tempered borosilicate glass is standard for high strength and resistance to thermal shock and erosion
- **Gasket and cushion** — die cut from quality material providing resiliency and long life

### Pressure/temperature ranges

Complete pressure and temperature ranges are given in the following chart. The maximum operating pressure and temperature ordinarily determine the largest glass size that can be used.

### Visible and overall gage lengths

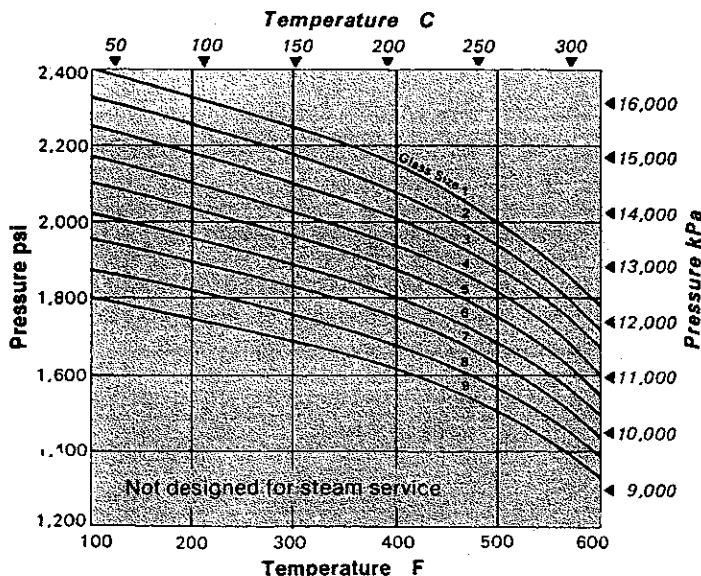
Model RL gages are available in single through 10 section units and visible lengths from 3 3/4 inches (9.5 cm) to 139 3/4 inches (355.0 cm). The visible and overall gage lengths for each combination of gage sections and glass size are given in the following table.



### DIMENSIONS

Sec-tions	Unit Designation		Visible Length Inches	Visible Length cm	End Connected Overall Length	
	Model	Glass Size			Inches	cm
1	RL	1	3 3/4	9.5	5 1/4	13.3
1	RL	2	4 1/4	12.1	6 1/4	15.9
1	RL	3	5 1/4	14.6	7 1/4	18.4
1	RL	4	6 1/4	17.1	8 1/4	21.0
1	RL	5	7 1/4	20.0	9 1/4	23.8
1	RL	6	9 1/4	23.2	10 1/4	27.0
1	RL	7	10 1/4	26.0	11 1/4	29.8
1	RL	8	11 1/4	30.2	13 3/4	34.0
1	RL	9	12 3/4	32.1	14 1/4	35.9
2	RL	4	15	38.1	16 1/2	41.9
2	RL	5	17 1/4	43.8	18 1/4	47.6
2	RL	6	19 1/4	50.2	21 1/4	54.0
2	RL	7	22	55.9	23 1/2	59.7
2	RL	8	25 1/4	64.1	26 1/4	67.9
2	RL	9	26 3/4	67.9	28 1/4	71.8
3	RL	6	30 3/8	77.2	31 1/8	81.0
3	RL	7	33 3/4	85.7	35 1/4	89.5
3	RL	8	38 3/8	98.1	40 1/8	101.9
3	RL	9	40 3/8	103.8	42 3/8	107.6
4	RL	7	45 1/2	115.6	47	119.4
4	RL	8	52	132.1	53 1/2	135.9
4	RL	9	55	139.7	56 1/2	143.5
5	RL	7	57 1/4	145.4	58 3/4	149.2
5	RL	8	65 3/4	166.1	66 3/8	169.9
5	RL	9	69 3/8	175.6	70 3/8	179.4
6	RL	8	78 3/4	200.0	80 1/4	203.8
6	RL	9	83 3/4	211.5	84 3/4	215.3
7	RL	8	92 3/8	234.0	93 3/8	237.8
7	RL	9	97 3/8	247.3	98 3/8	251.1
8	RL	8	105 1/2	268.0	107	271.8
8	RL	9	111 1/2	283.2	113	287.0
9	RL	8	118 3/8	301.9	120 3/8	305.8
9	RL	9	125 3/8	319.1	127 3/8	322.9
10	RL	8	132 3/4	335.9	133 3/4	339.7
10	RL	9	139 3/4	355.0	141 1/4	358.8

### PRESSURE/TEMPERATURE



### STANDARD/OPTIONAL FEATURES

		Standard	Optional
<b>END CONNECTIONS</b>			
Threaded	1/2" NPTF	X	
	3/4" NPTF		X
Socketweld	1/2" (12.7 mm) Female		X
	3/4" (19.1 mm) Female		X
Flanged			X
<b>SIDE OR BACK CONNECTIONS</b>			
Threaded	1/2" NPTF		X
	3/4" NPTF		X
Socketweld	1/2" (12.7 mm) Female		X
	3/4" (19.1 mm) Female		X
Flanged			X

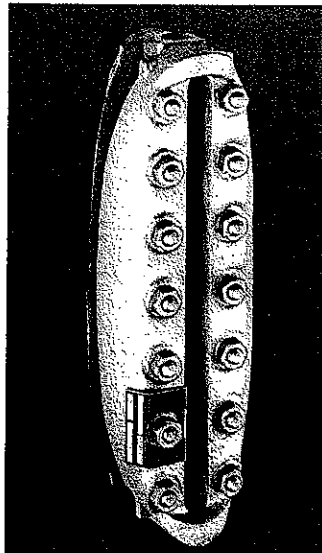
**PENBERTHY, INC.**

320 Locust St., Prophetstown, IL 61277 USA  
TEL: (815) 537-2311 FAX: (815) 537-5764

# TECHNICAL DATA direct reading flat glass liquid level gage model TH (TRANSPARENT-H SERIES)

Pressures to 3000 psi @ + 100F (20700 kPa @ + 38C)  
Two temperature ranges from - 300F to + 600F (- 184C to + 316C)

**Factory Mutual System**  
Approved Models Available



- Shields — used to protect glass from erosion or corrosive liquids (optional)
- Gasket and cushion — die cut from quality material providing resiliency and long life

### Pressure/temperature ranges

Complete pressure and temperature ranges are given in the following chart. All model TH gages, regardless of number of sections or glass size, can be used up to the maximum pressure shown in the chart.

### Visible and overall gage lengths

Model TH gages are available in single through 10 section units and visible lengths from 6 3/4 inches (17.1 cm) to 139 1/8 inches (355.0 cm). The visible and overall gage lengths for each combination of gage sections and glass size are given in the following table.

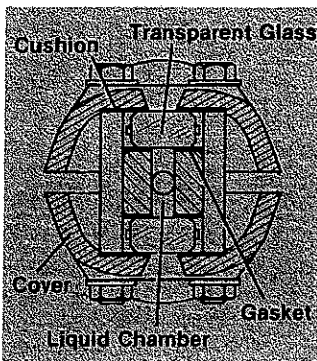
### DIMENSIONS

Sections	Unit Designation		Visible Length Inches	Visible Length cm	End Connected Overall Length	
	Model	Glass Size			Inches	cm
1	TH	4 H	6 3/4	17.1	8 1/4	21.0
1	TH	5 H	7 7/8	20.0	9 3/8	23.8
1	TH	6 H	9 1/8	23.2	10 3/8	27.0
1	TH	7 H	10 1/4	26.0	11 3/4	29.8
1	TH	8 H	11 7/8	30.2	13 3/8	34.0
1	TH	9 H	12 5/8	32.1	14 1/8	35.9
2	TH	4 H	15	38.1	16 1/2	41.9
2	TH	5 H	17 1/4	43.8	18 3/4	47.6
2	TH	6 H	19 3/4	50.2	21 1/4	54.0
2	TH	7 H	22	55.9	23 1/2	59.7
2	TH	8 H	25 1/4	64.1	26 3/4	67.9
2	TH	9 H	26 3/4	67.9	28 1/4	71.8
3	TH	6 H	30 3/8	77.2	31 7/8	81.0
3	TH	7 H	33 3/4	85.7	35 1/4	89.5
3	TH	8 H	38 5/8	98.1	40 1/8	101.9
3	TH	9 H	40 7/8	103.8	42 3/8	107.6
4	TH	7 H	45 1/2	115.6	47	119.4
4	TH	8 H	52	132.1	53 1/2	135.9
4	TH	9 H	55	139.7	56 1/2	143.5
5	TH	7 H	57 1/4	145.4	58 3/4	149.2
5	TH	8 H	65 3/8	166.1	66 7/8	169.9
5	TH	9 H	69 1/8	175.6	70 3/8	179.4
6	TH	8 H	78 3/4	200.0	80 1/4	203.8
6	TH	9 H	83 1/4	211.5	84 3/4	215.3
7	TH	8 H	92 1/8	234.0	93 3/8	237.8
7	TH	9 H	97 3/8	247.3	98 7/8	251.1
8	TH	8 H	105 1/2	268.0	107	271.8
8	TH	9 H	111 1/2	283.2	113	287.0
9	TH	8 H	118 7/8	301.9	120 3/8	305.8
9	TH	9 H	125 5/8	319.1	127 1/8	322.9
10	TH	8 H	132 1/4	335.9	133 3/4	339.7
10	TH	9 H	139 3/4	355.0	141 1/4	358.8

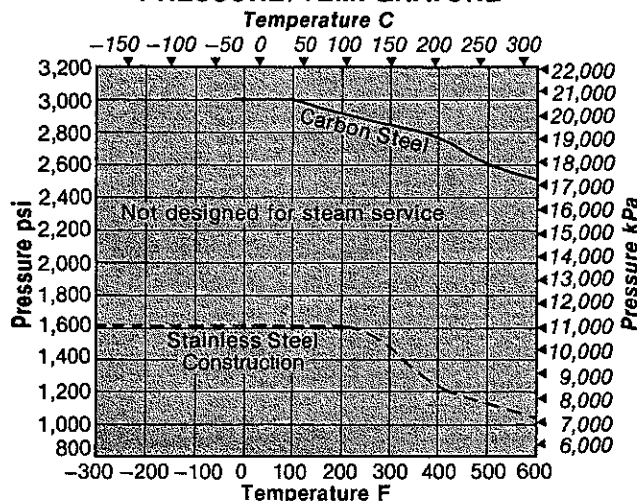
### Quality construction

All materials conform to AISI or ASTM Specifications.

- **Liquid chamber** — one piece steel regardless of number of gage sections — reinforcement bars tie the sides of chamber together for added strength — optional materials available.
- **Cover** — unique shape allows maximum rated pressure regardless of glass size
- **Bolts and nuts** — alloy steel for high temperature service
- **Glass** — tempered borosilicate glass is standard for high strength and resistance to thermal shock and erosion



### PRESSURE/TEMPERATURE



### STANDARD/OPTIONAL FEATURES

		Standard	Optional
<b>END CONNECTIONS</b>			
Threaded	1/2" NPTF	X	
	3/4" NPTF		X
Socketweld	1/2" (12.7 mm) Female		X
	3/4" (19.1 mm) Female		X
Flanged			X
<b>SIDE CONNECTIONS</b>			
Threaded	1/2" NPTF		X
	3/4" NPTF		X
Socketweld	1/2" (12.7 mm) Female		X
	3/4" (19.1 mm) Female		X
Flanged			X
<b>SHIELDS</b>			X

# PENBERTHY, INC.

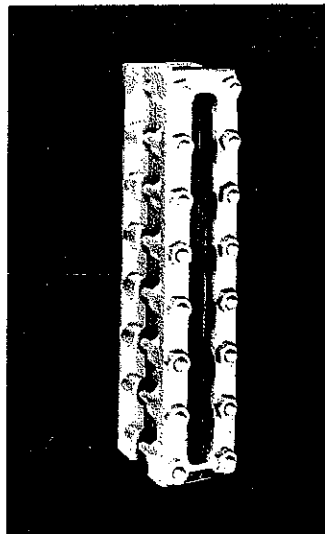
320 Locust St., Prophetstown, IL 61277 USA  
TEL: (815) 537-2311 FAX: (815) 537-5764  
TELEX: 257-339 PMCO PRWN

# TECHNICAL DATA direct reading flat glass liquid level gage model TL (TRANSPARENT-L SERIES)

Pressures to 2000 psi @ + 100F (13800 kPa @ + 38C)  
Temperature range - 20F to + 600F (- 29C to + 316C)



Approved Models Available



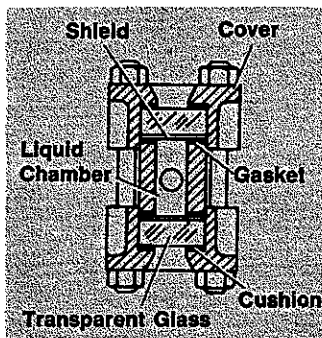
- Shields — used to protect glass from erosion or corrosive liquids (optional)
- Gasket and cushion — die cut from quality material providing resiliency and long life

### Pressure/temperature ranges

Complete pressure and temperature ranges are given in the following chart. The maximum operating pressure and temperature ordinarily determine the largest glass size that can be used.

### Visible and overall gage lengths

Model TL gages are available in single through 10 section units and visible lengths from 3 3/4 inches (9.5 cm) to 139 1/2 inches (355.0 cm). The visible and overall gage lengths for each combination of gage sections and glass size are given in the following table.



### Quality construction

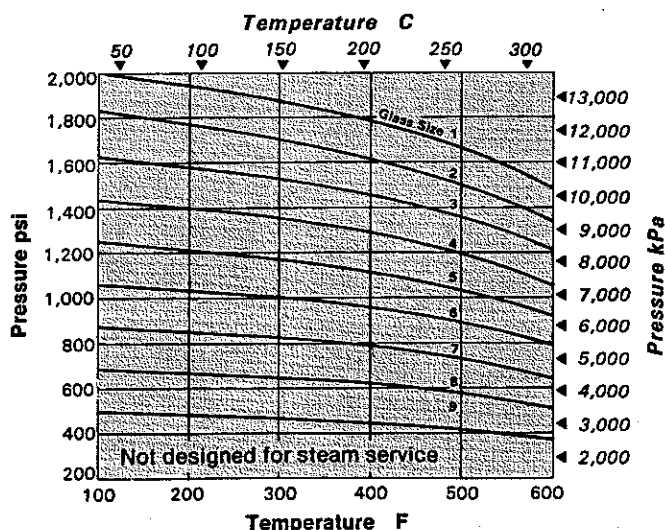
All materials conform to AISI or ASTM Specifications.

- Liquid chamber — one piece steel regardless of number of gage sections — reinforcement bars tie sides of chamber together for added strength — optional materials available.
- Cover — encloses glass to reduce stress and resist glass breakage
- Bolts and nuts — alloy steel for high temperature service
- Glass — tempered borosilicate glass is standard for high strength and resistance to thermal shock and erosion

### DIMENSIONS

Sec-tions	Unit Designation		Glass Size	Visible Length		End Connected Overall Length	
	Model			Inches	cm	Inches	cm
1	TL	1	3 3/4	9.5	5 1/4	13.3	
1	TL	2	4 3/4	12.1	6 1/4	15.9	
1	TL	3	5 3/4	14.6	7 1/4	18.4	
1	TL	4	6 3/4	17.1	8 1/4	21.0	
1	TL	5	7 3/4	20.0	9 1/4	23.8	
1	TL	6	9 1/4	23.2	10 3/4	27.0	
1	TL	7	10 3/4	26.0	11 3/4	29.8	
1	TL	8	11 3/4	30.2	13 3/4	34.0	
1	TL	9	12 3/4	32.1	14 3/4	35.9	
2	TL	4	15	38.1	16 1/2	41.9	
2	TL	5	17 1/4	43.8	18 3/4	47.6	
2	TL	6	19 3/4	50.2	21 1/4	54.0	
2	TL	7	22	55.9	23 1/2	59.7	
2	TL	8	25 1/4	64.1	26 3/4	67.9	
2	TL	9	26 3/4	67.9	28 1/4	71.8	
3	TL	6	30 3/4	77.2	31 3/4	81.0	
3	TL	7	33 3/4	85.7	35 1/4	89.5	
3	TL	8	38 3/4	98.1	40 1/4	101.9	
3	TL	9	40 3/4	103.8	42 3/4	107.6	
4	TL	7	45 1/2	115.6	47	119.4	
4	TL	8	52	132.1	53 1/2	135.9	
4	TL	9	55	139.7	56 1/2	143.5	
5	TL	7	57 1/4	145.4	58 3/4	149.2	
5	TL	8	65 3/4	166.1	66 3/4	169.9	
5	TL	9	69 3/4	175.6	70 3/4	179.4	
6	TL	8	78 3/4	200.0	80 3/4	203.8	
6	TL	9	83 3/4	211.5	84 3/4	215.3	
7	TL	8	92 3/4	234.0	93 3/4	237.8	
7	TL	9	97 3/4	247.3	98 3/4	251.1	
8	TL	8	105 1/2	268.0	107	271.8	
8	TL	9	111 1/2	283.2	113	287.0	
9	TL	8	118 3/4	301.9	120 3/4	305.8	
9	TL	9	125 3/4	319.1	127 3/4	322.9	
10	TL	8	132 3/4	335.9	133 3/4	339.7	
10	TL	9	139 3/4	355.0	141 1/4	358.8	

### PRESSURE/TEMPERATURE



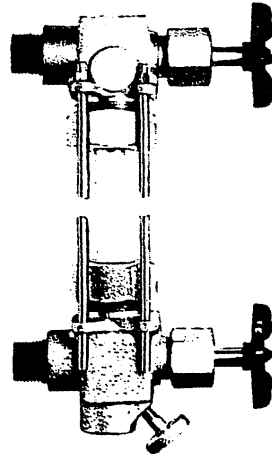
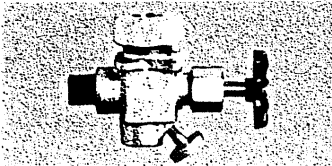
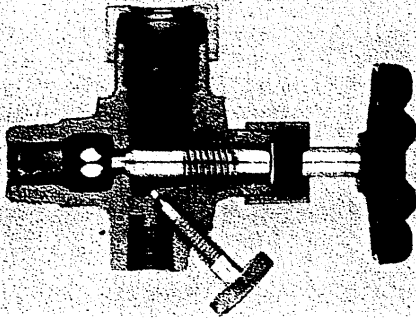
### STANDARD/OPTIONAL FEATURES

	Standard	Optional
<b>END CONNECTIONS</b>		
Threaded 1/2" NPTF		X
3/4" NPTF		X
Socketweld 1/2" (12.7 mm) Female		X
3/4" (19.1 mm) Female		X
Flanged		X
<b>SIDE CONNECTIONS</b>		
Threaded 1/2" NPTF		X
3/4" NPTF		X
Socketweld 1/2" (12.7 mm) Female		X
3/4" (19.1 mm) Female		X
Flanged		X
<b>SHIELDS</b>		
		X



# TECHNICAL DATA valves for tubular glass gages series N7 [STRAIGHT PATTERN]

Pressures to 500 psi @ + 100F (3400 kPa @ + 38C)  
Temperature range - 20F to + 500F (- 29C to + 260C)



**Design features**

The N7 series includes models N7A and N7B with these design features —

- Straight pattern
- Integral bonnet
- Stuffing box gage connection
- Rigid vessel connection
- Ball check shutoff
- Integral drain cock

Combinations of optional features and materials are available. Each combination is designated by a model number as shown in the table of Features.

Optional materials can be specified for the valve body and trim. (Trim consists of the stem, stem packing retainer, glass packing gland and ball check.) Standard and optional materials are available for service as described by AISI or ASTM Specifications.

**Pressure temperature ranges**

The pressure/temperature ranges in the following table are subject to the limitations of the tubular glass.

**ASME Boiler Code**

Series N7 valve sets that are acceptable for ASME Boiler Code are available as an option. These valve sets have vertical rising ball check in lower valve, horizontal in upper valve and ball inspection plug.

**STANDARD/OPTIONAL FEATURES**

	Model N7A	Model N7B	Optional	Optional
<b>STRAIGHT PATTERN</b>	Standard	Optional	Standard	Optional
<b>INTEGRAL BONNET</b>				
<b>GAGE CONNECTION</b>				
Stuffing Box	1/8" Glass Dia.			
	1/4" Glass Dia.			
<b>VESSEL CONNECTION</b>				
Solid Shank	1/2" NPTM			
	1/4" NPTM			
Socketweld	1/2" Male		X	
	1/4" Male			X
Flanged		X		X
<b>DRAIN CONNECTION</b>				
	1/4" NPTF			
<b>BALL CHECK SHUTOFF</b>				
Horizontal Lower and Upper (Iron, STS Valves)				
Vertical Lower/Horizontal Upper (Bronze Valves)			X	X
Vertical Lower/Horizontal Upper (Acceptable for ASME Service)		X		X
Omitted (Acceptable for ASME Service)				
<b>BALL INSPECTION PLUG (Required for ASME Service)</b>				
Furnished		X		X
Omitted				
<b>SEAT — Integral</b>				
<b>HANDWHEEL w/STANDARD PITCH THREAD (Iron, STS Valves)</b>				
<b>HANDWHEEL w/QUICK CLOSING THREAD (Bronze valves)</b>				
<b>INTEGRAL DRAIN COCK</b>				
POLISHED BODY (bronze valves)		X		X
<b>GUARD RODS (4 per valve set)</b>				
	1/4" (4.8 mm) Dia.		X	X

**DIMENSIONS**

Model	Dimension X inches (cm)	Dimension Y inches (cm)
All models	2 (5.1)	1/4 (1.9)

**Dimensions**

To obtain length of glass tubing needed to make up gage set for given vessel center-to-center dimension —

$$\text{Glass Tubing Length} = \left( \frac{\text{Vessel Center-to-Center Dimension}}{\text{Dimension X}} \right) - \text{Dimension X}$$

To obtain length of guard rods for given valve center-to-center dimension —

$$\text{Guard Rod Length} = \left( \frac{\text{Valve Center-to-Center Dimension}}{\text{Dimension Y}} \right) - \text{Dimension Y}$$

**PRESSURE/TEMPERATURE RANGES**

Model	Maximum working pressure, psi (kPa) at temperatures to —							Maximum Steam Pressure
	with standard neoprene glass packing				with optional teflon glass packing			
	-20F (-29C)	+100F (+38C)	+200F (+93C)	+300F (+149C)	+400F (+204C)	+450F (+232C)	+500F (+260C)	
	psi (kPa)	psi (kPa)	psi (kPa)	psi (kPa)	psi (kPa)	psi (kPa)	psi (kPa)	psi (kPa)
N7A	200	200	190	165	125	—	—	125
Bronze	(1400)	(1400)	(1300)	(1100)	(900)	—	—	(900)
N7B	400	400	385	335	250	—	—	250
Bronze	(2800)	(2800)	(2700)	(2300)	(1700)	—	—	(1700)
N7A	185	185	170	165	165	160	—	165
Iron	(1300)	(1300)	(1200)	(1100)	(1100)	(1100)	—	(1100)
N7B	490	490	445	435	425	415	—	415
Iron	(3400)	(3400)	(3100)	(3000)	(2900)	(2900)	—	(2900)
N7A, N7B	500	500	500	500	500	500	500	500
STL, STS	(3500)	(3500)	(3500)	(3500)	(3500)	(3500)	(3500)	(3500)

Pressure/temperature ranges in above table subject to limitations of tubular glass.



# (TUBULAR GLASS GAGES) valves

Offset and straight pattern designs for use with tubular glass in a variety of materials and configurations for most needs

straight and offset pattern designs.

**Series 500 and 700 Valves -- OS&Y**

These are outside screw and yoke valves that are used for high-temperature or corrosive-liquid applications. The OS&Y design isolates the stem threads from the liquid. Penberthy OS&Y valves are offered with many features in both straight and offset pattern designs.

Penberthy tubular glass gage valves are for use in lower pressure applications. They are available with many combinations of features for a range of uses.

Valves are available with union or solid shank vessel connections, and with a choice of stuffing box sizes for various glass diameters. All stuffing box connections are designed for positive seal with minimum compression.






These valves can be used with flat glass gages by using special tubular adapters.

Both straight and offset pattern valves are offered. Offset pattern valves permit easy cleaning of gage glass since they provide a passage straight through the vent connection, glass, and drain connection.

All standard Penberthy tubular glass valves have corrosion resistant steel ball checks for instant shutoff should the glass break.

Upper valves in a valve set have horizontal ball checks, while lower valves have either horizontal or vertical acting balls, depending on the model.

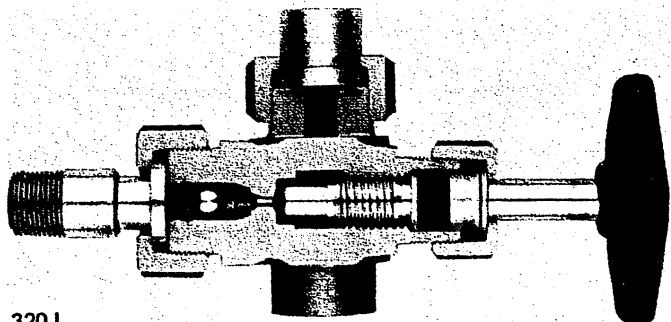
Horizontal ball check valves have extensions on the stems to unseat the ball when the valve is closed.

series design type	Standard Features	Connection Size Combinations			Vessel Connection Type Standard <i>Optional</i>	Maximum Pressure subject to limitations of glass	Temperature Range	
		vessel (NPTM)	glass dia.	Model			min	max
 <p><b>N2</b> offset pattern Bulletin 2250</p>	Ball Check Shut-off Integral Bonnet Integral Seat Handwheel	1/2" 3/4" 1"	3/4" 1/2" 3/4"	N2AJ N2BJ N2CJ	Union <i>Socketweld</i> <i>Flanged</i> <i>Spherical Union</i>	600 psi @ +100F 4100 kPa @ +38C	-300F -184C	+750F +399C
 <p><b>K2</b> offset pattern Bulletin 2250</p>	Ball Check Shut-off Union Bonnet Threaded Seat Handwheel	1/2" 3/4" 1"	3/4" 1/2" 3/4"	K2AJ K2BJ K2CJ	Union <i>Socketweld</i> <i>Flanged</i> <i>Spherical Union</i>	600 psi @ +100F 4100 kPa @ +38C	-300F -30C	+750F +400C
 <p><b>K3</b> offset pattern Bulletin 2251</p>	Ball Check Shut-off Union Bonnet Backseating Stem Drain Cock Furnished Handwheel Quick Closing Stem	1/2" 3/4"	3/4" 1/2"	K3A K3B	Solid Shank <i>Socketweld</i> <i>Flanged</i>	500 psi @ +100F 3500 kPa @ +38C Max. steam pressure 360 psi 2500 kPa	-20F -29C	+550F +288C
 <p><b>N6</b> straight pattern Bulletin 2252</p>	Ball Check Shut-off Integral Bonnet Drain Cock Furnished Handwheel	1/2"	3/4"	N6A	Solid Shank <i>Socketweld</i> <i>Flanged</i>	200 psi @ +100F 1400 kPa @ +38C Max. steam pressure 125 psi 900 kPa	-20F -29C	+400F +204C
 <p><b>N7</b> straight pattern Bulletin 2255</p>	Ball Check Shut-off Integral Bonnet Integral Drain Cock Handwheel	1/2" 3/4"	3/4" 1/2"	N7A N7B	Solid Shank <i>Socketweld</i> <i>Flanged</i>	500 psi @ +500F 3500 kPa @ +260C Max. steam pressure 500 psi 3500 kPa	-20F -29C	+500F +260C

# TECHNICAL DATA valves for flat glass gages series 300 (OFFSET PATTERN)

Section 2000  
Bulletin 2231  
Issued 5/87  
Replaces 4/86

1500 lb. ASA rating — Pressures to 4000 psi @ +100F (27600 kPa @ +38C)  
Three temperature ranges from -300F to +750F (-184C to +399C)



320J



330J

### Dimensions

To obtain maximum gage length permissible for given vessel center-to-center dimension —

Maximum Gage Length =

$$\left( \frac{\text{Valve Center-to-Center}}{\text{Dimension}} \right) - \left( \frac{\text{Dimension}}{X} \right)$$

To determine overall length of nipples needed to make up a gage set for fixed vessel center-to-center dimension —

Combined Nipple Length =

$$\left( \frac{\text{Valve Center-to-Center}}{\text{Dimension}} \right) - \left( \frac{\text{Gage Length} + \text{Dimension}}{Y} \right)$$

Overall nipple length can be divided between nipples to suit the application. Minimum length required for each nipple is: 1 1/8" for 1/2" NPT nipple; 1 3/8" for 3/4" NPT nipple.

Penberthy Floating Shank union vessel connection permits valve center-to-center dimension to vary 3/8" (9.5 mm) total from actual vessel center-to-center dimension.

### DIMENSIONS

Model	Dimension X inches (cm)	Dimension Y inches (cm)
320J	6-1/8 (15.6)	3-7/8 (9.8)
330J	2-7/8 (7.3)	5/8 (1.6)

### STANDARD/OPTIONAL FEATURES

		Model 320J	Model 330J	Optional	Optional
		Standard	Optional	Standard	Optional
<b>OFFSET PATTERN</b>		X		X	
<b>INTEGRAL BONNET</b>		X		X	
<b>GAGE CONNECTION</b>					
Union	1/2" NPTF	X			
	1/2" NPTM		X		
	3/4" NPTF		X		
	3/4" NPTM		X		
Rigid	1/2" NPTF			X	
	1/2" NPTM				X
Socketweld	1/2" Female		X		X
	1/2" Male		X		
	3/4" Male		X		
	3/4" Female				X
Flanged		X			X
Spherical Union	1/2" NPTF		X		
	1/2" NPTM		X		
	3/4" NPTM		X		
<b>VESSEL CONNECTION</b>					
Union	1/2" NPTF		X		X
	1/2" NPTM		X		X
	3/4" NPTM	X		X	
	1" NPTM (Non-Floating)		X		X
*Solid Shank	1/2" NPTM		X		X
	3/4" NPTM		X		X
	1" NPTM		X		X
Socketweld	1/2" Male		X		X
	3/4" Male		X		X
	1" Male		X		X
Flanged		X			X
Spherical Union	1/2" NPTF		X		X
	1/2" NPTM		X		X
	3/4" NPTM		X		X
<b>VENT/DRAIN CONNECTION</b>					
1/2" NPTF		X		X	
3/4" NPTF			X		X
<b>BALL CHECK SHUTOFF</b>					
Horizontal Lower and Upper Valves		X		X	
Vertical Lower/Horizontal Upper Valve (Acceptable for ASME Service)			X		
Omitted (Acceptable for ASME Service)			X		X
Vacuum — Horizontal Upper and Lower			X		X
<b>SEAT — Integral</b>		X		X	
<b>HANDWHEEL w/STANDARD PITCH THREADS</b>		X		X	
<b>HANDWHEEL w/QUICK CLOSING THREAD</b>			X		X
<b>LEVER w/QUICK CLOSING THREAD (1/4 TURN)</b>			X		X

\* BALL CHECKS ARE NOT AVAILABLE WITH SOLID SHANK VESSEL

### Design features

The 300 series includes models 320J and 330J with these standard features —

- Offset pattern
- Integral bonnet
- Gage connection  
Model 320J — Union  
Model 330J — Rigid
- Union vessel connection
- Ball check shutoff
- Integral seat

A variety of optional features are available when specified.

Optional materials can be specified for the valve body and trim. (Trim consists of the stem, stem packing retainer, and ball check.) Standard and optional materials conform to AISI or ASTM Specifications.

### ASME Boiler Code

Series 300 valve sets that are acceptable for ASME Boiler Code are available as an option.

Model 320J valve sets with this option can be supplied either with ball check shutoffs or with them omitted, as specified. Valve sets with ball checks have a vertical rising ball in the lower valve and a horizontal ball in the upper valve.

Model 330J valve sets with the ASME Boiler Code option have the ball check shutoffs omitted.

### PRESSURE/TEMPERATURE RANGES

Construction	Maximum working pressure, psi (kPa) at temperatures to —									
	-300F (-184C)	-150F (-101C)	-20F (-29C)	+100F (+38C)	+200F (+93C)	+300F (+149C)	+400F (+204C)	+500F (+260C)	+550F (+288C)	+750F (+399C)
Forged Steel	4000 (27600)	4000 (27600)	4000 (27600)	3900 (26900)	3815 (26300)	3730 (25700)	3525 (24300)	3355 (23100)	2620 (18100)	
3 1/4 Nkl Steel	4000 (27600)	4000 (27600)	4000 (27600)	3900 (26900)	3815 (26300)	3730 (25700)	3525 (24300)	3355 (23100)	2620 (18100)	
Stainless Steel	4000 (27600)	4000 (27600)	4000 (27600)	3900 (26900)	3815 (26300)	3730 (25700)	3525 (24300)	3355 (23100)	2755 (19000)	

# PENBERTHY

320 Locust St., Prophetstown, IL 61277 USA  
TEL: (815) 537-2311 FAX: (815) 537-5764

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL INSTRUMENTS (DISPLACER OR FLOAT)				SHEET 1 OF 1											
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : LEVEL SWITCHES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.L										
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468										
								DATE	03/11/2005										
								REQ.											
								BY	CHK'D	APPR.									
1	TAG NO.			LSH-610		LSH-620		LSH-630		LSH-690									
2	SERVICE			CHILLER		LTS		DEETHANIZER		FUEL GAS SCRUBER									
3	LINE NO. / VESSEL NO.			E-610		V-620		T-630		V-690									
B O D Y / C A S E / G R O U P	4 BODY OR CAGE MATERIAL			303SS		303SS		303 SS		303SS									
	RATING			150#		600#		300#		150#									
	5	CONN. SIZE	LOC. UPPER	33	mm	TOP	33	mm	TOP	33	mm	TOP							
	TYPE			NPT		NPT		NPT		NPT									
	6	CONN. SIZE	LOC. LOWER	33	mm	BOTTOM	33	mm	BOTTOM	33	mm	BOTTOM							
	TYPE			NPT		NPT		NPT		NPT									
	7	CASE MOUNTING (RH, LH, TOP)																	
	TYPE			60 NPT		60 MM NPT		60 MM NPT		60MM NPT									
	8	ROTATABLE HEAD																	
	9	ORIENTATION																	
	10	COOLING EXTENSION																	
	11																		
12				PSL FAB CAGE		PSL FAB CAGE		PSL FAB CAGE		PSL FAB CAGE									
D I M E N S I O N S	13	DIMENSIONS			MFR STD	mm	MFR STD	mm	MFR STD	mm	MFR STD	mm							
	14	INSERTION DEPTH				mm		mm		mm		mm							
	15	DISPLACER EXTENSION				mm		mm		mm		mm							
	16	DISP. OR FLOAT MATERIAL			316SS		316SS		316SS		316SS								
	17	DISPLACER SPRING/TUBE MTL			MFR STD		MFR STD		MFR STD		MFR STD								
	18																		
	19																		
X M T R	20	FUNCTION			SWITCH		SWITCH		SWITCH		SWITCH								
	21	OUTPUT			24 VDC		24 VDC		24 VDC		24 VDC								
	22	CONTROL MODES																	
	23	DIFFERENTIAL																	
	24	OUTPUT ACTION: LEVEL RISE			CONTACTS OPEN		CONTACTS OPEN		CONTACTS OPEN		CONTACTS OPEN								
	25	MOUNTING			INTEGRAL		INTEGRAL		INTEGRAL		INTEGRAL								
	26	ENCLOSURE CLASS			XP, CSA APPROVED		XP, CSA APPROVED		XP, CSA APPROVED		XP, CSA APPROVED								
	27	ELEC. POWER OR AIR SUPPLY			24 VDC		24 VDC		24 VDC		24 VDC								
	28																		
S E R V I C E	29	UPPER LIQUID																	
	30	LOWER LIQUID			PROPANE		HC LIQUID		HC LIQUID		HC LIQUID								
	31	SP. GR. UPPER	SP. GR. LOWER		0.580		0.467		0.505		0.500								
	32	PRES. MAX.	PRES. NORMAL	1724	kPa(g)	100	kPa(g)	8963	kPa(g)	6780	kPa(g)	3792	kPa(g)	1970	kPa(g)	1724	kPa(g)	700	kPa(g)
	33	TEMP. MAX.	TEMP. NORM.	66	° C	-26	° C	66	° C	-23	° C	204	° C	108	° C	66	° C	26	° C
34																			
35																			
O P T I O N S	36	AIRSET	SUPPLY GAGE																
	37	GAGE GLASS CONNECTIONS																	
	38	GAGE GLASS MODEL NO.																	
	39	CONT: NUM	CONT: FORM	ONE (1) SPDT		ONE (1) SPDT		ONE (1) SPDT		ONE (1) SPDT									
	40	CONTACT RATING			0.5A @ 24 VDC		0.5A @ 24 VDC		0.5A @ 24 VDC		0.5A @ 24 VDC								
	41	ACTION OF CONTACTS			OPEN ON HIGH LEVEL		OPEN ON HIGH LEVEL		OPEN ON HIGH LEVEL		OPEN ON HIGH LEVEL								
	42																		
	43																		
44																			
45	MANUFACTURER			SOR		SOR		SOR		SOR									
46	MODEL NO.			1510B-G2A-C-W9-ES		1510B-G2A-C-W9-ES		1510B-G2A-C-W9-ES		1510B-G2A-C-W9-ES									
47	P. O. NUMBER																		

NOTES:

AREA. UNIT # :

ISA FORM SM20.26

MLEVEL-INS.XLT

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL INSTRUMENTS (DISPLACER OR FLOAT)				SHEET 2 OF 2			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : LEVEL SWITCHES				NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.L		
				0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468		
								DATE	03/11/2005		
								REQ.			
				BY	CHK'D	APPR.					
1	TAG NO.		LSH-640								
2	SERVICE		GLYCOL FLASH TANK								
3	LINE NO. / VESSEL NO.		E-640								
B O D Y / C A S E / M O U N T I N G / H E A D / O R I E N T A T I O N / C O O L I N G / E X T E N S I O N	4 BODY OR CAGE MATERIAL		303 SS								
	RATING		150#								
	5	CONN. SIZE	LOC. UPPER	33	mm			mm		mm	
	TYPE		NPT								
	6	CONN. SIZE	LOC. LOWER	33	mm			mm		mm	
	TYPE		NPT								
	7 CASE MOUNTING (RH, LH, TOP)										
	TYPE		60 MM NPT								
	8 ROTATABLE HEAD										
	10 ORIENTATION										
	11 COOLING EXTENSION										
	12			PSL FAB CAGE							
D I M E N S I O N / I N S E R T I O N / D I S P L A C E R / E X T E N S I O N	13 DIMENSIONS		MFR STD		mm		mm		mm	mm	
	14 INSERTION DEPTH				mm		mm		mm	mm	
	15 DISPLACER EXTENSION				mm		mm		mm	mm	
	16 DISP. OR FLOAT MATERIAL		316SS								
	17 DISPLACER SPRING/TUBE MTL		MFR STD								
X M T R / O U T P U T / A C T I O N / M O U N T I N G / E N C L O S U R E / E L E C . P O W E R / O R / A I R / S U P P L Y	20 FUNCTION		SWITCH								
	21 OUTPUT		24 VDC								
	22 CONTROL MODES										
	23 DIFFERENTIAL										
	24 OUTPUT ACTION: LEVEL RISE		CONTACTS OPEN								
	25 MOUNTING		INTEGRAL								
	26 ENCLOSURE CLASS		XP, CSA APPROVED								
	27 ELEC. POWER OR AIR SUPPLY		24 VDC								
	28										
	S E R V I C E / L I Q U I D / P R E S S U R E / T E M P E R A T U R E	29 UPPER LIQUID									
30 LOWER LIQUID		E. GLYCOL									
31		SP. GR. UPPER	SP. GR. LOWER			1.10					
32		PRES. MAX.	PRES. NORMAL	1724	kPa(g)	420	kPa(g)	kPa(g)	kPa(g)	kPa(g)	
I N S T R U M E N T / T E M P E R A T U R E	33	TEMP. MAX.	TEMP. NORM.	93	° C	57	° C	° C	° C	° C	
	34										
35											
O P E R A T I O N / A I R S E T / S U P P L Y / G A G E / C O N T A C T S / R A T I N G / A C T I O N / M O D E L / N O . / M A N U F A C T U R E / M O D E L / N O . / P . O . N U M B E R	36 AIRSET		SUPPLY GAGE								
	37 GAGE GLASS CONNECTIONS										
	38 GAGE GLASS MODEL NO.										
	39	CONT:NUM	CONT: FORM	ONE (1) SPDT							
	40	CONTACT RATING		0.5A @ 24 VDC							
	41	ACTION OF CONTACTS		OPEN ON HIGH LEVEL							
	42										
	43										
44											
45	MANUFACTURER		SOR								
46	MODEL NO.		1510B-G2A-C-W9-ES								
47	P. O. NUMBER										

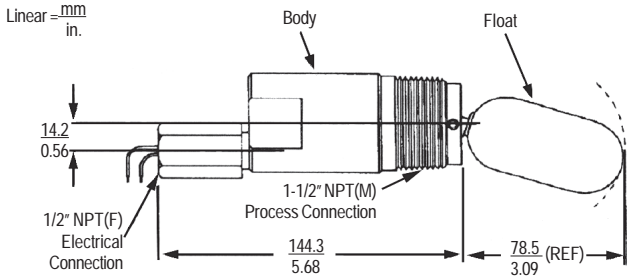
NOTES:

AREA. UNIT # :

# Type 1510 Side-Mount Electric Level Switch



## General Instructions



### General

The SOR Type 1510 Electric Level Switch mounts into the side of a vessel.

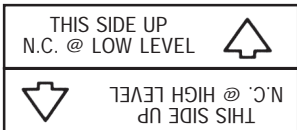
Electric switching action is provided by the float moving a magnet into the field of a hermetically sealed reed switch capsule.

The unit may be mounted for either high or low liquid level alarm by rotating the switch body to the proper position. The body wrench flats provide for ease of rotation and proper positioning. See decal on housing.

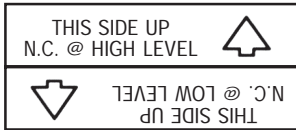
*Design and specifications are subject to change without notice.*

### Before Installation of the Level Switch

1. Inspect the unit for any shipment damage.
2. Check for mechanical clearance of the float. Float must move freely without binding throughout its stroke.
3. Use an acceptable thread compound when installing unit to ensure a leak-free fit and avoid thread galling.
4. To achieve required function, install unit according to the nameplate instructions shown here.



Nameplate Position for Low Level Alarm



Nameplate Position for High Level Alarm

### Installation

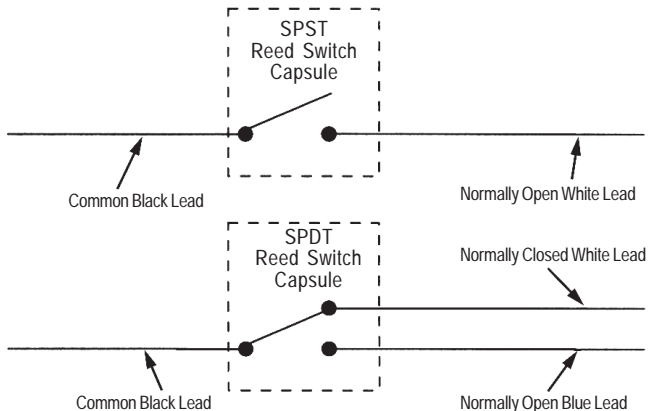
The unit may be mounted in any of the following installation arrangements.

- a. 1-1/2" NPT half coupling (No full coupling).
- b. 2" NPT full coupling. (Use in conjunction with 2 x 1-1/2" NPT bushing as required.)
- c. 2" NPT pipe tee. (Use in conjunction with 2 x 1-1/2" NPT bushing as required.)
- d. Optional flanged mounting.
- e. Optional chamber mounting.

### Electrical Connection

Ensure that wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.

Electrical connection is free wire leads with a 1/2" NPT(F) conduit connection. Use two wrenches — one to hold hex conduit connection, the other to tighten conduit fitting. Switching element is a hermetically sealed reed switch.



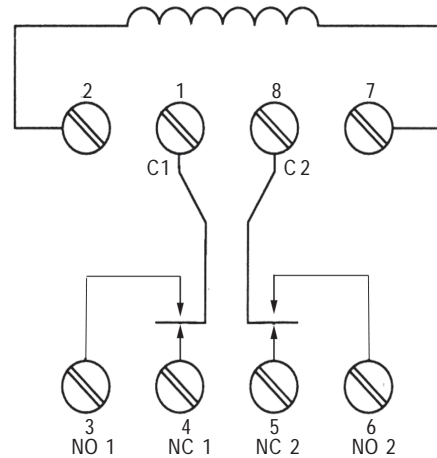
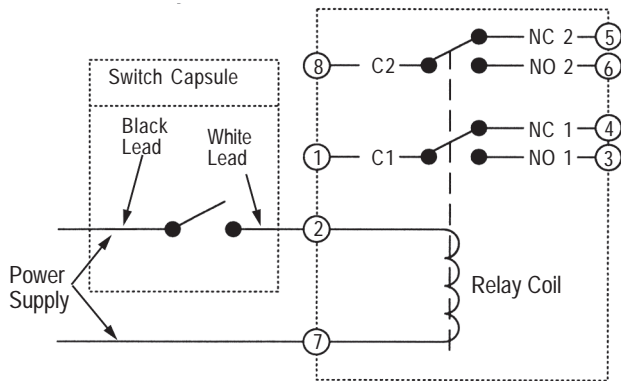
Wiring schematic for DPDT relay option shown on reverse.

**NOTE:** NC - indicates circuit is closed

**CAUTION:** Do not exceed 1 amp @ 110 VAC or 3 amps @ 28 VDC (resistive). High current input to switch will cause permanent damage to contacts.

## Wiring for DPDT Relay

For Type 1510 Level Switches equipped with DPDT relays, a wiring schematic and pin position schematic is shown below. When the 1510 is actuated, the coil will energize and “make” both NO1 and NO2 while it will “break” NC1 and NC2. This provides a DPDT circuit.



## Troubleshooting

Symptom	Probable Cause
1. Float in actuated position but no output signal.	a. No power supply. b. Switch damaged. (Replace.)
2. Float in de-actuated position but still receiving an output signal.	a. Switch damaged. (Replace.)
3. Control will not function when installed but operates when removed from process connection.	a. Inadequate float travel. Float travel restricted by mounting nozzle. See Mounting Requirements.
4. Liquid in vessel at the actuation level but unit does not respond.	a. Leaky or collapsed float. (Replace.) b. Liquid specific gravity too low. c. Float stem bound up or dirty. (Clean.)

## Replacement Parts

Part Number	Description
3130-091	SPST Hermetically Sealed Reed Switch Capsule
3130-242	SPDT Hermetically Sealed Reed Switch Capsule
3130-106	SPST Hermetically Sealed Reed Switch Capsule for CSA Certified units
3130-243	SPDT Hermetically Sealed Reed Switch Capsule for CSA Certified units
3130-052	316SS Float Assembly

All information and specifications in this bulletin are current at the time of printing. Changes in product design and specifications may occur without notice. Contact the SOR representative in your area or the factory for the current revision of this bulletin.



PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3			DIRECT FIRED HEATER		SHEET 1	OF 1
CUSTOMER : XXXXXX			REV	BY	DATE	REVISION DESCRIPTION
PLANT : REFRIGERATION PLANT 8B						
SERVICE : GLYCOL REGENERATOR						
JOB NO. : XXXXXX TAG NO: H-650						
MFR. : MODEL NO:						
1						
2	TYPE GLYCOL REGENERATOR W/ FIRETUBE					
3						
4	DESIGN CONDITIONS					
5	HEAT TRANSFERRED	kW	100			
6	MOLECULAR WEIGHT					
7	DENSITY	kg/cu.m				
8	QUANTITY	kg/m	240			
9	INLET TEMP	° C	54			
10	OUTLET TEMP	° C	66			
11	VAPORIZATION WEIGHT % -	INLET				
12		OUTLET				
13	MAXI PRESSURE DROP / CALC.	kpa				
14	INLET PRESSURE	kpa	7			
15	ELEVATION ABOVE SEA LEVEL	m				
16	EFFICIENCY ( FROM LOW HEAT VALUE ) %					
17						
18	FUEL					
19	TYPE		HC FUEL GAS			
20	LOW HEATING VALUE	MJ/cu.m@STP				
21	BURNER PRESSURE	kpa	47			
22						
23	MECHANICAL DATA					
24	OVERALL WIDTH/ LENGTH/ HEIGHT	mm X mm X mm	610 OD X 3010 LG REBOILER; 610 OD X 2400 LG SURGE; 324 OD X 2000 LG STILL			
25	DESIGN PRESSURE	kpa	ATMOSPHERIC			
26	STACK SIZE	mm	219 OD X 6096			
27	WIND LOAD	km/h				
28	NUMBER OF PASSES - FIRE TUBE		TWO			
29		- CONVECTION	N/A			
30	TOTAL EFF. SURFACE - RADIATION	m2	N/A			
31		- CONVECTION	N/A			
32	MAXI RADIANT INPUT	kW/m2	N/A			
33	ACTUAL TRANSFER RATE - RADIATION	kW	N/A			
34		- CONVECTION	N/A			
35						
36	FIRE TUBE					
37	NUMBER OF TUBE		ONE			
38	LENGTH	mm	5770			
39	SIZE	mm	219 OD			
40	MATERIAL		SA-106B			
41						
42	TUBES					
43	CONVECTION		N/A			
44	NUMBER OF TUBES		ONE COIL			
45	SIZE	mm	25 OD			
46	LENGTH	mm	79000			
47	MATERIAL		SA-179			
48						
49						
50	FITTINGS:					
51	STRESS RELIEVE FIRE TUBE REQUIRED		NO			
52						
53	NOTES:					
54						
55						



TORONTO  
Caloritech Inc.  
2767 Brighton Road  
Oakville, Ontario  
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H-650 / 670

MI110 REV. 1

## INSTALLATION AND MAINTENANCE INSTRUCTIONS IMMERSION HEATERS - TYPES CX & DX



### 1.0 INSTALLATION

- 1.1 Immersion heaters are designed for operation only while completely immersed in liquids. Never allow the heating elements to be exposed while energized or failure will result.
- 1.2 **CAUTION:** Use the heater only in liquids and at pressures for which it was designed. Normally copper sheath is recommended in water, steel or alloy sheath in oil, and the appropriate alloy sheath for heating chemical solutions. Check factory for recommendations.
- 1.3 In the case of flanged (and some screwplug type) heaters where a gasket seal is required, the gasket surface should be clean and dry before the heater is seated.
- 1.4 The terminals must be protected at all times from moisture or vapour. In hazardous locations, explosion resistant terminal housings must be used. In outdoor locations, moisture resistant housings are required.
- 1.5 Protect terminals of heating elements from drippings, condensation, fumes, spray or any other substance which could result in element contamination.
- 1.6 When melting solids by direct immersion, a surface vent should be provided to allow gases to escape. Operate the heater on  $1/2$  voltage until melted material completely covers the heating elements. Heaters used for this purpose may require special design features. Check factory for recommendations.

### 2.0 WIRING AND CONTROL

- 2.1 Heaters must be wired by qualified personnel to electrical code requirements.
- 2.2 Check supply voltage for compliance with heater nameplate voltage.
- 2.3 A line voltage or pilot duty thermostat should be used to control the heater. The pilot duty thermostat must be used with a contactor and (if required) a transformer. Generally, heaters supplied with built-in thermostats will be factory prewired if suitable for line voltage operation. Integral thermostats not factory prewired are usually intended for pilot duty.
- 2.4 It is recommended that the control circuits be supplied from the isolated secondary windings of transformers obviating the need for two supply circuits, or as an alternative, that mechanical or electrical interlocking be provided so that both supplies must be disconnected before live parts can be made accessible.
- 2.5 If there is even the slightest possibility that the liquid level may fall below the elements, a level control switch or over-temperature sensing device affixed to the uppermost heating element is required. Check factory for recommendations.
- 2.6 Heaters with explosion resistant terminal housings must only be used in locations for which the heaters are certified.
  - a) Check heater nameplate information for approval code.
  - b) Never energize an explosion resistant heater unless the terminal housing cover is properly tightened.
  - c) An immersion heater for hazardous locations is approved for use only if an approved liquid level control is used to de-energize the heater under low liquid conditions.

### 3.0 START-UP INSPECTION

- 3.1 Check that all terminal connections are tight.
- 3.2 Heaters stored for prolonged periods may absorb moisture. Using a megger (insulation resistance tester) check the value of the insulation resistance to ground for each circuit. Initial readings of over 500,000 ohms to ground are normally acceptable. Should lower readings be observed, check factory for instructions.

### 4.0 MAINTENANCE

- 4.1 DISCONNECT POWER BEFORE SERVICING.
- 4.2 Remove the immersion heater periodically to inspect for corrosion, sludge built-up and for scale removal.
- 4.3 Periodically check electrical connections for tightness.





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## INSTRUCTIONS POUR L'INSTALLATION ET L'ENTRETIEN THERMOPLONGEURS - MODÈLES CX & DX



### 1.0 INSTALLATION

- 1.1 Les thermoplongeurs sont conçus pour opérer lorsqu'ils sont complètement immergés dans un liquide. Le niveau du liquid doit toujours recouvrir les éléments chauffants lorsque ces derniers sont en opération, sinon une rupture suivra très rapidement.
- 1.2 **MISE EN GARDE:** Il faut toujours utiliser le thermoplongeur pour le type de liquide (solution) et la pression pour lesquels il fut conçu. Normalement, une gaine de cuivre est adéquate pour l'eau, une gaine en acier ou alliage pour l'huile, et une gaine en alliage pour des solutions chimiques. Vérifiez auprès du manufacturier pour toutes informations pertinentes.
- 1.3 Pour les thermoplongeurs à bride (et à bouchon fileté) requérant un joint d'étanchéité, la surface recevant le joint d'étanchéité doit être propre et sèche avant la mise en place du thermoplongeur.
- 1.4 Les terminaux des éléments doivent être protégés en tout temps contre l'humidité ou les vapeurs. Dans les emplacements dangereux, des boîtiers de terminaison antidéflagrants sont requis. Pour les installations extérieures, des boîtiers à l'épreuve des intempéries sont essentiels.
- 1.5 Les terminaux des éléments chauffants doivent être protégés contre les contaminants tels que: condensation, pulvérisation, dégouttements, vapeurs.
- 1.6 Pour la fusion des solides par immersion directe, unévent de surface est requis afin de permettre l'échappement des gaz. Opérez le réchauffeur à demi-tension ( $1/2$ ) jusqu'à ce que le solide fondu recouvre complètement les éléments chauffants. Les réchauffeurs utilisés pour cette application spécifique nécessitent certaines caractéristiques spéciales de conception. Vérifiez auprès du manufacturier pour obtenir les information appropriées sur ce sujet.

### 2.0 CÂBLAGE ET CONTRÔLE

- 2.1 Le raccordement doit être effectué par un personnel qualifié et selon le code électrique en vigueur.
- 2.2 La tension d'alimentation doit être identique à la tension indiquée sur la plaque signalétique du thermoplongeur.
- 2.3 Un thermostat à tension de secteur ou de circuit de commande doit être utilisé pour contrôler le réchauffeur. Le thermostat de circuit de commande doit être utilisé avec un contacteur magnétique et (au besoin) un transformateur de contrôle. En général, les thermoplongeurs avec thermostat intégré seront préfilés en usine si acceptable pour la tension de secteur. Les thermostats intégrés non préfilés en usine sont utilisés dans un circuit de commande.
- 2.4 Il est recommandé d'alimenter les circuits de contrôle à partir de l'enroulement secondaire isolé du transformateur évitant ainsi deux circuits d'alimentation séparés. Ou, comme alternative, d'intégrer un entrebarrage électrique ou mécanique afin que les deux alimentations soient coupées avant d'avoir accès aux composants sous tension.
- 2.5 S'il y a une possibilité si légère soit'elle, que le niveau de liquide tombe sous les éléments, un interrupteur de bas niveau, ou un interrupteur de surchauffe attaché à l'élément le plus haut est requis.
- 2.6 Les réchauffeurs avec boîtier de terminaison antidéflagrant doivent être utilisés dans les emplacements dangereux pour lesquels ils ont été approuvés.
- a) Vérifiez l'information de la plaque signalétique pour le code d'approbation.
  - b) Ne mettez jamais sous tension un réchauffeur antidéflagrant sans vous assurer, au préalable, que le couvercle du boîtier de terminaison a été adéquatement fermé et bien vissé.
  - c) L'utilisation d'un thermoplongeur dans un emplacement dangereux est approuvée si, et seulement si, un régulateur approuvé de contrôle de niveau est utilisé pour couper la tension d'alimentation lorsque le thermoplongeur est en situation de bas niveau.

### 3.0 VÉRIFICATION À LA MISE EN MARCHÉ

- 3.1 Assurez vous que toutes les connexions électriques sont bien serrées.
- 3.2 Les réchauffeurs qui ont été entreposés durant de longues périodes peuvent absorber l'humidité. Utilisez un megohmmètre (essai de résistance) pour vérifier la valeur de la résistance à la terre pour chacun des circuits. Des lectures initiales de plus de 500,000 ohms à la terre sont normalement acceptables. Si vous obtenez des lectures plus basses, vérifiez auprès du manufacturier avant de mettre le réchauffeur sous tension.

### 4.0 ENTRETIEN

- 4.1 **METTRE L'APPAREIL HORS-TENSION AVANT DE PROCÉDER À L'ENTRETIEN.**
- 4.2 Retirez le thermoplongeur périodiquement pour vérifier les effets de la corrosion, les accumulations de sédiments et pour enlever l'entartrage si nécessaire.
- 4.3 Périodiquement, vérifiez la fermeté des connexions électriques.



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## IMMERSION HEATERS SUPPLIED WITH *x-Max*<sup>®</sup> TERMINAL ENCLOSURES & BUILT-IN THERMOSTATS



### 1.0 GENERAL

- 1.1 For information on the general installation, wiring and control of immersion heaters see bulletin MI110 enclosed.
- 1.2 Immersion heaters fitted with *x-Max*<sup>®</sup> enclosures are suitable for weather resistant applications or hazardous locations. Check the heater nameplate to ensure that the unit you have is suited to your application and operating conditions and environment.
- 1.3 Specific installation and operation information on the XT Thermostat factory installed on your unit is found in MI133 enclosed.

### 2.0 CONVERTING FROM KNOB-ADJUST TO TAMPER-PROOF MODE:

To convert to tamper-proof mode you will require a factory supplied socket head cap screw.

- 2.1 Disconnect the power to the device. Remove the knurled cover from the housing assembly. Using finger pressure, gently spring the thermostat away from the bracket assembly, as shown in Fig. 1 (DO NOT press down on the steel bracket). While the thermostat is sprung down, rotate the thermostat knob counterclockwise to remove the operating shaft.
- 2.2 Ensuring that the thermostat shaft remains aligned with the operating shaft hole, place the socket-head cap screw into the hole at the front of the housing and tighten. Replace the knurled cover.

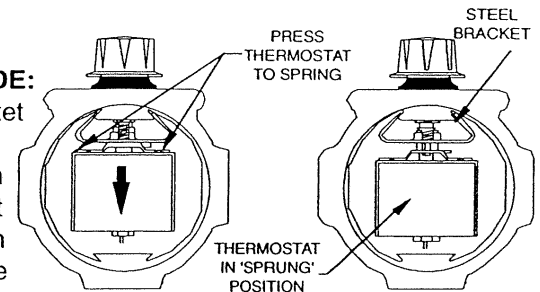


Figure 1: 'Springing' the thermostat

### 3.0 CONVERTING FROM TAMPER-PROOF TO KNOB-ADJUST MODE

To convert to knob-adjust mode you will require a knob, an operating shaft and a rubber seal to place on the shaft below the knob. Disconnect the power to the device.

- 3.1 Remove the knurled cover from the housing assembly. Remove the socket-head cap screw.
- 3.2 Ensuring that the thermostat shaft remains aligned with the cap screw hole, place the knob onto the operating shaft and thread it into the cap screw hole.
- 3.3 When the operating shaft engages with the thermostat shaft, with light finger pressure, gently spring the thermostat away from the bracket assembly, as shown in Figure 1 (DO NOT press down on the steel bracket). Rotate the knob one more full revolution to assure a positive engagement of the thermostat. Release the thermostat.
- 3.4 Upon release, the thermostat should spring back into its original position. If the thermostat remains sprung down, a slight twisting of the knob in both directions should create a positive engagement. The knob should be able to turn through the entire temperature range but should not turn one full revolution. If the knob turns completely around, repeat

### 4.0 OPERATION

4.1 TAMPER-PROOF MODE: To set the thermostat temperature:

- 4.1.1 Disconnect the power to the unit.
- 4.1.2 Completely remove the socket-head cap screw from the housing assembly.
- 4.1.3 Insert a flat-head screwdriver into the slot cut in the thermostat shaft.

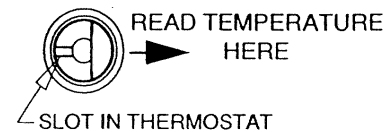


Figure 2: Thermostat temperature setting

4.1.4 Rotate the screwdriver to set the thermostat to the desired temperature. See Figure 2 to determine the temperature setting. Turning the shaft clockwise increases the set point temperature, counterclockwise rotation decreases the set point temperature (As a quick check, note that the thermostat will switch at the ambient temperature when the shaft is rotated).

4.1.5 Read the temperature from the front face of unit, as shown in Figure 2.

4.2 KNOB-ADJUST MODE: To set the thermostat temperature:

4.2.1 Rotate the knob to set the thermostat to the desired temperature. Turning the shaft clockwise increases the set point temperature, counterclockwise rotation decreases the set point temperature.



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## THERMOPLONGEURS AVEC THERMOSTATS INTÉGRÉS ET MUNIS DE BOÎTIERS DE TERMINAISON *x-Max*®



### 1.0 GÉNÉRALITÉ

1.1 Pour les informations générales relatives à l'installation, le raccordement et la régulation des thermoplongeurs, veuillez référer au bulletin MI110F sous-pli.

1.2 Les thermoplongeurs munis de boîtiers de terminaison *x-Max*® sont utilisés lorsque l'application nécessite un boîtier de terminaison à l'épreuve des intempéries ou un boîtier antidéflagrant dans un endroit classifié dangereux. Vérifiez la plaque signalétique du thermoplongeur pour vous assurer que l'appareil est adéquat pour votre application, les conditions d'opération et pour l'endroit spécifique d'utilisation.

1.3 Des informations spécifiques relatives à l'installation et l'opération du thermostat intégré XT sont détaillées au bulletin MI133F sous-pli.

### 2.0 CONVERSION D'UN BOUTON DE RÉGLAGE EXTERNE À UN MÉCANISME ANTI-VANDALISME:

Pour convertir au mode anti-vandalisme, vous aurez besoin de la vis à tête cylindrique à six pans creux (incluse avec l'unité).

2.1 Coupez l'alimentation à l'appareil. Retirez le couvercle carrelé de l'appareil. D'une pression du doigt, dégagez le thermostat du support, voir Fig. 1 (NE PUSSEZ PAS le support vers le bas). Avec le thermostat en position inférieure, effectuez une rotation anti-horaire du bouton du thermostat pour retirer la tige de commande.

2.2 Assurez vous de conserver l'alignement de la tige du thermostat avec le trou de la tige de commande, et vissez fermement la vis à tête cylindrique à six pans creux dans le trou frontal du boîtier. Remplacez le couvercle carrelé.

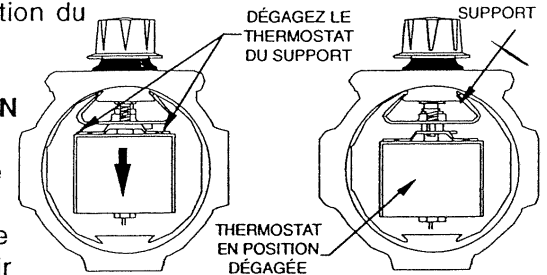


Figure 1: Dégagement du thermostat

### 3.0 CONVERSION D'UN MÉCANISME ANTI-VANDALISME À UN BOUTON DE RÉGLAGE EXTERNE

Pour convertir à un bouton de réglage externe, vous avez besoin d'un bouton, une tige de commande et un joint d'étanchéité en caoutchouc à placer sur la tige sous le bouton de réglage. Coupez l'alimentation électrique.

3.1 Retirez le couvercle carrelé de l'appareil. Retirez la vis à tête cylindrique à six pans creux.

3.2 Assurez vous de conserver l'alignement de la tige du thermostat avec le trou de la vis cylindrique. Placez le bouton sur la tige de commande et vissez à l'intérieur du trou de la vis cylindrique.

3.3 Lorsque la tige de commande est engagée avec la tige du thermostat, d'une légère pression du doigt, dégagez le thermostat du support, voir Figure 1 (NE PUSSEZ PAS le support vers le bas). Tournez le bouton d'un autre tour complet pour assurer l'accouplement positif avec le thermostat et relâchez le thermostat.

3.4 Dès la relâche, le thermostat devrait reprendre sa position originale. Si le thermostat demeure en sa position inférieure, une légère rotation du bouton dans les deux directions devrait être suffisante pour assurer l'accouplement du thermostat. La rotation du bouton doit couvrir complètement la plage de température sans toutefois pouvoir effectuer une rotation complète. Si le bouton effectue une rotation complète, recommencez la procédure.

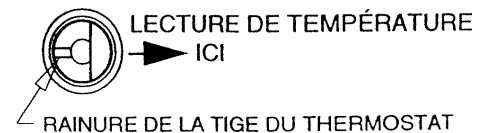


Figure 2: Réglage du thermostat

### 4.0 OPÉRATION

4.1 ANTI-VANDALISME: Réglage du thermostat:

4.1.1 Coupez l'alimentation à l'unité.

4.1.2 Retirez complètement la vis à tête cylindrique à six pans creux.

4.1.3 Insérez un tournevis plat dans la rainure de la tige du thermostat.

4.1.4 Réglez la température de consigne du thermostat à l'aide du tournevis. Voir Figure 2 pour déterminer le point de consigne. Pour élever la température, effectuez un mouvement horaire, pour abaisser la température, effectuez un mouvement anti-horaire (comme vérification rapide, notez le déclic du thermostat à la température ambiante).

4.1.5 La lecture de la température est établie sur la face frontale de l'appareil, voir Figure 2.

4.2 BOUTON DE RÉGLAGE EXTERNE: Réglage de température:

4.2.1 À l'aide du bouton, réglez le thermostat à la température désirée. Pour élever la température effectuez un mouvement horaire, pour abaisser la température effectuez un mouvement anti-horaire.



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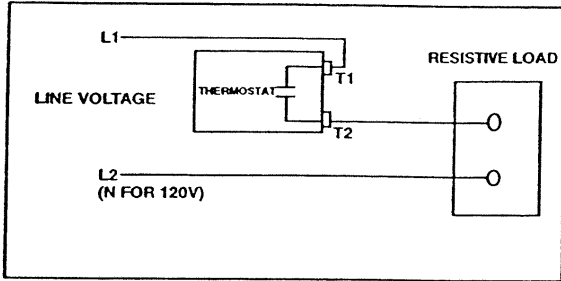
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## WIRING DIAGRAMS FOR IMMERSION HEATERS WITH THERMOSTATS

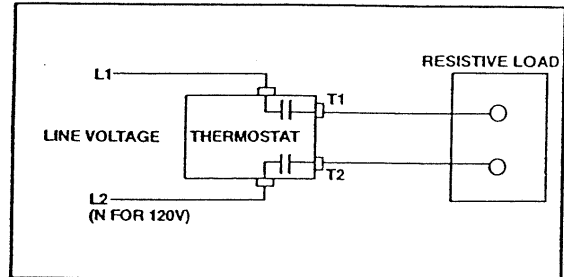
NOTE: Check thermostat label for maximum voltage and current rating.



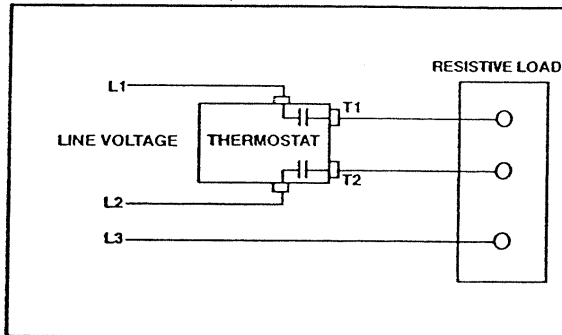
### LINE DUTY 1 $\phi$ SPST THERMOSTAT



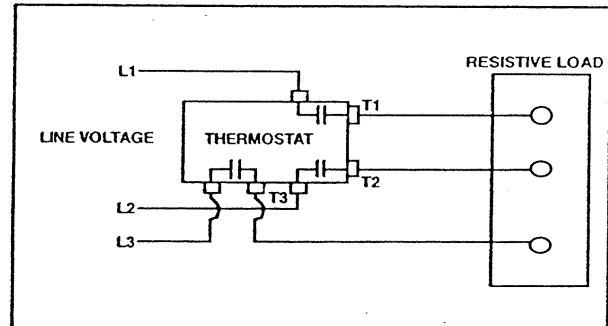
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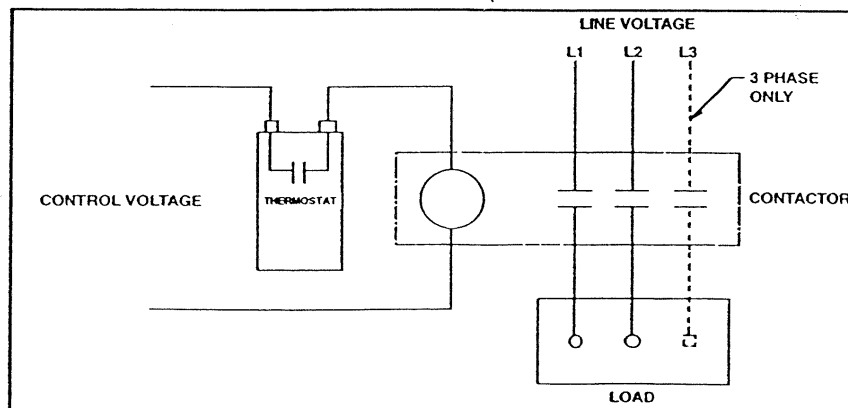
### LINE DUTY 3 $\phi$ DPST THERMOSTAT



### LINE DUTY 3 $\phi$ TPST THERMOSTAT



### PILOT DUTY 1 $\phi$ SPST





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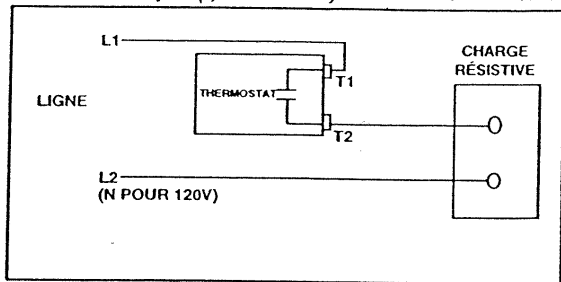
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## DIAGRAMMES DE FILAGE POUR THERMOPLONGEURS AVEC THERMOSTATS

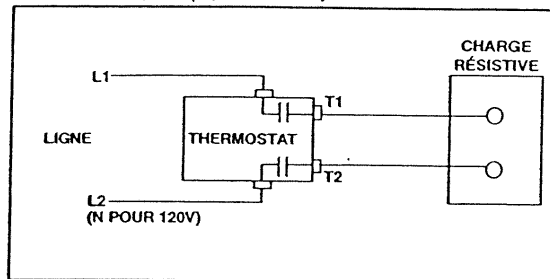
NOTE: Vérifier la plaque signalétique du thermostat pour tension et courant maximum.



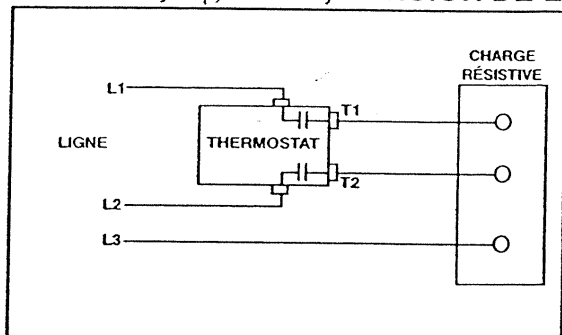
**THERMOSTAT, 1 $\phi$ , BPUD, TENSION DE LIGNE**



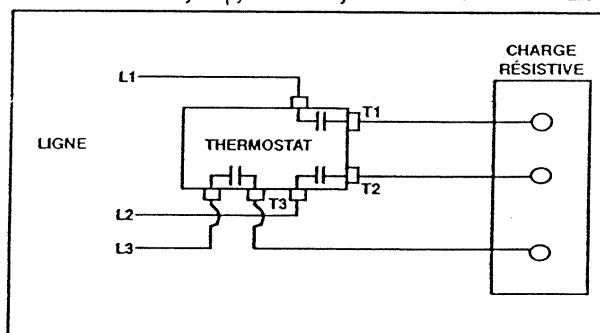
**THERMOSTAT, 1 $\phi$ , UPUD, TENSION DE LIGNE**



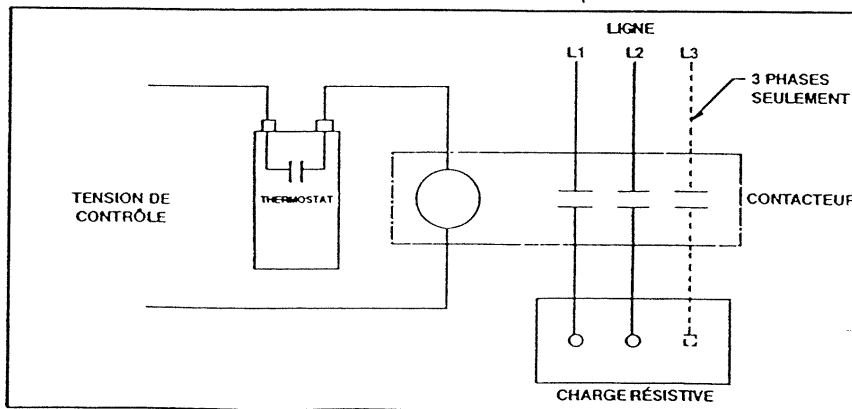
**THERMOSTAT, 3 $\phi$ , UPUD, TENSION DE LIGNE**



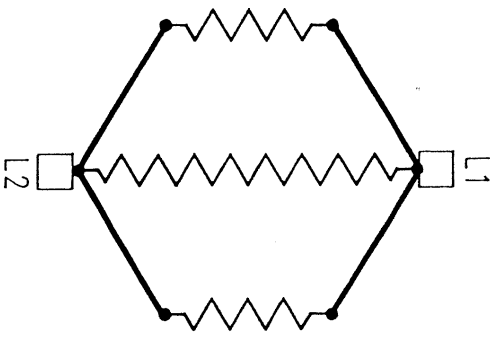
**THERMOSTAT, 3 $\phi$ , TPUD, TENSION DE LIGNE**



### CIRCUIT DE COMMANDE 1 $\phi$ BPUD



NO.: A10244-03

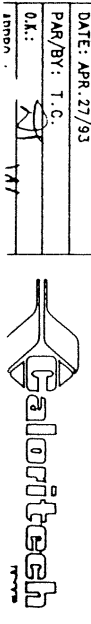


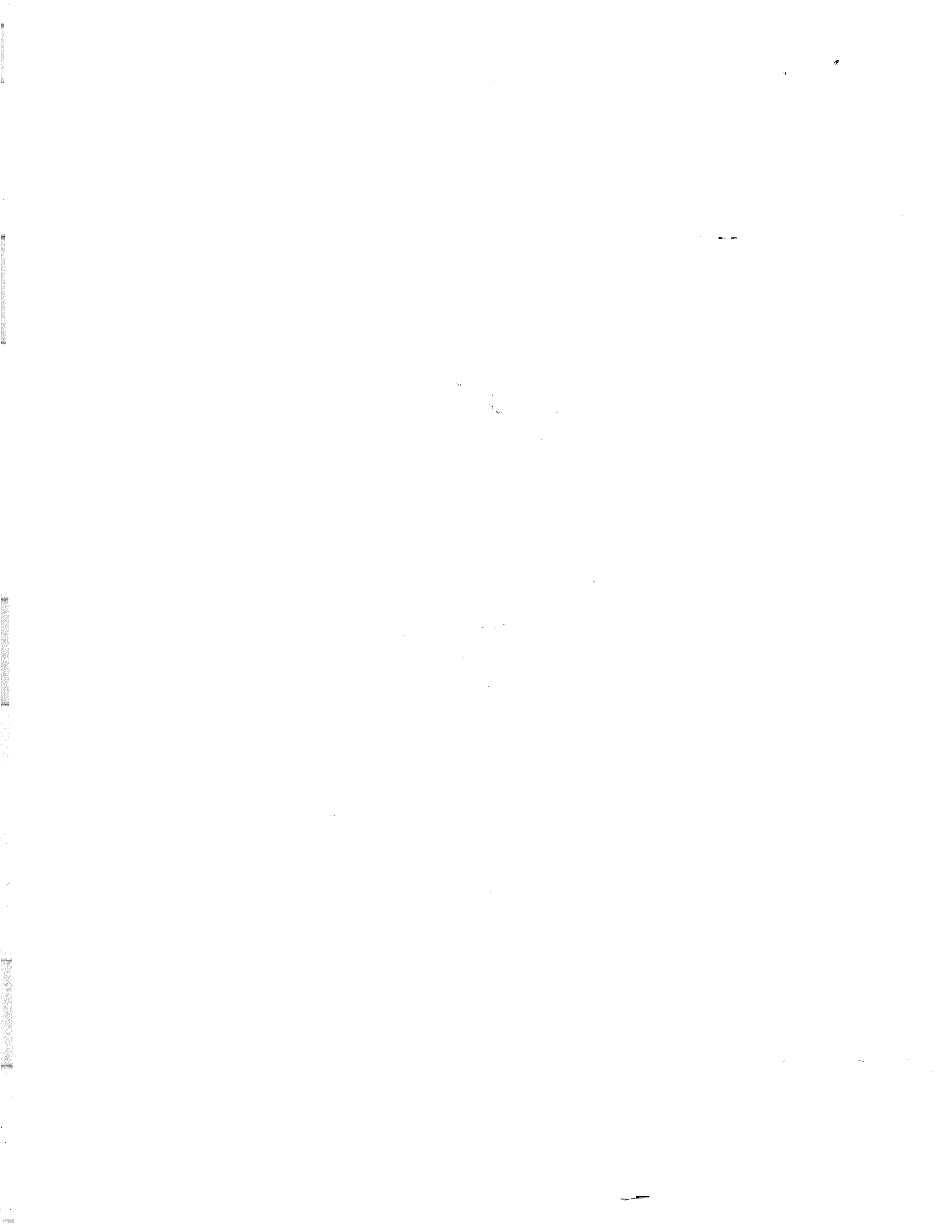
NO.	REVISION	DATE	PAR/BY
1	REDRAWN.	OCT. 3/94	T.C. [Signature]

DET. DESCRIPTION NO. PIECE PART NO. 815  
 LISTE DE MATERIEL / BILL OF MATERIAL  
**WIRING DIAGRAM**  
 3 ELEMENT - 1 PHASE

NO.: A10244-03  
 REF.: 1  
 REV.

S.O.: TOLERANCE  
 ECHELLE: ± DECIM. ± FRACT.  
 SCALE: ± DECIM. ± FRACT.  
 DATE: APR. 27/93  
 PAR/BY: T.C.  
 O.K.: [Signature]





# FullJet NOZZLES

FULL CONE SPRAY PATTERN



**Type G**  
female connection  
removable cap



**Type GG**  
male connection  
removable cap

Patent Nos. 3,146,674,  
3,104,829 and Foreign  
Patents.



**Type H**  
female connection  
one-piece body



**Type HH**  
male connection  
one-piece body

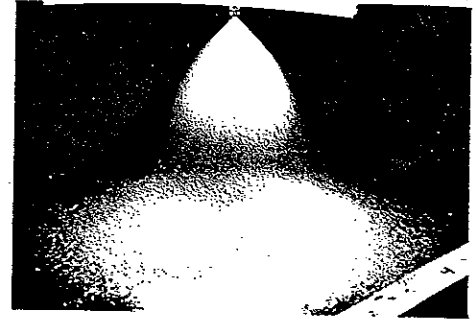
### TYPICAL APPLICATIONS

- Air and Gas Washing
- Product Washing
- Cooling and Quenching
- Dust Control
- Fire Protection
- Foam Breaking

**Spray Characteristics**—Full cone spray pattern with uniform distribution.

**Construction**—Nozzles made with internal, removable vane design. Types G and GG have removable caps. All nozzles made of bar stock. See page 15 for larger capacity cast type nozzles.

**Materials**—Available from stock in brass, mild steel, type 303 or 316 stainless steel or PVC. See page 3 for list of other materials.



**HOW TO ORDER:** Specify Nozzle No., Material. Example: 1/8G3 303 Stainless Steel.

Nozzle No.		Pipe Conn. NPT	Orifice Diam. Nom. Inches	Maximum Free Passage Diam. Inches	CAPACITY ΔP (PSI)															SPRAY ANGLE**			
Female Conn.	Male Conn.				GPM (gallons per minute) at p.s.i. (pounds per square inch)															7	20	80	
					3	5	7	10	15	20	30	40	60	80	100	150	7	20	80				
					p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.				
1/8G1	1/8GG1	1/8	1/32	.025				.10	.12	.14	.17	.19	.23	.26	.30	.36				58°	53°		
1/8G1.5	1/8GG1.5		1/64	.025			.13	.15	.18	.21	.25	.29	.35	.40	.44	.53				52°	65°	59°	
1/8G2	1/8GG2		1/16	.040		.14	.17	.20	.24	.28	.34	.38	.46	.53	.59	.70	.81				43°	50°	46°
1/8G3	1/8GG3		1/16	.040	.17	.22	.26	.30	.36	.42	.50	.57	.69	.79	.88	1.0	1.3				52°	65°	59°
1/8G3.5	1/8GG3.5		1/16	.050	.20	.25	.30	.35	.42	.48	.58	.67	.81	.92	1.0	1.3				43°	50°	46°	
1/8G5	1/8GG5	1/8	3/64	.050	.28	.36	.42	.50	.60	.69	.82	.95	1.2	1.3	1.5	1.8				52°	65°	59°	
1/4G6.5	1/4GG6.5	1/4	1/32	1/16	.37	.47	.55	.65	.78	.89	1.1	1.3	1.5	1.7	1.9	2.3	45°	50°	46°				
1/4G10	1/4GG10		1/16	1/8	.37	.47	.55	.65	.78	.89	1.1	1.3	1.5	1.7	1.9	2.3	45°	50°	46°				
1/4G10	1/4GG10		1/16	3/64	.57	.73	.85	1.0	1.3	1.4	1.7	1.9	2.4	2.7	3.0	3.6	58°	67°	61°				
1/4G9.5	1/4GG9.5	3/8	1/16	1/8	.54	.69	.80	.95	1.2	1.3	1.6	1.8	2.2	2.5	2.8	3.4	45°	50°	46°				
1/4G15	1/4GG15		1/8	3/32	.54	.69	.80	.95	1.2	1.3	1.6	1.8	2.2	2.5	2.8	3.4	45°	50°	46°				
1/4G22	1/4GG22		1/16	1/4	.84	1.1	1.3	1.5	1.8	2.1	2.5	2.9	3.5	4.0	4.4	5.3	64°	67°	61°				
1/4G22	1/4GG22		1/16	3/8	1.3	1.6	1.9	2.2	2.7	3.0	3.7	4.2	5.1	5.8	6.4	7.8	87°	90°	82°				
1/4G22	1/4GG22		1/16	1/2	1.3	1.6	1.9	2.2	2.7	3.0	3.7	4.2	5.1	5.8	6.4	7.8	87°	90°	82°				
1/2G16	1/2GG16	1/2	3/16	1/8	.89	1.2	1.4	1.6	1.9	2.2	2.7	3.1	3.7	4.3	4.7	5.7	48°	50°	46°				
1/2G25	1/2GG25		1/8	1/4	1.4	1.8	2.1	2.5	3.0	3.5	4.2	4.8	5.8	6.7	7.4	8.9	64°	67°	61°				
1/2G32	1/2GG32		1/16	3/8	1.4	1.8	2.1	2.5	3.0	3.5	4.2	4.8	5.8	6.7	7.4	8.9	64°	67°	61°				
1/2G40	1/2GG40		1/8	1/2	1.8	2.3	2.7	3.2	3.9	4.4	5.3	6.1	7.4	8.5	9.4	11.3	72°	75°	68°				
1/2G40	1/2GG40		1/8	3/4	2.3	2.9	3.2	4.0	4.8	5.5	6.6	7.6	9.2	10.6	11.8	14.3	88°	91°	83°				
3/4H2.5	3/4HH2.5	3/4	1/16	1/8	1.7	2.1	2.5	3.0	3.6	4.1	4.9	5.6	6.8	7.8	8.6	10.4	48°	50°	46°				
3/4H4	3/4HH4		1/8	3/16	2.7	3.4	4.0	4.7	5.7	6.5	7.8	8.9	10.7	12.4	13.7	16.6	67°	70°	63°				
3/4H7	3/4HH7		1/8	1/2	4.7	6.0	7.0	8.3	10.0	11.4	13.8	15.8	19.1	22	24	29	89°	92°	84°				
1H4.2	1HH4.2	1	1/16	1/4	2.8	3.6	4.2	5.0	6.0	6.8	8.2	9.4	11.5	13.1	14.5	17.6	48°	50°	46°				
1H7	1HH7		1/8	1/2	4.7	6.0	7.0	8.3	10.0	11.4	13.8	15.8	19.1	22	24	29	67°	68°	62°				
1H8	1HH8		1/16	3/4	5.4	6.9	8.0	9.4	11.4	13.0	15.6	17.8	21	25	27	33	70°	71°	65°				
1H10	1HH10		1/8	1	6.8	8.6	10.0	12.0	14.5	16.5	19.9	23	27	31	35	42	75°	78°	71°				
1H12	1HH12		1/16	1 1/2	8.0	10.2	12.0	14.2	17.1	19.4	24	27	32	37	41	50	89°	92°	84°				
1H12	1HH12		1/8	1 1/2	8.0	10.2	12.0	14.2	17.1	19.4	24	27	32	37	41	50	89°	92°	84°				

\*Foreign matter with maximum diameter as listed can pass through nozzle without clogging.  
\*\*See page 5 for spray coverage information and page 25 for DIMENSIONS AND WEIGHTS.  
Spray Dimension Data... write for Data Sheets 5140, 5150, 6858, 14266.

## TYPE TG FULLCONE SPRAY NOZZLES

**HOW TO ORDER:** For complete nozzle, specify Nozzle No., Material. Example: 1/4TG1 Brass.  
For spray tip only, specify Tip No., Material. Example: TG1 Brass.



Full cone spray pattern with uniform distribution. Supplied in brass or type 303 stainless steel.



**1/4TG1**  
1/4" NPT (F)  
Spray Nozzle  
(See page 26 for  
body, cap and  
strainer)

**Type TG**  
Tip

SAME TYPICAL APPLICATIONS AS THE FULLJET NOZZLES ABOVE.

Complete Nozzle No.		Tip No. Only	Orifice Diam. Nom. Inches	Mesh of Screen	CAPACITY GPM (gallons per minute) at p.s.i. Δ															SPRAY ANGLE**		
Type T Fem. Conn.	Type TT Male Conn.				GPM (gallons per minute) at p.s.i. Δ (pounds per square inch)															20	40	100
					10	15	20	30	40	60	80	100	150	200	300	20	40	100				
					p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.	p.s.i.				
1/4TG0.3	1/4TTG0.3	TG0.3	.020	100			.042	.052	.060	.073	.085	.095	.12	.13	.16	50°	58°	61°				
1/4TG0.4	1/4TTG0.4	TG0.4	.022	100			.057	.069	.080	.098	.11	.13	.16	.18	.22	56°	60°	63°				
1/4TG0.5	1/4TTG0.5	TG0.5	.024	100		.061	.071	.087	.10	.12	.14	.16	.19	.22	.27	56°	60°	63°				
1/4TG0.6	1/4TTG0.6	TG0.6	.027	100		.074	.085	.10	.12	.15	.17	.19	.23	.27	.33	54°	59°	62°				
1/4TG0.7	1/4TTG0.7	TG0.7	.030	100		.086	.10	.12	.14	.17	.20	.22	.27	.31	.38	54°	60°	63°				
1/4TG1	1/4TTG1	TG1	.036	*		.12	.14	.17	.19	.23	.26	.30	.36	.40	.48	58°	59°	53°				
1/4TG2	1/4TTG2	TG2	.047	*	20	.24	.28	.34	.38	.46	.53	.59	.77	.79	.96	50°	50°	46°				
1/4TG3	1/4TTG3	TG3	.062	*	30	.36	.42	.50	.57	.69	.79	.88	1.1	1.2	1.4	65°	65°	59°				
1/4TG3.5	1/4TTG3.5	TG3.5	.067	*	35	.42	.48	.58	.67	.81	.92	1.0	1.3	1.4	1.7	50°	50°	46°				
1/4TG5	1/4TTG5	TG5	.082	*	50	.60	.69	.82	.95	1.2	1.3	1.5	1.8	2.0	2.4	65°	65°	59°				
1/4TG6.5	1/4TTG6.5	TG6.5	.102	*	65	.78	.89	1.1	1.3	1.5	1.7	1.9	2.3	2.6	3.1	50°	50°	46°				
1/4TG10	1/4TTG10	TG10	.130	*	1.0	1.3	1.4	1.7	1.9	2.4	2.7	3.0	3.6	4.0	4.8	67°	67°	61°				

\*Strainers in these larger capacities are normally not required and are NOT supplied as part of standard nozzle assembly.  
\*\*See page 5 for spray coverage information.



## DIMENSIONS & WEIGHTS

Based on largest/heaviest version of each type.

	Nozzle Type	Nozzle Inlet Conn. NPT or BSPT	A	B	Net Weight
	G	1/8 1/4 3/8 1/2	1 1/2" 1 5/8" 1 3/4" 2 1/4"	3/16" hex. 1/8" hex. 3/16" hex. 1" hex.	1 oz. 1 1/2 oz. 2 1/2 oz. 6 oz.
	GG	1/8 1/4 3/8 1/2	1 1/2" 1 5/8" 1 3/4" 2 1/2"	3/16" hex. 1/8" hex. 3/16" hex. 1" hex.	3/4 oz. 1 1/2 oz. 2 1/2 oz. 6 oz.
	H Bar Stock	3/4 1	2 3/16" 2 3/4"	1 1/4" dia. 1 1/2" dia.	7 1/4 oz. 13 oz.
	HH	1/4 3/8 1/2 3/4 1	2 3/8" 1 3/16" 1 3/4" 1 5/8" 2 3/4"	1 1/2" dia. 2 1/2" dia. 1 3/8" dia. 1 1/4" dia. 1 5/8" dia.	1/2 oz. 1 oz. 1 1/2 oz. 3 1/2 oz. 7 oz.
	H Cast	1 1/4 1 1/2 2 2 1/2 3 4 5 6 8	3 1/8" 4 1/8" 5 1/8" 6 1/8" 7 3/8" 9" 12 1/4" 14 1/4" 18 1/2"	2 1/8" dia. 2 5/8" dia. 3" dia. 3 3/8" dia. 4 1/8" dia. 5 1/8" dia. 6 1/2" oct. 8" oct. 9 1/2" oct.	1 1/4 lbs. 1 3/4 lbs. 3 1/4 lbs. 4 3/4 lbs. 6 lbs. 18 lbs. 38 lbs. 53 lbs. 92 lbs.
	HF	4 5 6 8 10	8 1/4" 10" 12 5/8" 16 3/4" 20 1/4"	9" dia. 10" dia. 11" dia. 13 1/2" dia. 16" dia.	27 lbs. 36 lbs. 49 lbs. 106 lbs. 173 lbs.

## ANGLE TYPE

	Nozzle Type	Nozzle Inlet Conn. NPT or BSPT	A	B	C	D	L	Net Weight
	GA	1/8 1/4 3/8 1/2	1 1/8" 3/4" 1" 1 1/2"	3/8" 2 3/8" 3/8" 1 1/8"	3/16" sq. 1 1/8" sq. 3/16" sq. 1" sq.	2 3/8" 1 1/2" 1 7/8" 2 1/2"	2 3/8" 1 3/4" 1 3/4" 1 7/8"	1 1/2 oz. 2 oz. 3 1/4 oz. 6 1/4 oz.
	GGA	1/8 1/4 3/8 1/2	1 1/8" 3/4" 1" 1 1/2"	2 1/2" 1 3/8" 2 3/8" 1 1/8"	3/16" sq. 1 1/8" sq. 3/16" sq. 1" sq.	2 3/8" 1 1/2" 1 7/8" 2 1/2"	1 5/8" 1 3/4" 1 3/4" 1 7/8"	1 1/2 oz. 2 oz. 3 1/4 oz. 6 1/4 oz.

## WALL MOUNTED

	Nozzle Type	Nozzle Inlet Conn. NPT or BSPT	A	B	Net Weight
	GD	1/8 1/4 3/8 1/2	1 3/8" 1 3/4" 1 3/4" 1 3/4"	3/16" hex. 1/8" hex. 3/16" hex. 1" hex.	1 oz. 1 1/2 oz. 2 1/2 oz. 4 1/4 oz.
	GGD	1/8 1/4 3/8 1/2	1 3/8" 1 3/4" 1 3/4" 2 1/4"	3/16" hex. 1/8" hex. 3/16" hex. 1" hex.	1 oz. 1 1/2 oz. 2 1/2 oz. 4 1/2 oz.
	HD	3/4 1 1 1/4 1 1/2 2 2 1/2 3	2 1/4" 2 1/4" 4 1/4" 5 1/4" 6 1/4" 7 1/4" 7 1/4"	1 1/4" dia. 1 1/2" dia. 2 1/4" dia. 2 3/4" dia. 3 1/4" dia. 3 3/4" dia. 4" dia.	6 oz. 14 oz. 1 1/2 lbs. 2 1/2 lbs. 4 1/2 lbs. 7 lbs. 12 1/4 lbs.

## MATERIALS

MATERIAL	MATERIAL CODE	STANDARD					WALL MOUNTED			ANGLE TYPE	
		G	GG	H	HH	HF	GD	GGD	HD	GA	GGA
BRASS	(none)	•	•	•	•	•	•	•	•	•	
MILD STEEL		•	•	•	•	•	•	•	•	•	
303 STAINLESS STEEL	SS	•	•	•	•	•	•	•	•	•	
316 STAINLESS STEEL	316 SS*	•	•	•	•	•	•	•	•	•	
PVC	PVC	•	•	•	•	•	•	•	•	•	
CAST IRON		•	•	•	•	•	•	•	•	•	

\*Bar stock nozzles only; SS in material code = 316 stainless steel for cast nozzles.

## ORDERING INFORMATION

STANDARD SPRAY NOZZLE			
1/4	G	- SS	10
Inlet Connection Pipe Size	Nozzle Type	Material Code	Capacity Size

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE CONTROL VALVE PILOTS AND REGULATORS				SHEET 1 OF 1					
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : BACK PRESSURE VALVE				NO		BY		DATE		REVISION			
				0		RDD		03/11/05		ISSUE FOR PURCHASE		JOB # 054468	
												DATE 03/11/2005	
												REQ.	
								BY		CHKD APPR.			
G	1	TAG NO.	BPV-640										
E	2	SERVICE	GLYCOL FLASH TANK										
N	3	LINE NO. / VESSEL NO.	V-640										
E	4	LINE SIZE / SCHED. NO.	33MM / SCH.80										
L	5	FUNCTION	BACK PRESSURE										
	6	TYPE OF BODY	PLUG										
	7	BODY SIZE	PORT SIZE	33 mm	12.7 mm	mm	mm	mm	mm	mm	mm		
	8	GUIDING	NO. OF PORTS	TOP									
B	9	END CONN. & RATING	33MM - NPT										
O	10	BODY MATERIAL	WCB										
D	11	PACKING MATERIAL	MFG STD										
Y	12	LUBRICATOR	ISOLAT. VALVE										
	13	SEAL TYPE											
	14	TRIM FORM	MFR STD										
	15	TRIM MATERIAL	SS										
	16	SEAT MATERIAL	MFR STD										
	17	REQUIRED SEAT TIGHTNESS	ASME IV										
	18	MAX. ALLOW SOUND LEV. dBA											
A	19	TYPE OF ACTUATOR	SPRING										
C	20	PILOT	X										
T	21	SUPPLY TO PILOT											
/	22	SELF CONT.	EXT. CONN.										
P	23	DISPHRAGM MATERIAL	MFR STD										
I	24	DISPHRAGM RATING	1724 kPa										
L	25	SPRING RANGE	345 - 655 kPa			kPa		kPa		kPa			
O	26	SET POINT	420 kPa			kPa		kPa		kPa			
T	27												
A	28	FILT REG	SUPPLY GAGE										
C	29	LINE STRAINER											
C	30	HOUSING VENT											
E	31	INTERNAL RELIEF											
S	32	OPTIONS											
S	33												
	34	FLOW UNITS	SCMH										
	35	FLUID	HYDROCARBON GAS										
	36	QUANT. MAX.	MAX. Cv										
S	37	QUANT. OPER.	OPER Cv	SMALL									
E	38	VALVE CV	VALVE FL										
R	39	NORM IN PRES	NORM DELTA P	434 kPa(g)	400 kPa	kPa(g)	kPa	kPa(g)	kPa	kPa(g)	kPa		
V	40	MAX. INLET PRESS.	1724 kPa			kPa		kPa		kPa			
I	41	MAX. SHUT OFF	MAX. DELTA P	1724 kPa(g)	1724 kPa	kPa(g)	kPa	kPa(g)	kPa	kPa(g)	kPa		
C	42	TEMP. MAX.	OPERATING	82 °C	57 °C	°C	°C	°C	°C	°C	°C		
E	43	OPER. SP. GR.	MOL. WT.										
	44	OPER. VISC.	% FLASH										
	45	% SUPERHEAT	% SOLIDS										
	46	VAPOR PRESS	CRIT PRESS	kPag	kPag	kPag	kPag	kPag	kPag	kPag	kPag		
	47	PREDICTED SOUND LEVEL dBA											
	48	MANUFACTURER	FISHER										
	49	MODEL NO.	630R-103										
	50	P. O. NUMBER											

NOTES:

AREA. UNIT # :

Fisher Controls

Instruction Manual

## 630 Series Regulators and Relief Valves



December 1990

Form 1243

### Introduction

#### Scope of Manual

This instruction manual provides operating, installation, maintenance, and parts information for the 630 Series regulators and relief valves.

#### Description

The 630 Series consists of self-operated, spring loaded Type 630 **Big Joe**® pressure regulators and Type 630R relief valves which are designed for maximum inlet pressures to 1500 psig (103.4 bar) and outlet pressures from 3 to 500 psig (.21 to 34.5 bar).

#### Specifications

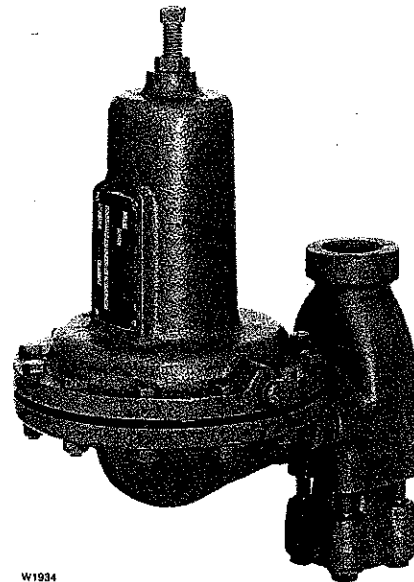
Table 1 lists the specifications for the 630 Series constructions.

### Installation

#### WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-pressured or is installed where service conditions could exceed the limits given in tables 1 through 4 or where conditions exceed any ratings of the adjacent piping or piping connections.

To avoid such injury or damage, provide pressure-relieving or pressure-limiting de-



W1934

Figure 1. Spring-Loaded Type 630 Regulator

vices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

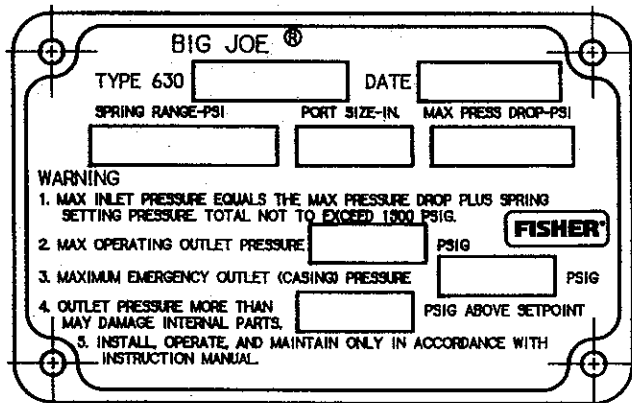
Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe location.

Before installing, inspect the unit for any damage and any foreign material. The regulator or relief valve may be mounted in any position, however ensure that the flow direction corresponds with the direction of the arrow on the nameplate. Apply a good grade of pipe compound to the male threads of the pipeline.

Table 1. Specifications

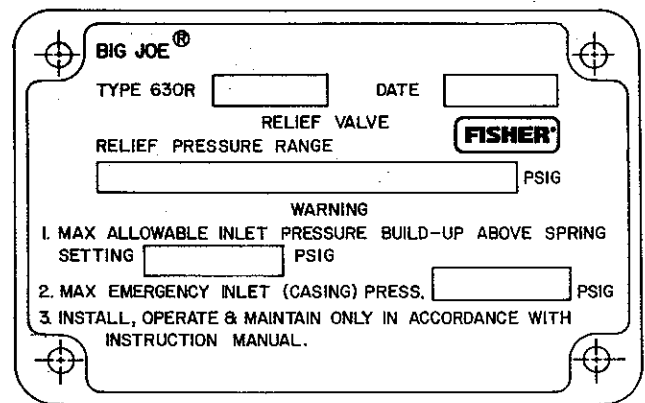
<p><b>Available Configurations</b></p> <p>Type 630: Spring-loaded reducing regulators Type 630R: Spring-loaded relief valves</p> <hr/> <p><b>End Connection Sizes And Style</b></p> <p>■ 1 or ■ 2-inch, screwed</p> <hr/> <p><b>Maximum Allowable Inlet Pressures<sup>(1)</sup></b></p> <p>Type 630 Regulators: See table 2 Type 630R Relief Valves: See table 4</p> <hr/> <p><b>Outlet Pressure Ranges<sup>(1)</sup></b></p> <p>3 to 500 psig (0.2 to 34.5 bar) with intermediate values shown in table 3</p> <hr/> <p><b>Maximum Allowable Outlet Pressures<sup>(1)</sup></b></p> <p>See table 3</p> <hr/> <p><b>Maximum Allowable Pressure Drops<sup>(1)</sup></b></p> <p>See table 2</p>	<p><b>Material Temperature Capabilities<sup>(1)</sup></b></p> <p>Standard: -20 to 150°F (-29 to 66°C) Optional: -20 to 300°F (-29 to 149°C)</p> <hr/> <p><b>Orifice Sizes</b></p> <p>■ 1/8 (3.2 mm), ■ 3/16 (4.8 mm), ■ 1/4 (6.4 mm), ■ 3/8 (9.5 mm), or ■ 1/2-inch (12.7 mm)</p> <hr/> <p><b>Coefficients For Relief Valve Sizing</b></p> <table border="1"> <thead> <tr> <th rowspan="2">ORIFICE SIZE, INCH (mm)</th> <th colspan="2">WIDE OPEN</th> </tr> <tr> <th>C<sub>g</sub></th> <th>C<sub>1</sub></th> </tr> </thead> <tbody> <tr> <td>1/8-inch (3.2 mm) orifice:</td> <td>13.9</td> <td>28.4</td> </tr> <tr> <td>3/16-inch (4.8 mm) orifice:</td> <td>31.3</td> <td>28.2</td> </tr> <tr> <td>1/4-inch (6.4 mm) orifice:</td> <td>55.1</td> <td>27.2</td> </tr> <tr> <td>3/8-inch (9.5 mm) orifice:</td> <td>122.5</td> <td>26.6</td> </tr> <tr> <td>1/2-inch (12.7 mm) orifice:</td> <td>216.0</td> <td>26.4</td> </tr> </tbody> </table> <hr/> <p><b>Approximate Weights</b></p> <p>1-inch End Connection: 25 lb (11.3 kg) 2-inch End Connection: 30 lb (13.5 kg)</p>	ORIFICE SIZE, INCH (mm)	WIDE OPEN		C <sub>g</sub>	C <sub>1</sub>	1/8-inch (3.2 mm) orifice:	13.9	28.4	3/16-inch (4.8 mm) orifice:	31.3	28.2	1/4-inch (6.4 mm) orifice:	55.1	27.2	3/8-inch (9.5 mm) orifice:	122.5	26.6	1/2-inch (12.7 mm) orifice:	216.0	26.4
ORIFICE SIZE, INCH (mm)	WIDE OPEN																				
	C <sub>g</sub>	C <sub>1</sub>																			
1/8-inch (3.2 mm) orifice:	13.9	28.4																			
3/16-inch (4.8 mm) orifice:	31.3	28.2																			
1/4-inch (6.4 mm) orifice:	55.1	27.2																			
3/8-inch (9.5 mm) orifice:	122.5	26.6																			
1/2-inch (12.7 mm) orifice:	216.0	26.4																			

1. The pressure/temperature limits in this manual and any applicable code or standard limitations should not be exceeded.



1F7496-K SHT 1

TYPE 630



21A5495-G SHT 1

TYPE 630R

Figure 2. 630 Series Nameplates

**Vents**

**WARNING**

When the unit is installed in an enclosed area or indoors, escaping gas may accumulate and be an explosion hazard. Under these conditions the vent should be piped away from the unit to a freely ventilated

outdoor location away from air intakes, windows, etc. Protect all vent openings against weather or the entrance of any foreign material that may plug the vent or affect operation of the regulator or relief valve. Inspect all vent openings periodically to be sure they are not plugged. If the vent is in an environment where freezing rain, ice, or snow could clog the vent, it is recommended that a weatherproof vent be used.

Table 2. Maximum Inlet Pressures and Pressure Drops for Type 630 Regulators

Description	1/8-inch (3.2 mm) and 3/16-inch (4.8 mm) Orifice Size	1/4-inch (6.4 mm) Orifice Size	3/8-inch (9.5 mm) Orifice Size	1/2-inch (12.7 mm) Orifice Size
Maximum Allowable Inlet Pressure, Psig (Bar)	1500 (103.5) <sup>(1)</sup>	1500 (103.5) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>	750 (51.8) <sup>(1)</sup>
Maximum Allowable Pressure Drop <sup>(2)</sup> (Bar, Differential)	1500 (103.5)	1000 (69)	500 (34.5)	250 (17.3)
<p>1. Inlet pressure must not exceed the sum of the actual outlet pressure setting and the maximum allowable pressure drop. For example, with an outlet pressure setting of 200 psig (13.7 bar) and a 3/8-inch (9.5 mm) orifice with a maximum allowable pressure drop of 500 psi (34.5 bar, differential), the maximum allowable inlet pressure is 700 psi (48.3 bar).</p> <p>2. Nitrile valve disks are normally furnished for pressure drops to 200 psi (13.7 bar, differential). For better erosion resistance, nylon valve disks are normally furnished for higher pressure drops. Some erosion of valve disks occurs at all pressure drops due to solid particles in the flow stream. The rate of erosion is higher with large amounts of impurities in the flow stream and with high pressure drops. Valve disks and other regulator parts must be inspected periodically for erosion and damage and must be replaced as necessary.</p>				

Table 3. Spring-Loaded Type 630 Regulator Outlet Pressure Limits

Description	Low-Pressure Regulator				High-Pressure Regulator					
	3 to 10 (0.2 to 0.7)	8 to 20 (0.5 to 1.4)	17 to 30 (1.2 to 2.0)	27 to 40 (1.9 to 2.8)	27 to 50 (1.9 to 3.5)	46 to 95 (3.2 to 6.6)	90 to 150 (6.2 to 10.3)	150 to 200 (10.3 to 13.8)	200 to 275 (13.8 to 18.9)	275 to 500 (18.9 to 34.5)
Outlet Pressure Range, Psig (Bar) and Spring Part Number	0W0192 27022	0W0191 27022	0W0190 27022	0Y0664 000A2	0W0192 27022	0W0190 27022	0W0190 27022	0Y0664 000A2	1J1469 27142	1K3709 27082
Maximum Allowable Operating Outlet Pressure, Psig (Bar)	10 (0.7)	20 (1.4)	30 (2.0)	40 (2.8)	50 (3.5)	95 (6.6)	150 (10.3)	200 (13.8)	275 (18.9)	500 (34.5)
Maximum Outlet Pressure Over Pressure Setting <sup>(1)</sup> Psig (Bar)	20 (1.4)		20 <sup>(2)</sup> (1.4)	Limited by Maximum Emergency Outlet Pressure	200 (13.8)					200 <sup>(3)</sup> (13.8)
Maximum Emergency Outlet (Casing) Pressure <sup>(4)</sup> Psig (Bar)	45 (3.1)				550 (38.0)					
<p>1. Damage to internal parts of the regulator may occur if outlet pressure exceeds the actual pressure setting by amounts greater than those shown in this row.</p> <p>2. For outlet pressure settings to 25 psig (1.7 bar) only. For pressure settings over 25 psig (1.7 bar), outlet pressure is limited by maximum emergency outlet pressure of 45 psig (3.1 bar).</p>					<p>3. For outlet pressure settings to 350 psig (24.1 bar) only. For pressure settings over 350 psig (24.1 bar), outlet pressure is limited by maximum emergency outlet pressure of 550 psig (38.0 bar).</p> <p>4. Leakage or bursting of pressure containing parts may occur if outlet pressure exceeds these values.</p>					

Spring-loaded constructions have a screened vent assembly (key 27, figures 5, 6 and 7) installed in the 1/4-inch NPT spring case vent opening. If a remote vent is required, remove the vent assembly and install a remote vent line.

## Overpressure Protection

As is the case with most regulators, the Type 630 spring-loaded regulators have outlet pressure ratings that are lower than the inlet pressure ratings. Overpressure protection must be provided if the actual inlet pressure can exceed the outlet pressure rating. Overpressure protection is also required for the loading regulator and main regulator spring case of relief valves.

Refer to the following tables to determine pressure ratings:

- Spring-loaded Type 630 regulators.
  - Inlet pressure and pressure drop—table 2.
  - Outlet pressure—table 3.
- Spring-loaded Type 630R relief valve pressure—table 4.

## WARNING

Overpressuring any portion of this equipment may cause damage to regulator parts, leaks in the regulator, or personal injury due to bursting of pressure-containing parts or explosion of accumulated gas.

Table 4. Spring-Loaded Type 630R Relief Valve Pressure Limits

Description	Low-Pressure Relief Valve					High-Pressure Relief Valve			
	Relief Pressure Setting Plus Maximum Allowable Buildup of 25 psig (1.7 bar)					Relief Pressure Setting Plus Maximum Allowable Buildup of 250 psig (17 bar)			
Maximum Allowable Relief (Inlet) Pressure, Psig (Bar)									
Maximum Emergency Inlet (Casing) Pressure <sup>(1)</sup> , Psig (Bar)	75 (5.2)					550 (38.0)			
Relief (Inlet) Pressure Settings, Psig (Bar) and Spring Part Number	3 to 8 (0.2 to 0.5) 0W0192 27022	6 to 17 (0.4 to 1.1) 0W0191 27022	15 to 22 (1.0 to 1.5) 0W0190 27022	20 to 35 (1.4 to 2.4) 0Y0664 000A2	27 to 50 (1.9 to 3.5) 1J1469 27142	30 to 70 (2.0 to 4.8) 0W0191 27022	50 to 95 (3.5 to 6.5) 0W0190 27022	75 to 175 (5.2 to 12.1) 0Y0664 000A2	150 to 250 (10.4 to 17.3) 1J1469 27142
1. Leakage or bursting of pressure-containing parts may occur if inlet pressure exceeds these values.									

To avoid overpressure, provide an appropriate overpressure protection device to ensure that none of the limits listed in tables 1 through 4 will be exceeded.

Regulator or relief valve operation below the limits specified in tables 1 through 4 does not preclude the possibility of damage from external sources or from debris in the gas line. Inspect the regulator for damage after any overpressure condition.

### Startup

Starting up the unit consists of opening the upstream block valve, introducing gas pressure. Use gauges to monitor pressures during startup.

The range of allowable pressure settings is marked on the nameplate. If a pressure setting beyond the nameplate range is required, substitute an appropriate spring selected from table 6. Be sure to change the nameplate to indicate the new pressure range.

### WARNING

To avoid the consequences of over-tightening the spring in spring-loaded regulators or relief valves, consult table 5 and replace the adjusting screw with one of the correct length when replacing the spring.

Some pressure ratings are dependent upon the actual outlet pressure settings being used. For example, with a Type 630 regulator, outlet pressure must not exceed the

setting by more than 20 psig (1.4 bar) for low pressure constructions or 200 psig (14 bar) for high pressure constructions, or damage to internal regulator parts may occur. However, with some higher pressure ranges, the setting plus 20 psig (1.4 bar) or 200 psig (14 bar) exceeds the maximum emergency outlet (casing) pressure. Before increasing the setting, refer to tables 3 and 4 (as appropriate). Review the pressure limits for the spring range being used, and be certain that the new pressure setting will not result in an overpressure condition. Always use a pressure gauge to monitor pressure when making adjustments.

### Adjusting Spring-Loaded Regulators and Relief Valves

Loosen the locknut (key 2, figures 5, 6 and 7) atop the spring case. While monitoring the pressure, rotate the adjusting screw (key 1, figures 5, 6 and 7) clockwise to increase set pressure or counterclockwise to decrease it. When the unit is regulating or relieving pressure at the desired value, tighten the locknut.

### Shutdown

Slowly close the upstream block valve.

### Principle Of Operation

This section describes the operation of the Type 630 regulator and the Type 630R relief valve with spring loading. Set pressure is changed with the adjusting screw on the regulator or relief valve. The Type 630R relief valve uses a light spring for added stability.

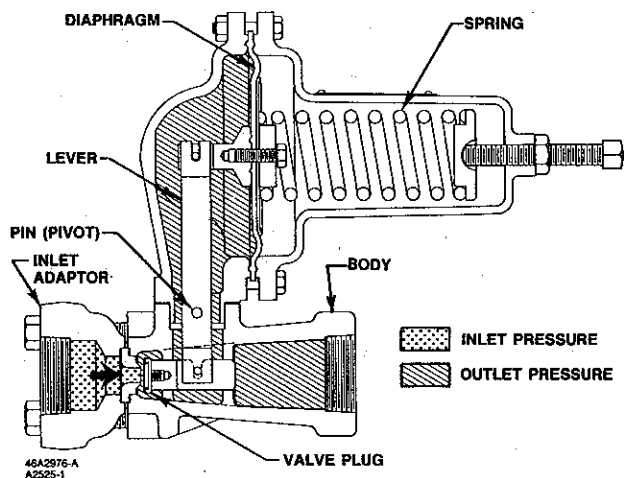


Figure 3. Type 630 Regulator Sectional View

## Type 630 Regulators

Refer to figure 3. In the regulator construction, outlet pressure registers beneath the diaphragm. As long as the outlet pressure is less than the set pressure, spring force on the diaphragm causes the lever to hold the valve open. When the outlet pressure exceeds the set pressure, the diaphragm moves to compress the spring and the lever closes the valve until the outlet pressure returns to set pressure.

## Type 630R Relief Valves

Refer to figure 4. In the relief valve construction, inlet pressure registers beneath the diaphragm. As long as the inlet pressure is less than the set pressure, spring force causes the lever to hold the valve closed. When the inlet pressure exceeds the set pressure, the diaphragm moves to compress the spring and the lever opens the valve allowing inlet pressure to bleed into the downstream line or to atmosphere until the inlet pressure returns to set pressure.

## Maintenance

Parts are subject to normal wear and must be inspected and replaced as necessary. Frequency of inspection depends upon severity of service conditions.

### WARNING

To avoid personal injury or equipment damage, isolate the regulator or relief valve

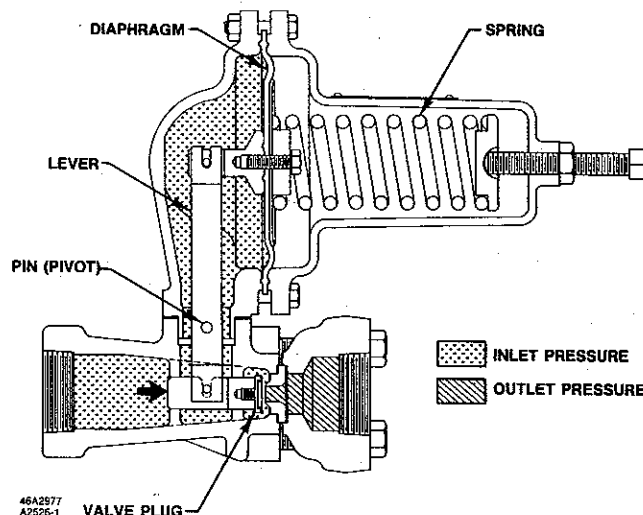


Figure 4. Type 630R Relief Valve Sectional View

from the pressure system and release all pressure from the regulator or relief valve before performing maintenance.

Except where indicated, key numbers in the following procedures are shown in figures 5 and 6 for the Type 630 regulator, in figure 7 for the Type 630R relief valve.

## Replacing Orifice, Valve Disk, and Lever

### Note

With some piping systems it may be possible to omit step 1 below by removing four cap screws (key 17) and spreading the body (key 23) and inlet adaptor (key 18) far enough apart to allow removal of the orifice (key 20) and Type 630 valve disk (key 21, figures 5 and 6) or the orifice (key 20) and the Type 630R valve seat O-ring (key 37, figure 7).

### CAUTION

If step 1 is omitted and the body and inlet adaptor are separated, take care to avoid pinching fingers between the body and the inlet adaptor.

1. Disconnect piping from inlet adaptor (key 18). Remove four cap screws (key 17) and adaptor.
2. Remove orifice (key 20) and gaskets (key 19).

3. To remove Type 630 valve disk (key 21, figures 5 and 6) or Type 630R valve seat O-ring (key 37, figure 7), first disconnect remote vent pipe (if one is used).
4. Unscrew the two cap screws (key 31, not shown) that secure diaphragm adaptor (key 13) to body (key 23); remove diaphragm adaptor and attached spring case (key 3).
5. If it is necessary to replace the lever (key 14), drive out the pin (key 15) and slide the lever out of the diaphragm adaptor. When replacing the lever, make sure the slot engages the connector assembly (key 12) and replace the pin.
6. Remove valve carrier assembly (key 22) from body.
7. To replace seating surface:
  - a. For Type 630, use a 3/4-inch socket wrench to remove and re-install valve disk and holder assembly (key 21, figures 5 and 6).
  - b. For Type 630R, unscrew machine screw (key 36, figure 7) and remove O-ring washer and O-ring (keys 32 and 37, figure 7) from O-ring holder (key 21, figure 7). When reassembling, apply a good-quality gasket shellac to the machine screw thread.
8. Use new orifice gaskets (key 19) and body gasket (key 16) when reassembling. Insert valve carrier assembly (key 22) into the body before re-installing the diaphragm adaptor.

#### Note

The spring case (key 3) must point away from the inlet adaptor (key 18) on Type 630 regulators as shown in figures 5 and 6. On Type 630R relief valves, the spring case must face the same direction as the inlet adaptor (key 18) as shown in figure 7.

9. Be certain the lever (key 14) engages the valve carrier.
10. Secure the diaphragm adaptor (key 13) to the body (key 23). Fit the inlet adaptor (key 18) to the body (key 23) and install and tighten the four cap screws (key 17).

## Replacing the Diaphragm

1. To relieve spring compression, loosen locknut (key 2, figures 5, 6, and 7). Turn the adjusting screw (key 1, figures 5, 6, and 7) counterclockwise until spring compression is relieved.
2. Disconnect remote vent line (if one is present).
3. Remove spring case (key 3) by unscrewing cap screws and nuts (keys 9, 10 and 30)
4. Remove diaphragm (key 11) and attached parts from the lever (key 14).
5. Unscrew cap screw (key 6) from connector head assembly (key 12) and disassemble the diaphragm assembly.
6. Install new diaphragm being certain that the diaphragm is centered. Note that low-pressure constructions use a diaphragm plate (key 8, figure 5) on the spring case side of the diaphragm. Install new gaskets when replacing diaphragm.
7. When reassembling, be certain that the diaphragm connector is engaged in the lever.

#### Note

**Be careful not to twist the diaphragm to lever attachment during assembly. Twisting will cause sufficient friction to interfere with the proper operation of the regulator.**

8. To ensure proper slack in the diaphragm, tighten the spring case cap screws finger-tight only. Compress the spring slightly with the adjusting screw then complete the tightening of the spring case cap screws and nuts.

## Parts Ordering

When corresponding with your Fisher sales office or sales representative concerning this unit, state the type number and all other pertinent information on the nameplate (key 34, figures 5, 6 and 7).

When ordering replacement parts, reference the key number and the eleven character part number as found in the following parts list.



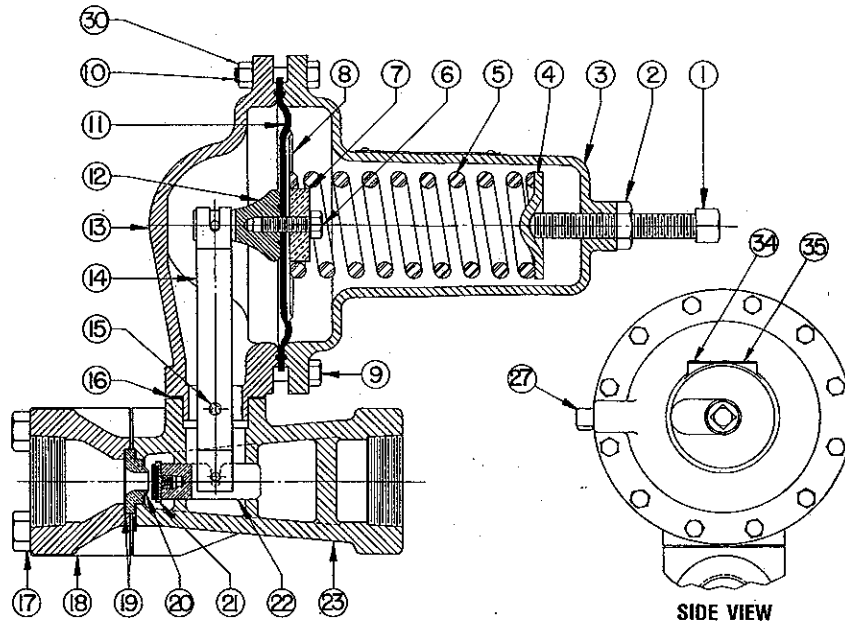


Figure 5. Spring-Loaded Type 630 Regulator—Low-Pressure Construction

**Parts List**

**Note**

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the National Association of Corrosion Engineers (NACE) standard MR-01-75.

**Parts Kits**

Type 630 regulator kits are for low or high pressure spring-loaded construction. Kits include neoprene diaphragm, copper inlet gasket material (for brass trim) or composition material (for stainless trim), and valve disk assembly material as noted. Orifice included only where indicated. If separate orifice is required, must be ordered separately by appropriate part number based on orifice size and material. (Included are keys 11, 16, 19, 21 and 20)

Key	Description	Part Number
	High Pressure	
	Without orifice	
	Brass/nitrile	R630X 000H12
	Brass/nylon	R630X 000H22
	Brass/TFE	R630X 000H32
	Stainless steel/nitrile	R630X 000H42
	Stainless steel/nylon (standard & NACE)	R630X 000H52
	Stainless steel/TFE	R630X 000H62
	With orifice (key 20)	
	1/8-inch (3.2 mm) brass/nylon	R630X 000HC2
	1/8-inch (3.2 mm) stainless steel/nylon (standard)	R630X 000HD2
	1/8-inch (3.2 mm) stainless steel/nylon (NACE)	R630X 00NHD2
	1/4-inch (6.4 mm) brass/nylon	R630X 000HA2
	1/4-inch (6.4 mm) stainless steel/nylon (standard)	R630X 000HB2
	1/4-inch (6.4 mm) stainless steel/nylon (NACE)	R630X 00NHB2
	Type 630R Relief Valve retrofit kit converts Type 630 to a Type 630R. (Included are keys 20, 21, 32, 34, 36 and 37)	
	1/2-inch (12.7mm) brass/nitrile	R630R X00B12
	1/2-inch (12.7mm) stainless steel/nitrile	R630R X00S12

Key	Description	Part Number
	Low Pressure	
	Without orifice	
	Brass/nitrile	R630X 000L12
	Brass/nylon	R630X 000L22
	Brass/TFE	R630X 000L32
	Stainless steel/nitrile	R630X 000L42
	Stainless steel/nylon (standard & NACE)	R630X 000L52
	Stainless steel/TFE	R630X 000L62
	With orifice (key 20)	
	1/2-inch (12.7 mm) brass/nylon	R630X 000LA2
	1/2-inch (12.7 mm) stainless steel/nylon	R630X 000LB2

1	Adjusting Screw, steel	See table 5
2	Hex Nut, zinc pl steel	1A3524 24122
3	Spring Case	
	Low-pressure	
	Cast iron	3C7809 19042
	Steel	3N6981 22012
	High-pressure	
	Cast iron	3C7808 19042
	Steel	3N6983 22012
4	Upper Spring Seat, zinc	
	Pressure range to 275 psig (19 bar)	16A9812 X012
	Pressure range over 275 psig (19 bar)	16A9813 X012

Table 5. Key 1, Adjusting Screw, Steel

TYPE	SPRING PART NUMBER	ADJUSTING SCREW PART NUMBER	ADJUSTING SCREW PART NUMBER (WIRE SEAL)	LENGTH OF THREADED PORTION	
				Inches	mm
630	0W0192 27022	1A2791 28982	1R8299 28992	4	102
	0W0191 27022	1B2120 28982	1R8300 28992	3-1/2	89
	0W0190 27022	1A5005 28982	1R8085 28992	3	76
	0Y0664 27022	1A5005 28982	1R8085 28992	3	76
	1J1469 27142	1A5005 28982	1R8085 28992	3	76
	1K3709 27082	1A5005 28982	1R8085 28992	3	76
630R	0W0192 27022	1A2791 28982	1R8299 28992	4	102
	0W0191 27022	1B2120 28982	1R8300 28992	3-1/2	89
	0W0190 27022	1A5005 28982	1R8085 28992	3	76
	0Y0664 27022	1D3366 28982	1R8301 28992	3-1/4	83
	1J1469 27142	1D3366 28982	1R8301 28992	3-1/4	83

Table 6. Key 5, Regulator Spring, Steel

Type		Outlet (or Relief) Pressure Setting, Psig (Bar)	Spring Part Number	Spring Color Code
Spring-Loaded Type 630	Low-Pressure	3 to 10 (0.2 to 0.7) 8 to 20 (0.8 to 1.4) 17 to 30 (1.2 to 2.0) 27 to 40 (1.9 to 2.8)	0W0192 27022 0W0191 27022 0W0190 27022 0Y0664 27022	Red Stripe Olive Drab Silver Green Stripe
	High-Pressure	27 to 50 (1.9 to 3.5) 46 to 95 (3.2 to 6.6) 90 to 150 (6.2 to 10.3) 150 to 200 (10.3 to 13.8) 200 to 275 (13.8 to 18.9) 275 to 500 (18.9 to 34.5)	0W0192 27022 0W0191 27022 0W0190 27022 0Y0664 27022 1J1469 27142 1K3709 27082	Red Stripe Olive Drab Silver Green Stripe Blue Stripe Yellow Stripe
Spring-Loaded Type 630R	Low-Pressure	3 to 8 (0.2 to 0.5) 6 to 17 (0.4 to 1.1) 15 to 22 (1.0 to 1.5) 20 to 35 (1.4 to 2.4) 35 to 50 (2.4 to 3.5)	0W0192 27022 0W0191 27022 0W0190 27022 0Y0664 27022 1J1469 27142	Red Stripe Olive Stripe Silver Green Stripe Blue Stripe
	High-Pressure	30 to 70 (2.0 to 4.8) 50 to 95 (3.5 to 6.5) 75 to 175 (5.2 to 12.1) 150 to 250 (10.4 to 17.3)	0W0191 27022 0W0190 27022 0Y0664 27022 1J1469 27142	Olive Drab Silver Green Stripe Blue Stripe

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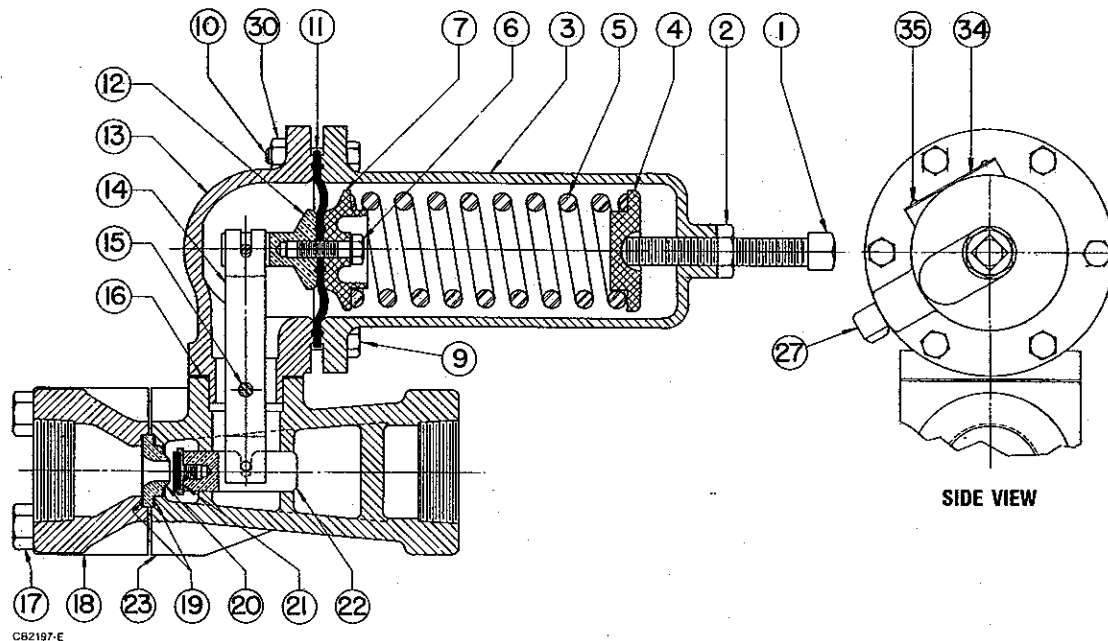


Figure 6. Spring-Loaded Type 630 Regulator—High-Pressure Construction

Key	Description	Part Number	Key	Description	Part Number
5	Spring, steel	See table 6	14	Lever Assembly, stainless steel	
6	Cap Screw, plated steel	1R8176 99012		Low-pressure	1B2891 000A2
7	Lower Spring Seat			Low-pressure (NACE)	1B2891 X0032
	Low-pressure, steel	0W0203 24102		High-pressure	1B2890 000A2
	High-pressure, zinc			High-pressure (NACE)	1B2890 X0022
	Pressure range to 275 psig		15	Pin, stainless steel	0W0188 35172
	(19 bar)	0W0201 44022		Stainless steel (NACE)	0W0188 X0022
	Pressure range over 275 psig		16*	Gasket, composition	0W0187 04022
	(19 bar)	1K3710 44022			
8	Diaphragm Plate, zinc plated steel		17	Cap Screw, steel (4 req'd)	
	Low-Pressure only, (1 req'd)	0W0202 25072		1-inch body	1A9359 24052
				2-inch body	1A3535 24052
9	Cap Screw, zinc plated steel		18	Inlet Adaptor, steel	
	For use with steel diaphragm adaptor			1-inch NPT	1F4798 23022
	For low-pressure regulator (10 req'd)	1C3791 24052		1-inch NPT (NACE)	1F4798 X0022
	For high-pressure regulator (4 req'd)	T11208 28982		2-inch NPT	1F4799 23022
10	Cap Screw, plated steel (for use with cast iron diaphragm adaptor)			2-inch NPT (NACE)	1F4799 X0022
	Low-pressure (10 req'd)	1A3525 24052	19*	Inlet Body Gasket (2 req'd)	
	High-pressure (4 req'd)	1A3525 24052		Copper, for brass trim	0W0184 15042
11*	Diaphragm			Composition, for stainless steel trim	0W0184 04022
	Neoprene		20*	Orifice	
	For low-pressure regulator	0W0200 02192		Type 630	
	For high-pressure regulator	0W0199 02192		Brass	
	Fluoroelastomer			1/8-inch (3.2 mm)	0Z0400 14012
	For low-pressure regulator	0W0200 X0022		3/16-inch (4.8 mm)	1B2195 14012
	For high-pressure regulator	0W0199 02402		1/4-inch (6.4 mm)	0W0183 14012
12	Connector Head Assembly			3/8-inch (9.5 mm)	0W0182 14012
	Aluminum trim	16A981 1X012		1/2-inch (12.7 mm)	0W0181 14012
	Aluminum trim (NACE)	16A981 1X032		Stainless steel	
	Stainless steel trim	1P8465 000B2		1/8-inch (3.2 mm)	1K4166 35032
	Stainless steel trim (NACE)	1P8465 X0012		3/16-inch (4.8 mm)	1K4165 35032
				1/4-inch (6.4 mm)	1K4164 35032
				3/8-inch (9.5 mm)	1K4163 35032
				1/2-inch (12.7 mm)	1K4162 35032
13	Diaphragm Adaptor			Type 630R	
	Low-pressure			Brass	
	Cast iron	0W0197 19012		1/2-inch (12.7 mm)	1B7350 14012
	Steel	2N6985 22012		Stainless steel	
	Steel (NACE)	2N6985 X0072		1/2-inch (12.7 mm)	1B7350 35032
	High-pressure				
	Cast iron	0W0198 19012			
	Steel	2N6987 22012			
	Steel (NACE)	2N6987 X0042			

\*Recommended spare part.

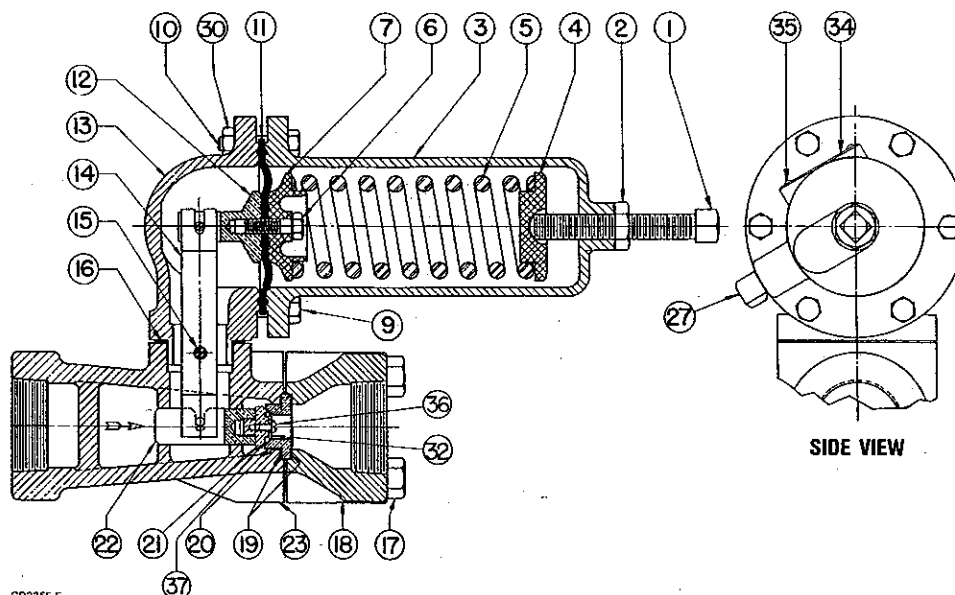


Figure 7. Spring-Loaded Type 630R Relief Valve—High-Pressure Construction

Key	Description	Part Number	Key	Description	Part Number
20*	Orifice (Continued)		23	Body	
	Stainless steel (NACE)			1-inch NPT, cast iron	0W0209 000A2
	1/8-inch (3.2 mm)	1K4166 X0012		1-inch NPT, steel	2N6990 000A2
	3/16-inch (4.8 mm)	1K4165 X0012		1-inch steel (NACE)	2N6990 X0092
	1/4-inch (6.4 mm)	1K4164 X0012		2-inch NPT, cast iron	0W0215 19012
	3/8-inch (9.5 mm)	1K4163 X0012		2-inch NPT, steel	2N6991 22012
	1/2-inch (12.7 mm)	1K4162 X0012		2-inch steel (NACE)	2N6991 X0032
21*	Valve Disk Assembly		27	Vent Assembly, Y602-12	27A551 6X012
	Type 630 only		30	Hex Nut, zinc plated steel, (used only with cast iron diaphragm adaptor, key 13)	
	For pressure ranges to 200 psig (13.8 bar)			Low-pressure (10 req'd)	1A3527 24122
	Brass holder, nitrile disk	1B4500 000A2		High-pressure (4 req'd)	1A3527 24122
	Stainless steel holder, nitrile disk	1B4500 000B2	31	Cap Screw, plated steel (2 req'd) (not shown)	1A3418 24052
	Brass holder, polyurethane disk	1P7351 X0012			
	Stainless steel holder, polyurethane disk	1P7351 000A2	32	O-Ring Washer (For 630R only)	
	Brass holder, fluoroelastomer disk	1B4500 X0042		Brass	1D3359 14012
	Stainless steel holder, fluoroelastomer disk	1B4500 X0012		Stainless steel	1D3359 35072
	For pressure ranges over 200 psig (13.8 bar)		33	Plug, plated steel (not shown) For 2-inch NPT bodies only	1D8293 28982
	Brass holder, nylon disk	1C1860 000A2	34	Nameplate, aluminum	
	Stainless steel holder, nylon disk	1C1860 000B2		Type 630	1F7496 11032
	Brass holder, TFE disk	1C1860 000C2		Type 630R	21A549 5X012
	Stainless steel holder, TFE disk	1C1860 000D2	35	Drive Screw, stainless steel (4 req'd)	1A3682 28982
	NACE construction		36	Machine Screw	
	For pressure ranges to 200 psig (13.8 bar)			Type 630R only	
	Stainless steel holder, nitrile disk	1B4500 X0072		Brass	1A6826 18992
	Stainless steel holder, fluoroelastomer disk	1B4500 X0082		Stainless steel	1D3364 35042
	For pressure ranges above 200 psig (13.8 bar)		37*	O-Ring	
	Stainless steel holder, nylon disk	1C1860 000B2		Type 630R only	
	Stainless steel holder, TFE disk	1C1860 000D2		Nitrile	1D2888 06992
21	O-Ring Holder			TFE	1F5819 06522
	Type 630R		52	NACE Tag (not shown), 18-8 stainless steel	19A603 4X012
	Brass	1D3360 14012	53	Tag Wire (not shown), 303 stainless steel	1U7581 X0022
	Stainless steel	1D3360 35032			
22	Valve Carrier				
	Brass	0W0186 14022			
	Stainless steel	0W0186 35032			
	Stainless steel (NACE)	0W0186 X0022			

\*Recommended spare part.

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3		PRESSURE INSTRUMENTS			SHEET 3 OF 3 SPEC NO _____ FILE 14.11.P	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE CONTROLLERS		NO 0 BY RDD DATE 03/11/05 REVISION ISSUE FOR PURCHASE	JOB # 054468 DATE 03/11/2005 REQ. _____ BY _____ CHK'D _____ APPR. _____			
1	TAG NO.	PC-630	SERVICE T-630 BACK PRESSURE CONTROL			
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL <input checked="" type="checkbox"/> BLIND _____ TRANS. _____ OTHER _____				
3	CASE	MFR STD <input checked="" type="checkbox"/> NOM SIZE _____ COLOR : MFR STD <input checked="" type="checkbox"/> OTHER _____				
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER _____				
5	ENCLOSURE CLASS	GENERAL PURPOSE <input checked="" type="checkbox"/> WEATHER PROOF _____ EXPLOSION PROOF _____ CLASS _____ FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____				
6	POWER SUPPLY	117 V 60Hz _____ OTHER AC _____ DC _____ VOLTS _____				
7	CHART	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____				
8	CHART DRIVE	SPEED _____ POWER _____				
9	SCALES	TYPE _____ RANGE 1 _____ 2 _____ 3 _____ 4 _____				
10	TRANSMITTER OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____ FOR RECEIVER SEE SPEC. SHEET _____				
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P <input checked="" type="checkbox"/> PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____				
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES <input checked="" type="checkbox"/>				
13	AUTO - MAN SWITCH	NONE <input checked="" type="checkbox"/> MFR STD _____ OTHER _____				
14	SET POINT ADJ.	MANUAL _____ EXTERNAL _____ REMOTE _____ OTHER _____				
15	MANUAL REG.	NONE _____ MFR STD _____ OTHER _____				
16	OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(ga) <input checked="" type="checkbox"/> 42 - 206 kPa (ga) _____ OTHER _____				
17	SERVICE	GAGE PRESS. <input checked="" type="checkbox"/> VACUUM _____ ABSOLUTE _____ COMPOUND _____				
18	ELEMENT TYPE	DIAPHRAGM _____ HELIX _____ BOURDON <input checked="" type="checkbox"/> BELLOWS _____ OTHER _____				
19	MATERIAL	316 SS <input checked="" type="checkbox"/> BER. COPPER _____ OTHER _____				
20	RANGE	FIXED <input checked="" type="checkbox"/> ADJ. RANGE _____ SET AT _____ OVERRANGE PROTECTION TO 3447 kPa				
21	PROCESS DATA	PRESSURE : NORMAL 1970 _____ MAX. 2850 _____ ELEMENT RANGE 0 - 3447 kPa				
22	PROCESS CONN.	14 mm NPT <input checked="" type="checkbox"/> 21 mm NPT _____ OTHER _____ LOCATION : BOTTOM _____ BACK _____ OTHER _____				
23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____				
24	FUNCTION	PRESSURE _____ DEVIATION _____ CONTACTS TO _____ ON INC. PRESS				
25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____ DIAPH SEAL _____ TYPE _____ DISPH _____ BOT BOWL _____ CONN. _____ CAPILLARY : LENGTH _____ MATERIAL _____ OTHER _____				
26	MFR. & MODEL NO.	FISHER _____				
27	MODEL NO.	4150 _____				
28	P. O. NUMBER	_____				
NOTES:						
AREA. UNIT # :						

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3		PRESSURE INSTRUMENTS				SHEET 1 OF 3
				SPEC NO		FILE 14.11.P
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE CONTROLLERS		NO	BY	DATE	REVISION	JOB # 054468
		0	RDD	03/11/05	ISSUE FOR PURCHASE	DATE 03/11/2005
		BY	CHK'D	APPR.		
1	TAG NO.	PC-670 SERVICE K-670 SUCTION CONTROL				
2	FUNCTIONS	RECORD	INDICATE	CONTROL <input checked="" type="checkbox"/>	BLIND	TRANS.
3	CASE	MFR STD <input checked="" type="checkbox"/>	NOM SIZE	COLOR : MFR STD <input checked="" type="checkbox"/>	OTHER	
4	MOUNTING	FLUSH <input checked="" type="checkbox"/>	SURFACE	YOKE	OTHER	
5	ENCLOSURE CLASS	GENERAL PURPOSE <input checked="" type="checkbox"/>	WEATHER PROOF	EXPLOSION PROOF	CLASS	
6	POWER SUPPLY	117 V 60Hz	OTHER AC	DC	VOLTS	
7	CHART	STRIP	ROLL	FOLD	CIRCULAR	TIME MARKS
8	CHART DRIVE	SPEED			POWER	
9	SCALES	TYPE				
10	TRANSMITTER OUTPUT	4 - 20 mA	10 - 50 mA	21 - 103 kPa(g)	42 - 206 kPa (g)	OTHER
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P <input checked="" type="checkbox"/> PI PD PID IF DF IS DS OTHER				
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES <input checked="" type="checkbox"/> DECREASES				
13	AUTO - MAN SWITCH	NONE <input checked="" type="checkbox"/>	MFR STD	OTHER		
14	SET POINT ADJ.	MANUAL	EXTERNAL	REMOTE	OTHER	
15	MANUAL REG.	NONE	MFR STD	OTHER		
16	OUTPUT	4 - 20 mA	10 - 50 mA	21 - 103 kPa(ga) <input checked="" type="checkbox"/>	42 - 206 kPa (ga)	OTHER
17	SERVICE	GAGE PRESS. <input checked="" type="checkbox"/>	VACUUM	ABSOLUTE	COMPOUND	
18	ELEMENT TYPE	DIAPHRAGM	HELIX	BOURDON	BELLOWS <input checked="" type="checkbox"/>	OTHER
19	MATERIAL	316 SS <input checked="" type="checkbox"/>	BER. COPPER	OTHER		
20	RANGE	FIXED <input checked="" type="checkbox"/>	ADJ. RANGE	SET AT		
21	PROCESS DATA	OVERRANGE PROTECTION TO 690 kPa				
22	PROCESS CONN.	PRESSURE : NORMAL 97	MAX. 690	ELEMENT RANGE 0 - 207 kPa		
		14 mm NPT <input checked="" type="checkbox"/>	21 mm NPT	OTHER		
		LOCATION : BOTTOM	BACK	OTHER		
23	ALARM SWITCHES	QUANTITY	FORM	RATING		
24	FUNCTION	PRESSURE	DEVIATION	CONTACTS TO	ON INC. PRESS	
25	OPTIONS	FILT - REG.	SUP. GAGE	OUTPUT GAGE	CHARTS	
		DIAPH SEAL	TYPE	DISPH	BOT BOWL	
		CONN.	CAPILLARY : LENGTH	MATERIAL		
		OTHER				
26	MFR. & MODEL NO.	FISHER				
27	MODEL NO.	4152				
28	P. O. NUMBER					

NOTES:

AREA. UNIT # : .113

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3		PRESSURE INSTRUMENTS				SHEET 2 OF 2	
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE CONTROLLERS		NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.P
		0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468
						DATE	03/11/2005
						REQ.	
				BY	CHK'D	APPR.	
1	TAG NO.	PC-680	AC-620 PRESSURE				
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL <input checked="" type="checkbox"/> BLIND _____ TRANS. _____					
3	CASE	MFR STD <input checked="" type="checkbox"/> NOM SIZE _____ COLOR : MFR STD <input checked="" type="checkbox"/> OTHER _____					
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER _____					
5	ENCLOSURE CLASS	GENERAL PURPOSE <input checked="" type="checkbox"/> WEATHER PROOF _____ EXPLOSION PROOF _____ CLASS _____					
6	POWER SUPPLY	FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____					
7	CHART	117 V 60Hz _____ OTHER AC _____ DC _____ VOLTS _____					
8	CHART DRIVE	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____					
9	SCALES	SPEED _____ POWER _____					
		TYPE _____					
		RANGE 1 0 - 2068 kPa 2 _____ 3 _____ 4 _____					
10	TRANSMITTER OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____					
		FOR RECEIVER SEE SPEC. SHEET _____					
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P <input checked="" type="checkbox"/> PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____					
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES <input checked="" type="checkbox"/> DECREASES _____					
13	AUTO - MAN SWITCH	NONE _____ MFR STD _____ OTHER _____					
14	SET POINT ADJ.	MANUAL _____ EXTERNAL _____ REMOTE _____ OTHER _____					
15	MANUAL REG.	NONE _____ MFR STD _____ OTHER _____					
16	OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(ga) <input checked="" type="checkbox"/> 42 - 206 kPa (ga) _____ OTHER _____					
17	SERVICE	GAGE PRESS. <input checked="" type="checkbox"/> VACUUM _____ ABSOLUTE _____ COMPOUND _____					
18	ELEMENT TYPE	DIAPHRAGM _____ HELIX _____ BOURDON <input checked="" type="checkbox"/> BELLOWS _____ OTHER _____					
19	MATERIAL	316 SS <input checked="" type="checkbox"/> BER. COPPER _____ OTHER _____					
20	RANGE	FIXED <input checked="" type="checkbox"/> ADJ. RANGE _____ SET AT _____					
21	PROCESS DATA	OVERRANGE PROTECTION TO 1724 kPa					
22	PROCESS CONN.	PRESSURE : NORMAL 1379 _____ MAX. 1724 _____ ELEMENT RANGE 0 - 2068 kPa					
		14 mm NPT <input checked="" type="checkbox"/> 21 mm NPT _____ OTHER _____					
		LOCATION : BOTTOM _____ BACK _____ OTHER _____					
23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____					
24	FUNCTION	PRESSURE _____ DEVIATION _____ CONTACTS TO _____ ON INC. PRESS					
25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____ DIAPH SEAL _____ TYPE _____ DISPH _____ BOT BOWL _____ CONN. _____ CAPILLARY : LENGTH _____ MATERIAL _____ OTHER _____					
26	MFR. & MODEL NO.	FISHER _____					
27	MODEL NO.	4150 _____					
28	P. O. NUMBER	_____					
NOTES: Direct Acting							
AREA. UNIT # :							

**Instruction Manual**

Form 5177  
February 2003

**4150K and 4160K Controllers and Transmitters**

# 4150K and 4160K Series Wizard® II Pressure Controllers and Transmitters

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Figure 1. Wizard® II Controller Yoke-Mounted on Control Valve Actuator





# 4150K and 4160K Controllers and Transmitters

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## Introduction

### Scope of Manual

This instruction manual provides installation, operating, maintenance, and parts information for the 4150K and 4160K Series Wizard® II pressure controllers and transmitters shown in figure 1. Refer to separate instruction manuals for information regarding the control valve, actuator, and accessories.

No person may install, operate, or maintain 4150K and 4160 Series Wizard® II pressure controllers and transmitters without first (1) being fully trained and qualified in valve, actuator and accessory installation, operation and maintenance, and (2) carefully reading and understanding the contents of this manual. If you have any questions about these instructions, contact your Fisher sales office.

## Description

The 4150K and 4160K Series pneumatic pressure controllers and transmitters use a bellows or Bourdon tube sensing element to sense the gauge pressure, vacuum, compound pressure, or differential pressure of a liquid or gas. The controller or transmitter output is a pneumatic pressure signal that can be used to operate a final control element, indicating device, or recording device.

## Specifications

Specifications for the 4150K and 4160K Series controllers and transmitters are listed in table 1. Table 2 explains available configurations and options.

### Note

**Fisher does not assume final responsibility for the selection, use, or maintenance of any product. Final responsibility for the selection, use, and maintenance of any Fisher product remains with the purchaser and end-user.**

## Installation

### WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure:

- Always wear protective clothing and eyewear, and if appropriate, gloves, when performing any installation operations to avoid personal injury.
- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

## Standard Installation

The instruments are normally mounted vertical with the case/cover as shown in figure 1. If installing the instrument in any other position, be sure that the vent opening shown in figure 3 is facing downward.

Table 1. Specifications

<p><b>Available Configurations</b> See table 2</p> <p><b>Input Signal<sup>(1)</sup></b> <b>Type:</b> ■ Gauge pressure, ■ vacuum, ■ compound pressure, or ■ differential pressure of a liquid or gas <b>Limits:</b> See table 3 or 4</p> <p><b>Output Signal<sup>(1)</sup></b> <b>Proportional-Only or Proportional-Plus-Reset Controllers and Transmitters:</b> ■ 0.2 to 1.0 bar (3 to 15 psig) or ■ 0.4 to 2.0 bar (6 to 30 psig) pneumatic pressure signal <b>Differential Gap Controllers:</b> ■ 0 and 1.4 bar (0 and 20 psig) or ■ 0 and 2.4 bar (0 and 35 psig) pneumatic pressure signal <b>Action:</b> Control action is field reversible between ■ direct (increasing sensed pressure produces increasing output signal) and ■ reverse (increasing sensed pressure produces decreasing output signal). The suffix R is added to the type number of a construction specified for reverse action.</p> <p><b>Supply Pressure Requirements<sup>(3)</sup></b> See table 5</p> <p><b>Steady-State Air Consumption<sup>(1)</sup></b> See figure 2</p> <p><b>Supply and Output Connections</b> 1/4-inch NPT female</p> <p><b>Common Signal Pressure Conversions</b> See table 6</p> <p><b>Proportional Band<sup>(1)</sup> Adjustment</b> <b>For Proportional-Only and Proportional-Plus-Reset Controllers:</b> Full output pressure change adjustable from 3 to 100% for a 0.2 to 1.0 bar (3 to 15 psig), or 6 to 100% for a 0.4 to 2.0 bar (6 to 30 psig) of the sensing element range.</p> <p><b>Differential Gap Adjustment</b> <b>For Differential Gap Controllers:</b> Full output pressure change adjustable from 15% to 100% of sensing element range</p> <p><b>Reset<sup>(1)</sup> Adjustment</b> <b>For Proportional-Plus-Reset Controllers:</b> Adjustable from 0.01 to 74 minutes per repeat (100 to 0.01 repeats per minute)</p>	<p><b>Zero<sup>(1)</sup> Adjustment (Transmitters Only)</b> Continuously adjustable to position span of less than 100% anywhere within the sensing element range</p> <p><b>Span<sup>(1)</sup> Adjustment (Transmitters Only)</b> Full output pressure change adjustable from 6 to 100% of sensing element range</p> <p><b>Performance</b> <b>Repeatability<sup>(1)</sup>:</b> 0.5% of sensing element range <b>Deadband<sup>(1)</sup> (Except Differential Gap Controllers<sup>(2)</sup>):</b> 0.1% of output span <b>Typical Frequency Response at 100% Proportional Band</b> <i>Output to Actuator:</i> 0.7 Hz and 110 degree phase shift with 1850 cm<sup>3</sup> (113 inches<sup>3</sup>) volume, actuator at mid-stroke <i>Output to Positioner Bellows:</i> 9 Hz and 130 degree phase shift with 0.2 to 1.0 bar (3 to 15 psig) output to 33 cm<sup>3</sup> (2 inches<sup>3</sup>) bellows</p> <p><b>Ambient Operating Temperature Limits<sup>(3)</sup></b> ■ <b>Standard Construction:</b> -40 to 71°C (-40 to 160°F) ■ <b>High Temperature Construction:</b> -18 to 104°C (0 to 220°F)</p> <p><b>Typical Ambient Temperature Operating Influence</b> <b>Proportional Control only:</b> Output pressure changes ±3.0% of sensing element range for each 28°C (50°F) change in temperature between -40 and 71°C (-40 and 160°F) for a controller set at 100% proportional band <b>Reset Control only:</b> Output pressure changes ±2.0% of sensing element range for each 28°C (50°F) change in temperature between -40 and 71°C (-40 and 160°F) for a controller set at 100% proportional band <b>Transmitters only:</b> Output pressure changes ±3.0% of sensing element range for each 28°C (50°F) change in temperature between -40 and 71°C (-40 and 160°F) for a transmitter set at 100% span</p> <p><b>Options</b> Case pressure tested to 0.14 bar (2 psig)</p> <p><b>Approximate Weight</b> 8.2 kg (18 pounds)</p>
--	--

1. This term is defined in ISA Standard S51.1

2. An adjustable differential gap (differential gap controllers) is equivalent to an adjustable deadband.

3. The pressure/temperature limits in this manual and any applicable standard or code limitation should not be exceeded.

# 4150K and 4160K Controllers and Transmitters

Table 2. Available Configurations

DESCRIPTION	TYPE NUMBER <sup>(1)</sup>		
	Bourdon Tube Sensing Element (Gauge Pressure Only)	Bellows Sensing Element	
		Gauge Pressure	Differential Pressure
Proportional-only controller	4150K	4152K	4154K
Proportional-plus-reset controller	Without anti-reset windup	4160K	4162K
	With anti-reset windup	4160KF	4162KF
Differential gap controller	4150KS	4152KS	---
Transmitter	4157K	4158K	4155K

1. The suffix R is added to the type number of a construction specified for reverse action.

Table 3. Bourdon Tube Pressure Ranges and Materials

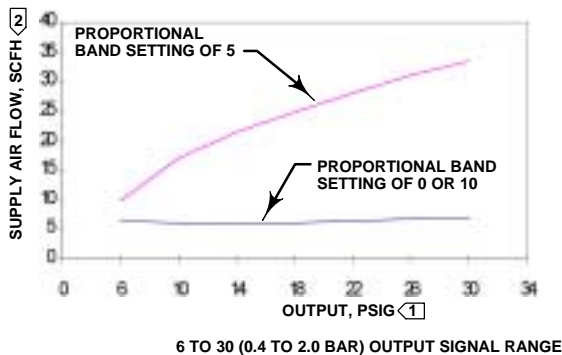
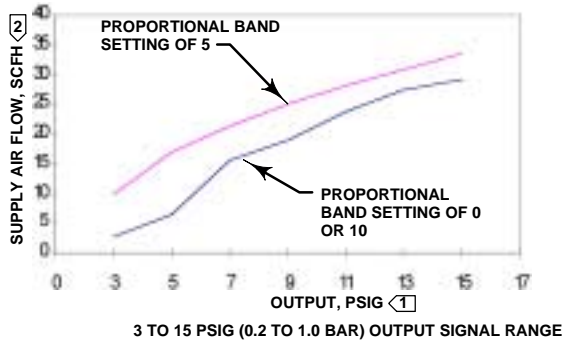
PRESSURE RANGES <sup>(1)</sup>		MAXIMUM ALLOWABLE STATIC PRESSURE <sup>(2)</sup> LIMITS <sup>(3)</sup>				MATERIAL
Bar	Psig	Standard		With Optional Travel Stop <sup>(4)</sup>		
		Bar	Psig	Bar	Psig	
0 to 2.0	0 to 30	2.0	30	3.3	48	316 stainless steel
0 to 4.0	0 to 60	4.0	60	6.6	96	
0 to 7.0	0 to 100	7.0	100	11	160	
0 to 14	0 to 200	14	200	19	280	
0 to 20	0 to 300	20	300	29	420	
0 to 40	0 to 600 <sup>(5)</sup>	40	600	50	720	
0 to 70	0 to 1000 <sup>(5)</sup>	70	1000	83	1200	
0 to 100	0 to 1500 <sup>(5)</sup>	100	1500	115	1650	
0 to 200	0 to 3000	200	3000	230	3300	
0 to 350	0 to 5000	350	5000	380	5500	
0 to 550	0 to 8000	550	8000	550	8000	
0 to 700	0 to 10,000	700	10,000	700	10,000	

1. Range marked on Bourdon tube may be in kPa (1 bar = 100 kPa)  
 2. This term is defined in ISA Standard S51.1.  
 3. Bourdon tube may be pressurized to limit shown without permanent zero shift.  
 4. With travel stop set at 110% of the range.  
 5. These Bourdon tubes are also available in K-Monel for sour gas service.

Table 4. Bellows Pressure Ranges and Materials

PRESSURE RANGES			MAXIMUM ALLOWABLE STATIC PRESSURE <sup>(1)</sup> LIMITS <sup>(2)</sup>			
			Brass Construction		Stainless Steel Construction	
			Bar	Psig	Bar	Psig
Gauge Pressure	Vacuum	0 to 150 mbar (0 to 60 inch wc)	1.6	20	---	---
		0 to 340 mbar (0 to 10 inch Hg)	2.8	40	---	---
		0 to 1.0 bar (0 to 30 inch Hg)	2.8	40	6.9	100
	Compound Pressure	75 mbar vac. to 75 mbar (30 inch wc vac. to 30 inch wc)	1.4	20	---	---
		500 mbar vac. to 500 mbar (15 inch Hg vac. to 7.5 psig)	2.8	40	6.9	100
		1.0 bar vac. to 1.0 bar (30 inch Hg vac. to 15 psig)	2.8	40	6.9	100
	Positive pressure	0 to 150 mbar (0 to 60 inch wc)	1.4	20	---	---
		0 to 250 mbar <sup>(3)</sup> (0 to 100 inch wc)	1.4	20	---	---
		0 to 350 mbar <sup>(4)</sup> (0 to 140 inch wc)	2.8	40	---	---
		0 to 0.35 bar (0 to 5 psig)	2.8	40	---	---
0 to 0.5 bar (0 to 7.5 psig)		2.8	40	---	---	
0 to 0.7 bar (0 to 10 psig)		2.8	40	---	---	
0 to 1.0 bar (0 to 15 psig)		2.8	40	6.9	100	
0 to 1.4 bar (0 to 20 psig)	2.8	40	---	---		
0 to 2.0 bar (0 to 30 psig)	2.8	40	6.9	100		
Differential Pressure <sup>(5)</sup>	0 to 300 mbar (0 to 80 inch wc)	1.4	20	---	---	
	0 to 0.7 bar (0 to 10 psi)	2.8	40	---	---	
	0 to 1.4 bar (0 to 20 psi)	2.8	40	---	---	
	0 to 2.0 bar (0 to 30 psi)	---	---	6.9	100	

1. This term is defined in ISA Standard S51.1.  
 2. Bellows may be pressurized to limit shown without permanent zero shift.  
 3. Type 4158K transmitter only.  
 4. Except Type 4158K transmitter.  
 5. The overrange limit for these sensing elements is a differential pressure equal to the maximum allowable static pressure limit.



**NOTES**  
 1 TO CONVERT PSIG TO BAR, MULTIPLY BY 0.06895.  
 2 SCFH—STANDARD CUBIC FEET PER HOUR (60°F AND 14.7 PSIA).  
 TO CONVERT TO NORMAL M<sup>3</sup>/HR—NORMAL CUBIC METERS PER HOUR (0°C AND 1.01325 BAR, ABSOLUTE), MULTIPLY BY 0.0268

A7242 / IL

Figure 2. Steady-State Air Consumption

Mount the controller to the bracket using the four cap screws (key 252) provided. Attach the bracket to the wall, using suitable screws or bolts.

### Pipestand Mounting

Refer to figure 3.

Attach the spacer spools (key 228) and the mounting plate (key 213) to the controller with cap screws, lock washers, and nuts (keys 215, 221, and 216). Attach the controller to a 2-inch (nominal) pipe with pipe clamps (key 250).

### Actuator Mounting

Refer to figure 4.

Controllers specified for mounting on a control valve actuator are mounted at the factory. If the instrument is ordered separately for installation on a control valve actuator, mount the instrument according to the following instructions.

Mounting parts for the different actuator types and sizes vary. Two typical actuator-mounting installations are shown in figure 4; see the parts list for parts required for the specific actuator type and size involved. Attach the spacer spools (key 228) and the mounting plate (key 213) to the controller with machine screws, lock washers, and nuts (keys 215, 221, and 216).

Attach the mounting bracket to the actuator yoke with cap screws (key 222) and, if needed, spacer spools. On some designs, the mounting bracket is attached to the actuator diaphragm casing rather than to the yoke.

### Panel Mounting

Refer to figure 3.

Cut a hole in the panel surface according to the dimensions shown in figure 3. Remove the cap screws (key 252), brackets (key 251), and vent assembly (key 15). Slide the controller or transmitter into the cutout and reattach the brackets. Tighten the cap screw located in the center of each bracket to draw the case snugly and evenly against the panel. Reinstall the vent unless a remote vent will be used.

### Wall Mounting

Refer to figure 3.

Drill four holes in the wall using the dimensions shown in figure 3. In the bracket (key 251) are 8.7 mm (11/32-inch) diameter holes. Back out the cap screw located in the center of each bracket. (The screws are used for panel mounting but are not required for wall mounting.) If tubing runs through the wall, drill holes in the wall to accommodate the tubings. Figure 3 shows the pressure connection locations in the back of the case.

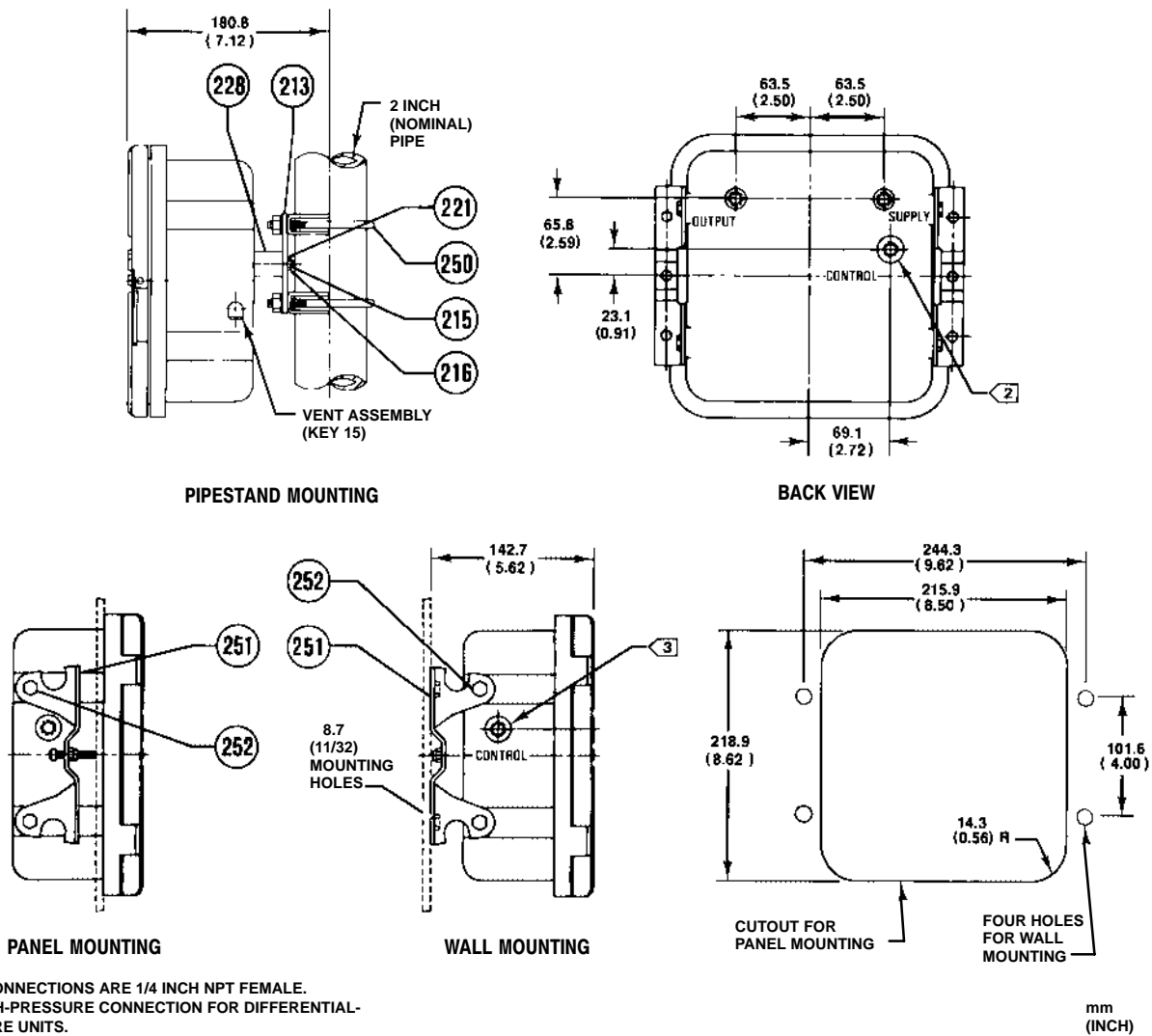
### Pressure Connections



**To avoid personal injury or property damage resulting from the sudden release of pressure, do not install any system component where service conditions could exceed the limits given in this manual. Use pressure-relieving devices as required by government or accepted industry codes and good engineering practices.**

All pressure connections on 4150K and 4160K Series instruments are 1/4-inch NPT female. Use 6

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- NOTES:
1. ALL CONNECTIONS ARE 1/4 INCH NPT FEMALE.
  - 2 > HIGH-PRESSURE CONNECTION FOR DIFFERENTIAL-PRESSURE UNITS.
  - 3 > LOW-PRESSURE CONNECTION FOR DIFFERENTIAL-PRESSURE UNITS.

B1563-2/IL

Figure 3. Panel, Wall, and Pipestand Mounting

mm (1/4-inch) or 10 mm (3/8-inch) pipe or tubing for supply and output piping. The pressure connection locations are shown in figure 3.

## Supply Pressure



**Severe personal injury or property damage may occur if the instrument air supply is not clean, dry and oil-free. While use and regular maintenance of a filter that removes particles smaller**

**than 40 microns in diameter will suffice in most applications, check with a Fisher Field office and Industry Instrument air quality standards for use with corrosive gas or if you are unsure about the proper amount or method of air filtration or filter maintenance.**

Supply pressure must be clean, dry air or noncorrosive gas that meets the requirements of ISA Standard S7.3. Use a suitable supply pressure regulator to reduce the supply pressure source to the normal operating supply pressure shown in table 5. Connect supply pressure to the SUPPLY connection at the back of the case.

Table 5. Supply Pressure Requirements

OUTPUT SIGNAL RANGE		NORMAL OPERATING SUPPLY PRESSURE <sup>(1)</sup>	MAXIMUM ALLOWABLE SUPPLY PRESSURE TO PREVENT INTERNAL PART DAMAGE
Bar	0.2 to 1.0 or 0 and 1.4 (differential gap)	1.4	2.8
	0.4 to 2.0 or 0 and 2.4 (differential gap)	2.4	2.8
Psig	3 to 15 or 0 and 20 (differential gap)	20	40
	6 to 30 or 0 and 35 (differential gap)	35	40

1. If this pressure is exceeded, control may be impaired.

Table 6. Common Signal Pressure Conversions

Mps	kg/cm <sup>2</sup>	bar	kPa	Psi
0.02	0.2	0.2 <sup>(2)</sup>	20 <sup>(1)</sup>	3
0.03	0.3	0.3	35	5
0.04	0.4	0.4	40 <sup>(1)</sup>	6
0.05	0.5	0.5	50	7
0.06	0.6	0.6	60	9
0.07	0.8	0.8	75	11
0.08	0.8	0.8	80	12
0.09	1.0	1.0	95	14
0.10	1.0 <sup>(3)</sup>	1.0 <sup>(2)</sup>	100 <sup>(1)</sup>	15
0.12	1.3	1.2	125	18
0.14	1.4	1.4	140	20
0.15	1.5	1.5	150	22
0.17	1.8	1.7	170	25
0.18	1.9	1.9	185	27
0.20	2.0	2.0 <sup>(3)</sup>	200 <sup>(1)</sup>	30
0.22	2.2	2.2	220	32
0.23	2.3	2.3	230	33
0.24	2.5	2.4	240	35
0.34	3.5	3.4	345	50
0.55	5.6	5.5	550	80
0.69	7.0	6.9	690	100
1.03	10.5	10.3	1035	150

1. Values as listed in ANSI/S7.4.  
2. Values as listed in IEC Standard 382.  
3. Values rounded to correspond with kPa values.

If operating the controller or transmitter from a high pressure source [up to 138 bar (2000 psig)], use a high pressure regulator system, such as the Type 1367 High Pressure Instrument Supply System. For Type 1367 system installation, adjustment, and maintenance information, see the separate instruction manual.

**Process Pressure**



**WARNING**

To avoid personal injury or property damage resulting from the sudden release of pressure when using corrosive media, make sure the tubing and instrument components that contact the corrosive medium are of suitable noncorrosive material.

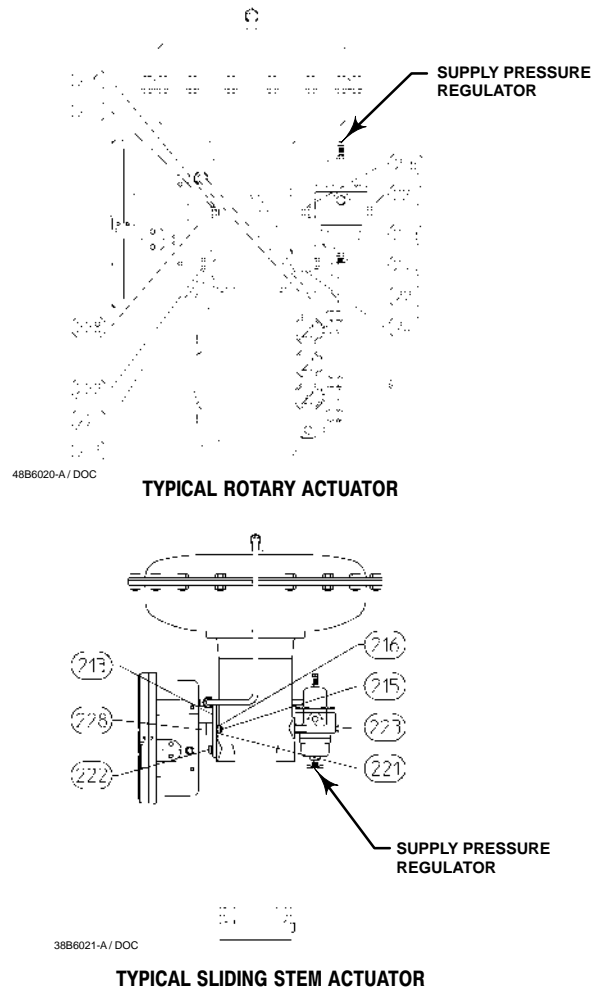


Figure 4. Actuator Mounting

The pressure connections to the controller depend upon the type of pressure sensing, gauge or differential. Gauge pressure controllers use either a Bourdon tube or bellows as the sensing element, as indicated in table 2. Differential pressure controllers use two bellows to sense differential pressure.

**For gauge pressure instruments:** The control pressure block (key 8 in figure 19) has two connections. Process pressure can be connected

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either to the CONTROL connection on the back of the case, or to the connection on the left side of the case, shown in figure 3, depending on the instrument application. Plug the unused connection.

**For differential pressure instruments:** Connect the low pressure line to the CONTROL connection on the side of the case and the high pressure line to the CONTROL connection on the back of the case as shown in figure 3.

When installing process piping, follow accepted practices to ensure accurate transmission of the process pressure to the controller or transmitter. Install shutoff valves, vents, drains, or seal systems as needed in the process pressure lines. If the instrument is located such that the adjacent process pressure lines will be approximately horizontal, the lines should slope downward to the instrument for liquid-filled lines and upward to instruments for gas-filled lines. This will minimize the possibility of air becoming trapped in the sensor with liquid-filled lines or of condensation becoming trapped with gas-filled lines. The recommended slope is 83 mm per meter (1 inch per foot).

If a controller is being used in conjunction with a control valve to control pipeline pressure, connect the process pressure line in a straight section of pipe approximately 10 pipe diameters from the valve but away from bends, elbows, and areas of abnormal fluid velocities. For pressure-reducing service, the process line must be connected downstream of the valve. For pressure-relief service, the process pressure line must be connected upstream of the control valve. Install a needle valve in the process pressure line to dampen pulsations.

## Vent Assembly



### WARNING

**If a flammable or hazardous gas is to be used as the supply pressure medium, personal injury or property damage could result from fire or explosion of accumulated gas or from contact with hazardous gas. The instrument case and cover assembly does not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should**

**be used. A remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.**

## CAUTION

**When installing a remote vent pipe, take care not to overtighten the pipe in the vent connection. Excessive torque will damage the threads in the connection.**

The vent assembly (key 15, figure 3) or the end of a remote vent pipe must be protected against the entrance of all foreign matter that could plug the vent. Use 13 mm (1/2-inch) pipe for the remote vent pipe, if one is required. Check the vent periodically to be certain it has not become plugged.

## Controller Operation

### Proportional-Only Controllers

This section describes the adjustments and procedures for calibration and startup. Adjustment locations are shown in figure 5 unless otherwise specified. All adjustments must be made with the cover open. When the adjustments and calibration procedures are complete, close and latch the cover.

To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for proportional-only controllers. Refer also to the schematic diagram in figure 14.

### Adjustments

#### Adjustment: Set Point

Adjust the pressure-setting knob by turning the knob clockwise to increase the set point and counterclockwise to decrease the set point. Note: The dial setting and actual process pressure may vary significantly, especially with a wide proportional band setting.

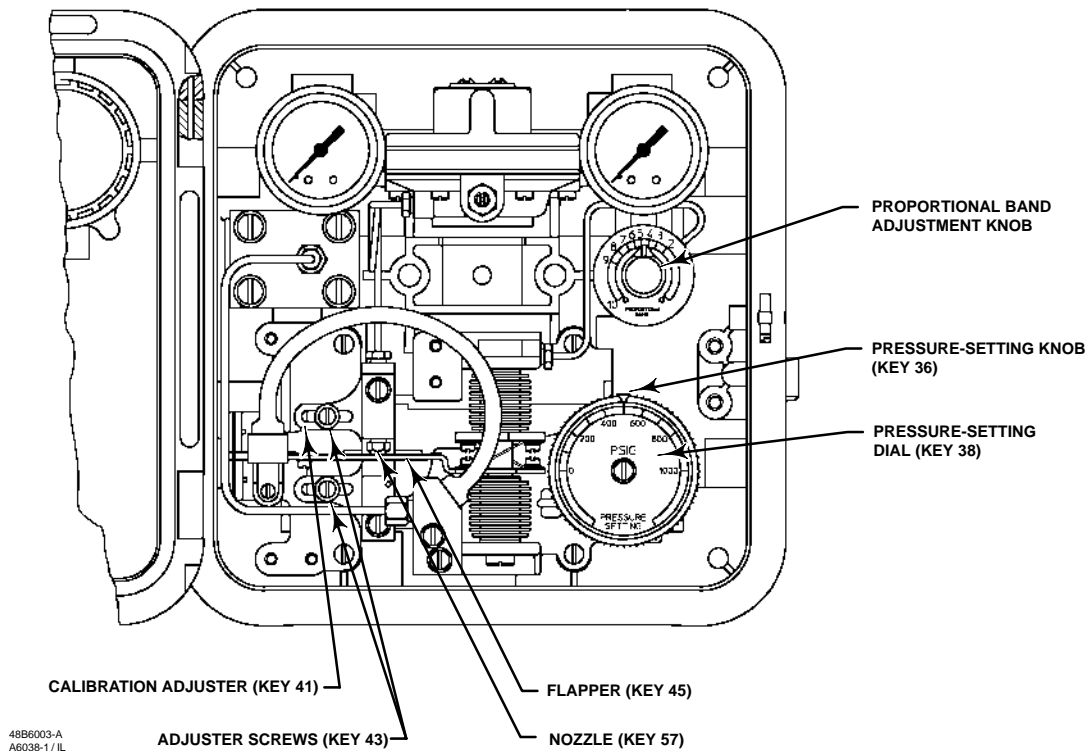


Figure 5. Proportional-Only Controller Adjustment Locations

**Adjustment: Proportional Band**

To adjust the proportional band, rotate the proportional band knob to the desired value.

The proportional band adjustment determines the amount of change in controlled pressure required to cause the control valve to stroke fully. It may be adjusted from 3-100 percent of the nominal sensing element pressure rating.

**Calibration: Proportional-Only Controllers**

Unless otherwise indicated, key number locations are shown in figure 5.

Provide a process pressure source capable of simulating the process pressure range of the controller. If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes.

Connect a pressure source to the supply pressure regulator and be sure the regulator is delivering the correct supply pressure to the controller. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge). The following procedures use a 0.2 to 1.0 bar (3 to 15 psig) output

pressure range as an example. For a 0.4 to 2.0 bar (6 to 30 psig) output range, adjust the values as appropriate.

1. Complete the above connections and provide a process pressure equal to the sensing element range.
2. Rotate the proportional band knob, shown in figure 5, to 1.5 (15 percent proportional band).
3. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

Depending upon the controller action, perform one or the other of the following procedures.

**For direct-acting controllers:**

4. Apply an input pressure equal to the sensing element lower range value.
5. Rotate the pressure setting knob to the minimum value.
6. Adjust the nozzle (key 57) until the controller output pressure is between 0.6 and 0.7 bar (8 and 10 psig.)
7. Apply an input pressure equal to the sensing element upper range value.
8. Rotate the pressure-setting knob to the maximum value.



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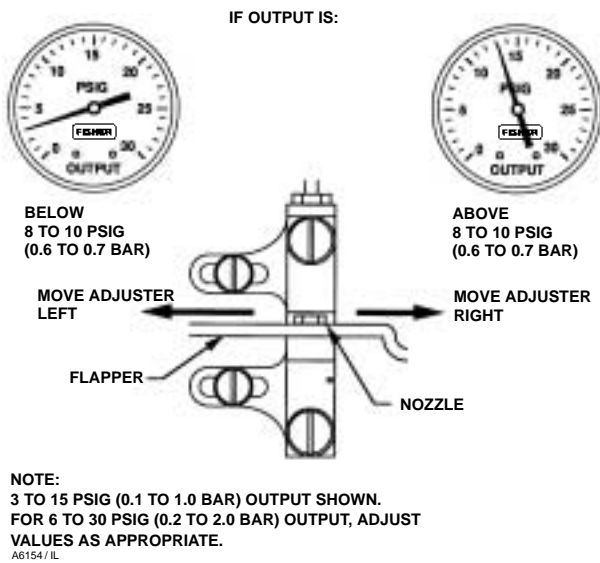


Figure 6. Direct-Acting Controller Span Adjustment—Proportional-Only Controllers

**Note**

When performing the span adjustment in step 9, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

9. If the output is not between 0.6 and 0.7 bar (8 and 10 psig), adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 6.

**Note**

When performing the span adjustment in step 9, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.

Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.

10. Repeat steps 4 through 9 until no further adjustment is necessary.

11. Proceed to the startup procedure for proportional controllers.

**For reverse-acting controllers:**

4. Apply an input pressure equal to the sensing element upper range value.

5. Rotate the pressure setting knob to the maximum value.

6. Adjust the nozzle (key 57) until the controller output pressure is between 0.6 and 0.7 bar (8 and 10 psig).

7. Apply an input pressure equal to the sensing element lower range value.

8. Rotate the pressure-setting knob to the minimum value.

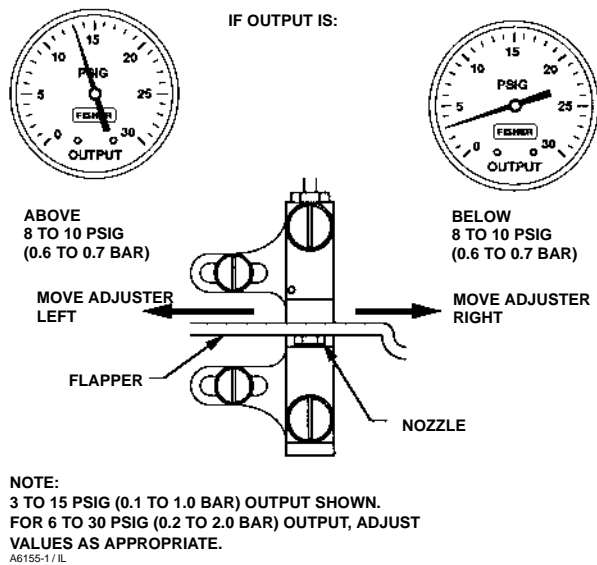


Figure 7. Reverse-Acting Controller Span Adjustment — Proportional-Only Controllers

10. Repeat steps 4 through 9 until no further adjustment is necessary.
11. Proceed to the startup procedure for proportional controllers.

### Startup: Proportional-Only Controllers (General Tuning Guidelines)

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Rotate the pressure-setting knob to the desired set point.
3. Set the proportional band adjustment to 100 percent for fast processes (example: liquid pressure or liquid flow). For slow processes (example: temperature), calculate the percentage from the equation below:

For a slow process, determine the initial proportional band setting in percent from the following equation:

$$\frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}} = \text{P.B.}$$

For example:

$$\frac{200 \times 1.4 \text{ bar}}{2.1 \text{ bar}} \cong 13\% \quad \left( \frac{200 \times 2 \text{ psig}}{30 \text{ psig}} \cong 13\% \right)$$

(1.3 proportional band setting)

#### 4. Proportional Action

Disturb the system by tapping the flapper lightly or change the set point a small amount and check for system cycling. If the system does not cycle then lower the proportional band (raising the gain) and disturb the system again. Continue this procedure until the system cycles. At that point, double the proportional band setting.

#### Note

**Proportional band adjustment affects the set point. Proportional-only controllers will show some offset from set point depending upon proportional band setting and process demand. After adjusting the proportional band, re-zero by carefully rotating the nozzle (key 57) until the steady-state process pressure equals the process pressure knob reading.**

This tuning procedure may be too conservative for some systems. The recommended proportional band setting should be checked for stability by introducing a disturbance and monitoring the process.

### Proportional-Plus-Reset Controllers

This section describes the adjustments and procedures for calibration and startup. The adjustment locations are shown in figure 8 unless otherwise specified. All adjustments must be made with the cover open. When the adjustments and calibration procedures are complete, close and latch the cover. To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for proportional-plus-reset controllers. Refer also to the schematic diagram in figure 14.

### Adjustments

#### Adjustment: Set Point

Adjust the pressure-setting knob by turning the knob clockwise to increase the set point and counterclockwise to decrease the set point.

Rotate the knob until the indicator points to the desired set point pressure value. The pressure setting dial will reflect the desired set point if the controller is accurately calibrated.

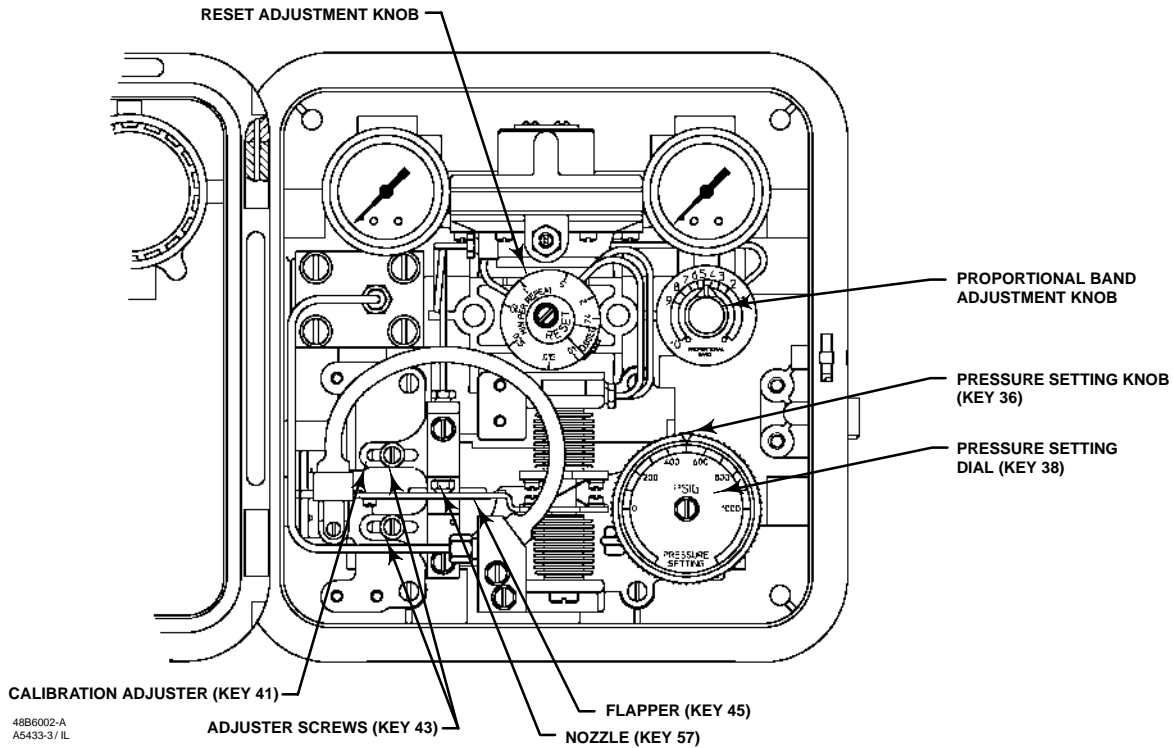


Figure 8. Proportional-Plus-Reset Controller Adjustment Locations

### Adjustment: Proportional Band

To adjust the proportional band, rotate the proportional band knob to the desired value.

The proportional band adjustment determines the amount of change in controlled pressure required to cause the control valve to stroke fully. It may be adjusted from 3-100 percent of the nominal sensing element pressure rating.

### Adjustment: Reset

To adjust reset action turn the knob clockwise to decrease the minutes per repeat. Turn the knob counterclockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

The reset adjustment dial is calibrated in minutes per repeat. By definition, this is the time in minutes required for the reset action to produce an output change which is equal to the change produced by proportional control action. This is in effect, the time in minutes required for the controller to increase (or decrease) its output pressure by an amount equal to

a proportional increase (or decrease) caused by a change in set point or process pressure.

### Adjustment: Anti-Reset Windup

The externally mounted differential relief valve can be mounted to relieve on increasing or decreasing output pressure.

### Calibration

#### Calibration: Proportional-Plus-Reset Controllers

Unless otherwise indicated, key number locations are shown in figure 8.

Before starting this procedure:

- Provide a process pressure source capable of simulating the process pressure range of the controller.
- If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge).

**Note**

**Type 4160KF and 4162KF (anti-reset windup) controllers are supplied with two O-rings (key 367, not shown), an anti-reset windup cover (key 369, not shown), and two machine screws (key 368, not shown). Use these parts in the next step.**

1. For controllers with anti-reset windup (Type 4160KF and 4162KF), record the direction of the arrow on the anti-reset windup assembly (key 186, in figure 20). Remove the assembly and install the two O-rings (key 367, not shown), and cover (key 369, not shown) supplied with the controller. Secure the cover with the two machine screws (key 368, not shown) provided.
2. Connect regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 5.
3. Rotate the reset knob to 0.01 minutes per repeat (fastest setting).
4. Rotate the proportional band knob to 1.5 (15 percent proportional band).
5. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

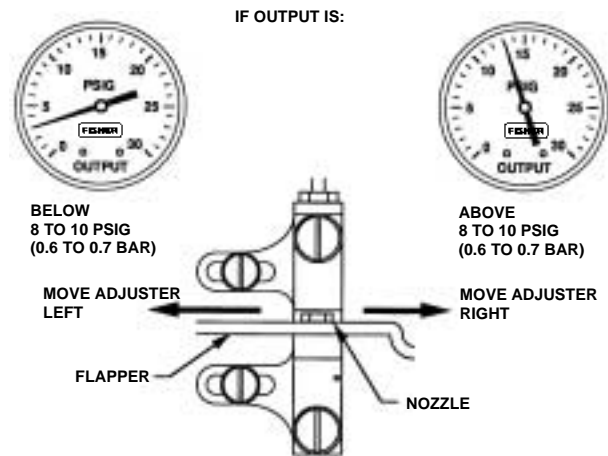
Depending upon the controller action, perform one or the other of the following procedures.

**For direct-acting controllers:**

6. Apply an input pressure equal to the sensing element lower range value.
7. Rotate the pressure setting knob to the minimum value.
8. Adjust the nozzle (key 57) until the controller output pressure is between 0.6 and 0.7 bar (8 and 10 psig).
9. Apply an input pressure equal to the sensing element upper range value.
10. Rotate the pressure-setting knob to the maximum value.

**Note**

**When performing the span adjustment in step 11, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster,**



**NOTE:**  
3 TO 15 PSIG (0.1 TO 1.0 BAR) OUTPUT SHOWN.  
FOR 6 TO 30 PSIG (0.2 TO 2.0 BAR) OUTPUT, ADJUST  
VALUES AS APPROPRIATE.  
A6154 / IL

*Figure 9. Direct-Acting Controller Span Adjustment  
—Proportional-Plus-Reset Controllers*

**the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.**

**Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.**

11. If the output pressure is not between 0.6 and 0.7 bar (8 and 10 psig), adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 9.

12. Repeat steps 6 through 11 until no further adjustment is necessary.

13. For controllers with anti-reset windup (Type 4160KF and 4162KF), remove the two machine screws, anti-reset windup cover, and two O-rings installed in step 1 of this procedure. Install the anti-reset windup assembly (key 186) with the arrow pointing in the direction recorded in step 1.

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14. Proceed to the Startup procedures for proportional-plus-reset controllers.

### For reverse-acting controllers:

6. Apply an input pressure equal to the sensing element upper range value.

7. Rotate the pressure setting knob to the maximum value.

8. Adjust the nozzle (key 57) until the controller output pressure is between 0.6 and 0.7 bar (8 and 10 psig).

9. Apply an input pressure equal to the sensing element lower range value.

10. Rotate the pressure-setting knob to the minimum value.

### Note

**When performing the span adjustment in step 11, do not watch the output gauge while changing the calibration adjuster. The change in output is not a good indication of the change in span. While moving the calibration adjuster, the output pressure may change in the opposite direction than expected. For example, while moving the calibration adjuster to increase span, the output pressure may decrease. This should be disregarded since even though the output pressure decreases, the span is increasing.**

**Loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.**

11. If the output pressure is not between 0.6 and 0.7 bar (8 and 10 psig), adjust the controller span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 10.

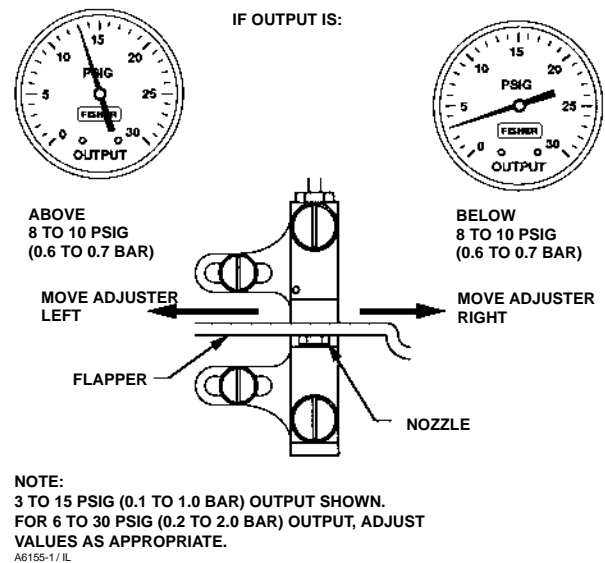


Figure 10. Reverse-Acting Controller Span Adjustment—Proportional-Plus-Reset Controllers

12. Repeat steps 6 through 11 until no further adjustment is necessary.

13. For controllers with anti-reset windup (Type 4160KF and 4162KF), remove the two machine screws, anti-reset windup cover, and two O-rings installed in step 1 of this procedure. Install the anti-reset windup assembly (key 186) with the arrow pointing in the direction recorded in step 1.

14. Proceed to the Startup procedures for proportional-plus-reset controllers.

### Calibration: Anti-Reset Windup

Controllers with anti-reset windup have a differential relief valve assembly (figure 20). This relief valve is set at the factory to relieve at a 0.3 bar (5 psi) pressure difference between the reset bellows pressure and the proportional bellows pressure. The valve can be adjusted to relieve from 0.14 to 0.4 bar (2 to 7 psig).

The relief valve can relieve on either rising controller output pressure or falling controller output pressure. If the arrow on the relief valve points toward the bottom of the controller case as shown in figure 20, the valve will relieve on falling output pressure. If the arrow points in the opposite direction, the valve will relieve on rising output pressure. The valve can be removed and reinstalled with the arrow pointing in the opposite direction to change the relief action.

**Startup: Proportional-Plus-Reset  
Controllers (General Tuning Guidelines)**

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.
2. Rotate the pressure-setting knob to the desired set point.
3. Start with a reset setting of 0.05 minutes per repeat (m/r) for fast processes, and 0.5 m/r for slow processes.
4. Set the proportional band adjustment to 100 percent for fast processes (example: liquid pressure or liquid flow). For a slow process (example: temperature), calculate the percentage from the equation below:

For a slow process, determine the initial proportional band setting in percent from the following equation:

$$\frac{200 \times \text{Allowable Overshoot}}{\text{Pressure Span}} = \text{P.B.}$$

For example:

$$\frac{200 \times 1.4 \text{ bar}}{2.1 \text{ bar}} \cong 13\% \quad \left( \frac{200 \times 2 \text{ psig}}{30 \text{ psig}} \cong 13\% \right)$$

(1.3 proportional band setting)

5. Proportional Action:

Disturb the system by tapping the flapper lightly or change the set point a small amount and check for system cycling. If the system does not cycle then lower the proportional band (raising the gain) and disturb the system again. Continue this procedure until the system cycles. At that point, double the proportional band setting and begin tuning the reset.

6. Reset Action:

Disturb the system. If the system does not cycle then speed up the reset and disturb the system again. Continue this procedure until the system cycles. When the system cycles multiply the reset time setting by a factor of three (3) and slow the reset down to the new value. The reset is now tuned.

This tuning procedure may be too conservative for some systems. The recommended proportional band and reset setting should be checked for stability by introducing a disturbance and monitoring the process as previously described. For some applications, tighter control may be desirable.

**Differential Gap Controllers**

This section describes the adjustments and procedures for calibration and startup. The adjustment locations are shown in figure 5 unless otherwise specified. The output of each controller is checked at the factory before the instrument is shipped.

To convert a differential gap controller to a proportional-only controller or vice versa, refer to the appropriate procedure in the Maintenance section.

If the process pressure can be varied through all or part of the sensing element range or through the two desired switching points, use the process pressure for calibration. If not, provide a pressure source to simulate the process pressure range for calibration procedures.

To better understand the adjustments and overall operation of the controller, refer to the Principle of Operation section in this manual for differential gap controllers and the schematic diagram in figure 14.

**Adjustments**

**Adjustment: Set Point**

The position of the pressure-setting knob determines the location of the differential gap within the range of the pressure sensing element. Move the pointer to the desired pressure where the output of the controller should switch from zero to full supply pressure with rising process pressure (direct-acting controllers) or with falling process pressure (reverse-acting controllers).

**Adjustment: Proportional Band**

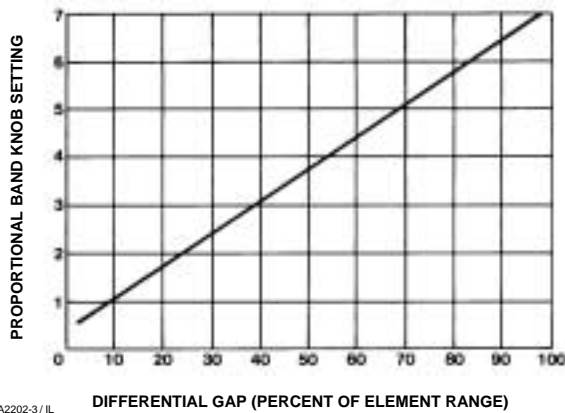
The proportional band adjustment shown in figure 5 determines the width of the differential gap. The width of the gap is the difference between the process pressures at which the controller output will switch from zero to full supply pressure, or from full supply pressure to zero. The relationship between the proportional band dial setting and the differential gap is shown in figure 11.

**Calibration: Differential Gap Controllers**

The output of each controller is checked at the factory before the unit is shipped. Before placing the controller in control of a process loop, check to verify that the controller is calibrated correctly for the application. The controller must be connected open loop (Open loop: The controller output pressure changes must be dead ended into a pressure gauge).

1. Temporarily convert the differential gap controller to a proportional-only controller by disconnecting the

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A2202-3 / L

DIFFERENTIAL GAP (PERCENT OF ELEMENT RANGE)

Figure 11. Differential Gap Adjustment for Differential Gap Controllers

proportional tubing (key 104, figure 16) from the mounting base. Reinstall the tubing into the other connection in the mounting base as shown in figure 16. Do not invert the reversing block (key 59, figure 16).

2. Use the calibration procedures for proportional-only controllers.
3. Upon completion of the calibration procedures, reinstall the tubing (key 104) in its original location, and continue with the following procedures.

**Note**

**After reinstalling the tubing (key 104) in step 3 a slight offset of the output pressure will be noticed due to switching from the proportional bellows to the reset bellows. This is because the effective area and spring rate of the two bellows may not match. Performing step 5b below adjusts for this offset.**

4. Refer to figure 11 to determine the proportional band dial setting required for the desired differential gap.

For example, assume that a 0 to 100 psig sensing element is being used and the controller is to switch from zero to full supply pressure at a process pressure of 80 psig with rising process pressure and from full supply pressure to zero at 20 psig with falling pressure. (This is for a direct-acting controller.) The differential gap is:

$$\frac{5.5 \text{ bar} - 1.3 \text{ bar}}{6.9 \text{ bar}} \times 100 = 60\%$$

$$\left( \frac{80 \text{ psig} - 20 \text{ psig}}{100 \text{ psig}} \times 100 = 60\% \right)$$

From figure 11, the proportional band dial setting should be approximately 4.5; rotate the proportional band knob to 4.5.

5. Setting the process pressure

**For a Direct-Acting Controller:**

- a. Rotate the pressure-setting knob to the pressure at which the controller output is to switch to the upper switching point (zero to full supply pressure) with rising process pressure. In the above example, this pressure is 5.5 bar (80 psig).
- b. Increase pressure to the sensing element while monitoring the output pressure gauge. The controller output pressure should switch from zero to full supply pressure when the upper switching point is reached with rising input pressure.

**Note**

**If the upper switching point is not correct, adjust the nozzle to correct the error. Repeat step 5b until the input pressure and upper switching point are at the desired setting.**

- c. With falling input pressure, the output should switch from full supply pressure back to zero when the lower switching point is reached.

Reverse-acting controllers produce the opposite response.

6. Vary the process pressure and observe the switching points. Widen or narrow the differential gap by rotating the proportional band knob, then repeat the above steps.

If the output is within the limits stated, refer to the startup procedures in this section. If the output pressure cannot be adjusted within the limits stated, refer to the maintenance procedures.

**Startup: Differential Gap Controllers**

Calibrate the controller prior to this procedure.

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the controller.

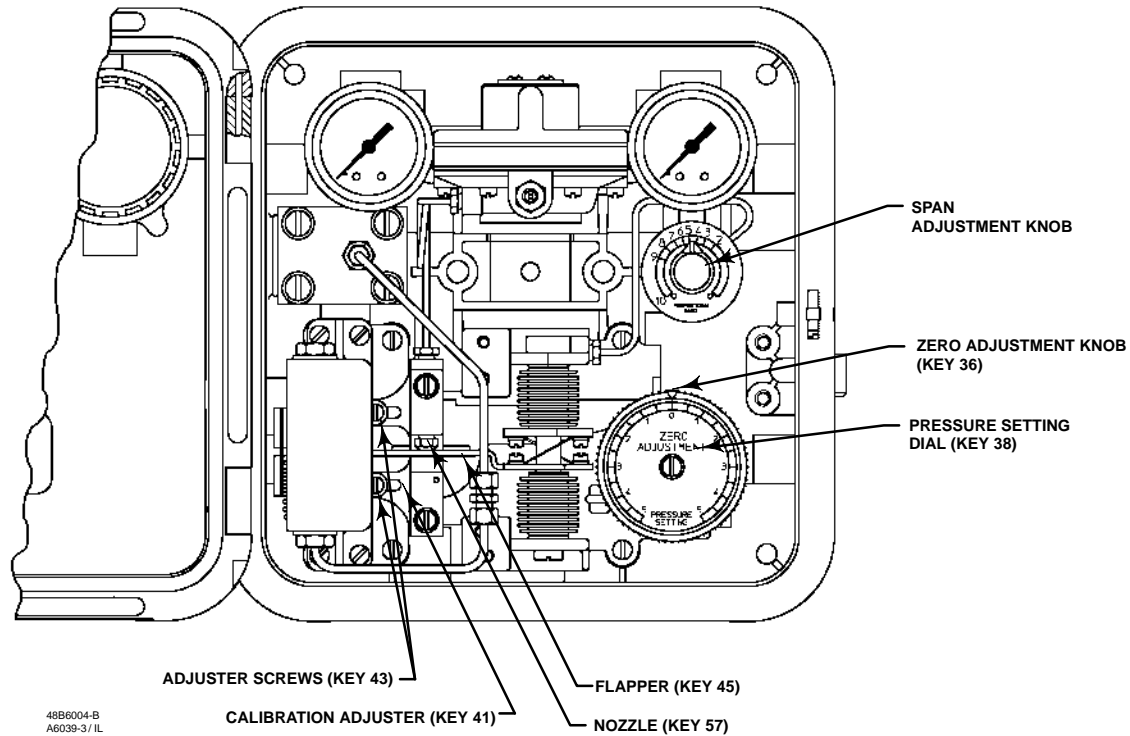


Figure 12. Transmitter Adjustment Locations

2. Adjust the proportional band knob for the proper differential gap (see figure 11).
3. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual shutoff valves, and close the bypass valves.
4. To change the differential gap, perform steps 1 through 4 of the calibration for differential gap controllers procedure.

## Transmitter Operation

This section describes the adjustments and procedures for calibration and startup. Refer to figure 12 for the adjustment locations. All adjustments must be made with the cover open. When the adjustments and calibration procedures are complete, close and latch the cover.

To better understand the adjustments and overall operation of the transmitter, refer to the Principle of Operation section in this manual for transmitters. Refer also to the schematic diagram in figure 14.

## Adjustments

### Adjustment: Zero

The pressure-setting dial is marked ZERO ADJUSTMENT PRESSURE SETTING. Zero is in the center of the dial, and the pressure values increase to the right and left of the center as shown in figure 12. To set the zero, rotate the pointer around the pressure setting dial. Rotate the pointer clockwise to increase or counterclockwise to decrease the output depending on transmitter action and desired setting.

For direct-acting transmitters, zero adjustment determines the process pressure at which the transmitter output signal will be at its lower range limit.

The dial (key 38) graduations are approximate indications of the transmitter zero setting. When making adjustments, do not rely solely on the dial setting. Monitor the process pressure and output pressure to be sure the desired settings are attained.

### Adjustment: Span

The span adjustment dial is graduated from 0 to 10. A setting of 10 on the dial represents a span setting of 100 percent of the process sensing element



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range. The transmitter achieves the highest accuracy when the span is 100 percent.

The transmitter span adjustment shown in figure 12 is the same as the controller proportional band adjustment.

## **Calibration: Transmitters**

The output of each transmitter is checked at the factory before the unit is shipped. The transmitter provides an output signal that is proportional to the pressure applied to the sensing element. The output pressure has no direct effect on the process pressure.

The transmitter is calibrated at the factory and should not need additional adjustment. Use the following calibration procedures when the sensing element has been changed or other maintenance procedures have altered the calibration of the transmitter. The following procedures use a 0.1 to 1.0 bar (3 to 15 psig) output pressure range as an example. For other output pressure ranges [such as 0.2 to 2.0 bar (6 to 30 psig)] adjust the values to match the application.

Provide a process pressure source capable of simulating the process pressure range of the transmitter. If an output pressure gauge is not provided, install a suitable pressure gauge for calibration purposes<sup>(1)</sup>. Connect a pressure source to the supply pressure regulator and be sure the regulator is delivering the correct supply pressure to the transmitter.

Unless otherwise indicated, key number locations are shown in figure 12.

1. Complete the above connections and provide a process pressure equal to the sensing element range.
2. Rotate the span adjustment knob to 10 on the dial (100 percent span).
3. Verify that the calibration adjuster screws (key 43) are at mid-position in the calibration adjuster (key 41) slots.

Depending upon the transmitter action, perform one or the other of the following procedures.

### **For direct-acting transmitters:**

4. Rotate the zero adjustment knob to zero.
5. Set the input pressure to zero.
6. Adjust the nozzle (key 57) until the transmitter output pressure is at 0.1 bar (3 psig).

7. Apply an input pressure equal to the sensing element upper range value.

### **Note**

**When performing the span adjustment in step 8, loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.**

8. If the output pressure is not 15 psig, adjust the span by loosening one of the two adjusting screws (key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 13.
9. Repeat steps 4 through 8 until no further adjustment is necessary.
10. Proceed to the startup procedure for transmitters.

### **For reverse-acting transmitters:**

4. Rotate the zero adjustment knob to zero.
5. Apply an input pressure equal to the sensing element upper range limit.
6. Adjust the nozzle (key 57) until the transmitter output pressure is at 0.1 bar (3 psig).
7. Set the input pressure equal to zero.

### **Note**

**When performing the span adjustment in step 8, loosen one screw only on the calibration adjuster and move the calibration adjuster a small amount using the tight screw as a pivot and retighten the screw. If the adjustment is repeated several times, alternate the loosening of the two screws to prevent the nozzle from being misaligned with the flapper. During calibration, always be sure the nozzle remains perpendicular to the flapper.**

8. If the output pressure is not 15 psig, adjust the span by loosening one of the two adjusting screws

1. For stability, some transmitter applications will require additional volume than just the gauge. Provide a minimum volume of approximately 25 cm<sup>3</sup> (1.5 in<sup>3</sup>) or greater if stability is a problem.

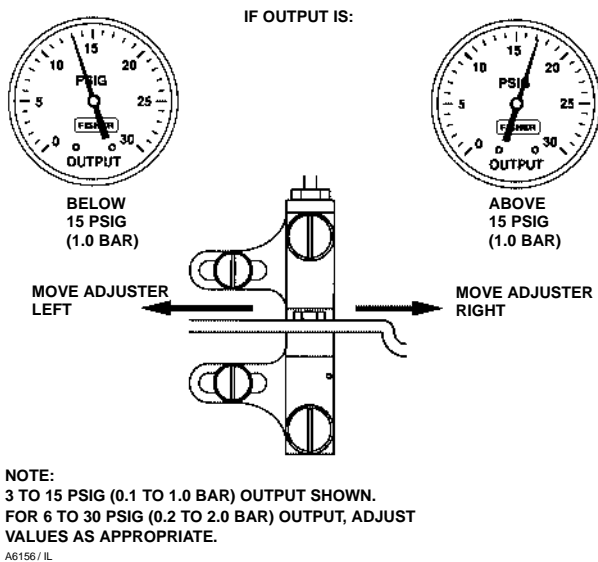


Figure 13. Transmitter Span Adjustment

(key 43) and move the calibration adjuster (key 41) a small distance as indicated in figure 13.

9. Repeat steps 4 through 8 until no further adjustment is necessary.

10. Proceed to the startup procedure for transmitters.

### Startup: Transmitters

1. Be sure that the supply pressure regulator is delivering the proper supply pressure to the transmitter.
2. Refer to the calibration procedures for the transmitter initial settings.
3. If the transmitter is used in conjunction with a control valve, slowly open the upstream and downstream manual shutoff valves, and close the bypass valves.

### Principle of Operation

The following sections describe the operation of a controller or transmitter using a Bourdon tube

sensing element. The operation is the same for an instrument using a bellows sensing element (key 71, figure 22) except that movement of the beam is caused by expansion or contraction of the bellows or differential bellows.

### Proportional-Only Controllers

As shown in figure 14, supply pressure enters the relay and bleeds through the fixed orifice before escaping through the nozzle. Nozzle pressure also registers on the large relay diaphragm, and loading pressure (controller output pressure) registers on the small relay diaphragm.

A change in the process pressure moves the beam and flapper with respect to the nozzle by either expanding or contracting the Bourdon tube arc. An increasing process pressure with direct action (or decreasing pressure with reverse action) produces a nozzle-flapper restriction that increases the loading on the large relay diaphragm and opens the relay valve. Additional supply pressure flows through the relay chamber to increase the loading pressure on the control valve actuator. A decreasing process pressure with direct action (or increasing pressure with reverse action) produces a nozzle-flapper opening that bleeds off pressure on the large relay diaphragm and opens the relay valve to exhaust controller output pressure from the actuator.

This controller output pressure change feeds back to the proportional bellows, countering the pressure change in the nozzle and equalizes the relay diaphragm pressure differential. The relay valve maintains a new loading pressure according to the change in sensed pressure.

If the proportional valve is wide open, all of the controller output pressure change feeds back to the proportional bellows. The more the proportional valve is closed, the more the controller output pressure change bleeds out through the proportional valve exhaust and the less there is to feed back to the proportional bellows. A fully open proportional valve results in a proportional band of 100 percent; closing the proportional valve reduces the proportional band.

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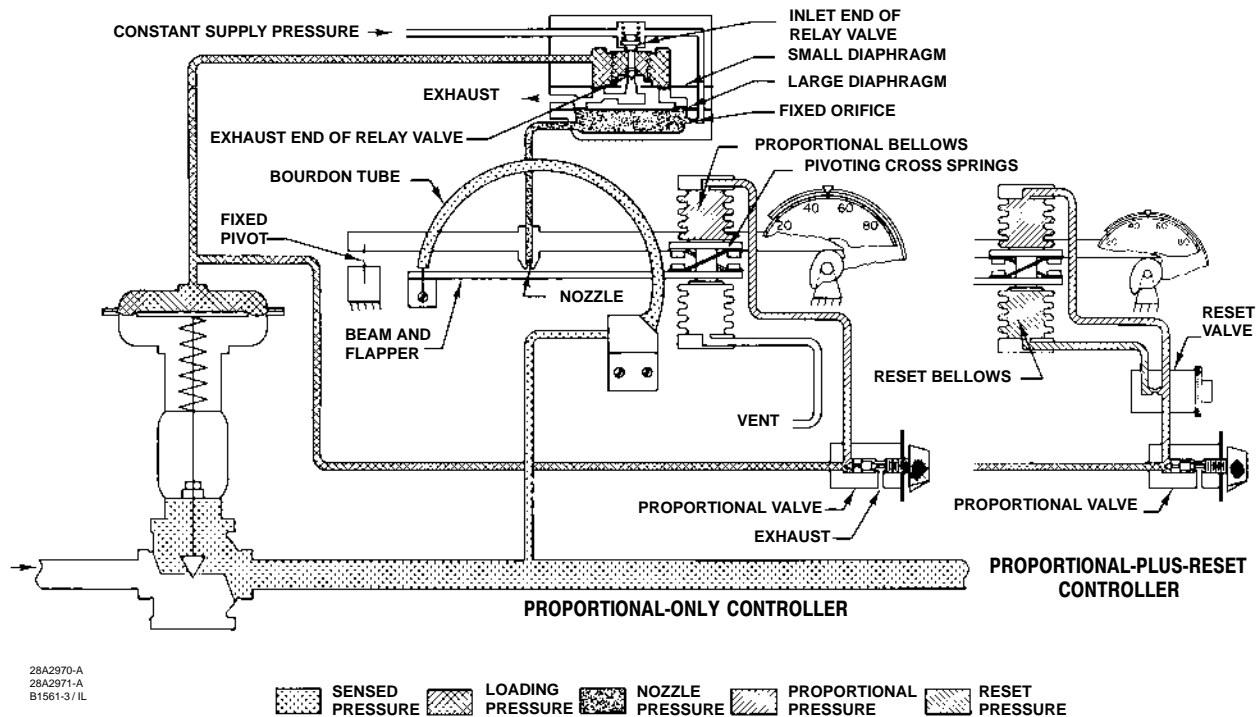


Figure 14. Schematic of Direct-Acting Proportional-Only and Proportional-Plus-Reset Controllers

## Proportional-Plus-Reset Controllers

Action of a proportional-plus-reset controller is similar to that of a proportional-only controller except that feedback from the controller output pressure is piped to a reset bellows as well as to the proportional bellows as shown at the right in figure 14.

With an increasing controller output pressure, pressure in the reset bellows increases. Increases in reset bellows pressure moves the beam and flapper closer to the nozzle, starting another increase of pressure throughout the system. Pressure buildup continues until the controlled pressure is brought back to the set point. The reset valve is adjustable to vary the amount of delay in the reset action. Closing the reset valve increases the delay in reset action.

## Controllers with Anti-Reset Windup

During a prolonged difference between set point and the controlled variable, such as encountered with intermittent control applications (e.g., batch temperature control or wide open monitors on pressure control), reset ramps the controller output to either zero or full supply pressure; this condition is reset windup. When the controlled variable crosses the set point, there will be a delay before the controller output responds to the change in

controlled variable. Anti-reset windup minimizes this delay and permits returning the controlled variable to set point more quickly with minimal overshoot.

As shown in figure 15 a proportional-plus-reset controller with anti-reset windup includes a differential relief valve. The valve consists of two pressure chambers separated by a spring-loaded diaphragm.

For the controller shown in figure 15, proportional pressure registers rapidly on the spring side of the relief valve diaphragm as well as in the proportional bellows, and reset pressure registers on the opposite side of the relief valve diaphragm. As long as controlled pressure changes are slow enough for normal proportional and reset action, the relief valve spring will keep the relief valve diaphragm from opening. However, a large or rapid decrease in controller pressure will cause the relay to exhaust loading pressure from the control device rapidly, and also from the proportional system and spring side of the relief diaphragm. If this decrease on the spring side of the diaphragm is greater than the relief valve spring setting, the diaphragm will move off the relief valve orifice and permit the proportional pressure on the opposite side of the relief valve diaphragm to bleed rapidly into the reset bellows. The anti-reset windup action also can be reversed to relieve with an increasing proportional pressure.

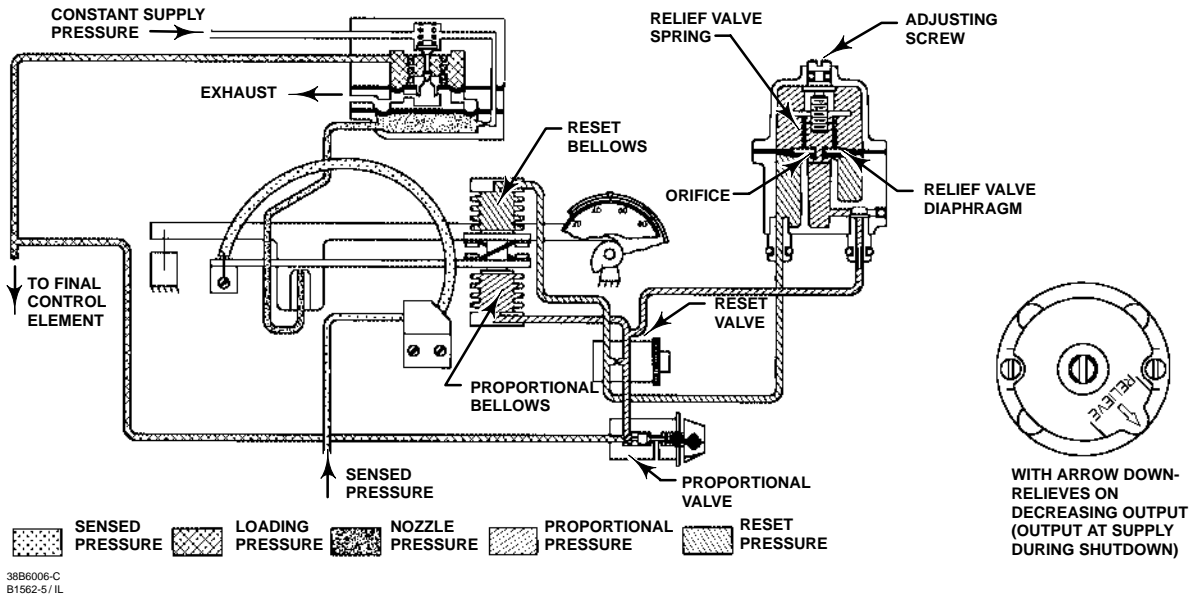


Figure 15. Schematic of Reverse-Acting Proportional-Plus-Reset Controller with Anti-Reset Windup

## Differential Gap Controllers

With a differential gap controller, feedback pressure does not counteract the change in flapper position as it does in a proportional-only controller. Instead, feedback pressure is piped through the proportional valve to the bellows located on the side of the beam and flapper opposite the nozzle (the lower bellows in figure 14 for direct-acting controllers). Then, as controller output pressure increases, feedback pressure moves the flapper closer to the nozzle (the lower bellows in figure 14 for direct-acting controllers). This process continues rapidly until the controller output pressure is at the upper range limit. The action of a differential gap controller is so rapid that output pressure changes from zero to maximum as soon as the switching point is reached. The action is similar with falling output pressure. Lower feedback pressure lowers the bellows pressure, which moves the flapper away from the nozzle. This again reduces the output pressure and continues until the output pressure is zero.

## Transmitters

Action of a pneumatic transmitter is similar to that of a proportional-only controller. Since the output pressure of the transmitter has no effect on the process pressure, transmitter output pressure is a proportional measure of the process pressure. The proportional valve determines the span of the transmitter, and the pressure setting mechanism determines the zero of the transmitter.

## Maintenance

If the installation includes a 67 Series filter regulator, periodically open the drain on the filter regulator to drain accumulated moisture. Also, push the cleaner wire on the relay orifice (key 88, figure 23). Check the opening of the vent assembly (key 15, figure 3) or the opening of the remote vent pipe, if one is used. If necessary, clean the openings.

Parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and parts replacement depends upon the severity of the service conditions.

### WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and property damage caused by the release of pressure or process fluid, observe the following before starting maintenance:

- Provide some temporary means of control for the process before taking the controller out of service.
- Provide a means of containing the process fluid before removing any measurement devices from the process.
- Check with your process or safety engineer for any additional measures

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**that must be taken to protect against process media.**

## Replacing Gauges

Refer to figures 19 and 20 for key number locations unless otherwise directed.

Three gauge configurations are available for 4150K and 4160K units.

- Output and supply pressure indications
- Output and process pressure indications
- Output, process, and supply pressure indications

One gauge type (key 13) is used for both output and supply pressure indications when the gauges are installed inside the controller case. Key 13 features a 1/8-inch connecting stem that matches the threaded gauge boss extending from the relay base.

In some cases, a process pressure gauge (key 106) covers the position of the internal supply pressure gauge. The supply pressure gauge has been removed and replaced with a pipe plug (key 108). The pressure control block (key 8) is different to accommodate a different control tubing assembly (key 132) with a pressure connection (key 107) for a process pressure gauge. If a supply pressure gauge is required, a gauge with a 1/4-inch connecting stem (key 14) must be mounted on the supply pressure regulator.

### CAUTION

**Before performing this procedure, be sure the replacement gauges are the correct range so they are not damaged by overpressure.**

#### Note

**One gauge type (key 13) is used for either supply pressure indication or output pressure indication when both gauges are installed inside the controller case.**

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Remove the gauge to be replaced:

- Unscrew the output or supply gauge (key 13) from the relay base.
  - Unscrew the process pressure gauge (key 106) from the process connection (key 107).
  - Unscrew the supply gauge (key 14) from the supply pressure regulator.
3. Coat the threads of the replacement gauge with a sealant.
  4. Screw the replacement gauge into the relay base, process connection, or supply pressure regulator.
  5. Check for leaks by applying the correct supply pressure with the nozzle capped to produce full output pressure.

## Replacing Bourdon Tube

Refer to figure 21 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Unscrew the machine screw (key 63) to disconnect the link (key 64) and bearing (key 65) from the beam (key 44). Be careful to avoid losing the bearing (key 65). Washer(s) (key 370) for the machine screw (key 63) are at times furnished for insertion at the beam (key 44) connection to ensure alignment of the connecting link (key 64).
3. Disconnect the control tubing (key 132). Unscrew two screws (key 77) and washers (key 76), and remove the Bourdon tube (key 62).
4. Unscrew the machine screw (key 63), and remove the link and bearing (keys 64 and 65) from the Bourdon tube. Be careful to avoid losing the bearing (key 65).
5. Attach the link and bearing to the replacement Bourdon tube.
6. Attach the Bourdon tube with two machine screws and washers (keys 77 and 76).
7. Connect the link and bearing to the beam (key 44).
8. After connecting the link to the beam, make sure the nozzle is centered in the slot in the beam. If not, carefully loosen the machine screw (key 63) enough so that you can slip a washer (key 370) between the bearing (key 65) and beam (key 44). Retighten the machine screw and check the nozzle and beam alignment.
9. Check to be sure that the beam is parallel with the bottom of the case and that the link (key 64) is in

tension. If the beam is not parallel with the case, loosen the machine screws (key 77), reposition the Bourdon tube to get the beam parallel, and retighten the screws.

10. If a Bourdon tube with a different range was installed, remove the machine screw and washer (keys 40 and 39) and dial (key 38). Install a new dial having an adjustment range corresponding to the range of the Bourdon tube. If an optional process pressure gauge (key 106, figure 19) is being used, install a new gauge with the appropriate measurement capability.

11. Check all tubing connections for leaks and the Bourdon tube machine screws, tighten as necessary. Perform the appropriate calibration procedures.

### **Replacing Bellows Sensing Element**

Refer to figure 22 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Disconnect the tubing from the mounting base (key 30) and calibration adjuster (key 41). Disconnect the tubing that connects the pressure block (key 8, figure 19) to the bellows assembly (key 71), at the pressure block end.
3. Unscrew the four machine screws (key 28, figure 19 or 20), and remove the pressure sensing subassembly from the case.
4. Remove the bellows yoke machine screws and washers (keys 75 and 76), and move the bellows yoke to the right to permit access to the link screw.
5. Disconnect the link (key 71M) and bearing (key 71L) from the beam. Be careful to avoid losing the bearing.
6. Loosen the nuts that secure the bellows assembly (key 71), and remove this assembly from the bellows yoke (key 70).
7. For a gauge-pressure sensing element (only one bellows in the assembly), install the proper bellows spring (key 80) into the bellows assembly if the input signal range is being changed. See the parts list for the correct part number.
8. Install the new bellows assembly into the bellows yoke.
9. Attach the link and bearing to the bellows assembly. Position the bellows yoke (key 70) on the mounting base (key 30), and attach the link and bearing to the beam. Start but do not tighten the four

machine screws (key 75) with washers (key 76) that attach the yoke to the mounting base. Slide the yoke up or down as necessary to position the beam horizontally, as shown in figure 22. Tighten the machine screws.

10. Replace the subassembly in the case and secure with the four machine screws (key 28, figure 19 or 20). Reconnect all tubing.

11. If a bellows assembly with a different range is installed, remove the machine screws and washer (keys 40 and 39) and dial (key 38), and install a new dial having an adjustment range corresponding to the range of the bellows. If an optional process pressure gauge (key 106, figure 19) is being used, install a new gauge with the appropriate measurement capability.

12. Check all tubing connections for leaks and the bellows yoke machine screws, tighten as necessary. Perform the appropriate calibration procedures.

### **Changing Proportional or Reset Valve**

1. Disconnect the appropriate tubing and remove the proportional band valve assembly (figure 19 or 20) or the reset restriction valve assembly (figure 20) by unscrewing it from the relay base (key 4, figure 19 or 20). Install the desired replacement assembly.
2. Connect the tubing, check all connections for leaks and perform the appropriate calibration procedures.

### **Changing Anti-Reset Windup Differential Relief Valve (4160KF)**

Refer to figure 20 for key number locations.

1. Note the controller output pressure (zero or supply) when the process is shut down.
2. Remove the differential relief valve assembly.
3. Refer to figure 20. Install the replacement relief valve with the arrow positioned so that the controller output will be as noted in step 1 when the process is shut down.

### **Changing Action**

#### ***Proportional-Only to a Differential Gap Controller***

A proportional-only controller may be changed to a differential gap controller, or vice versa, by changing the position of the proportional tubing (key 104,

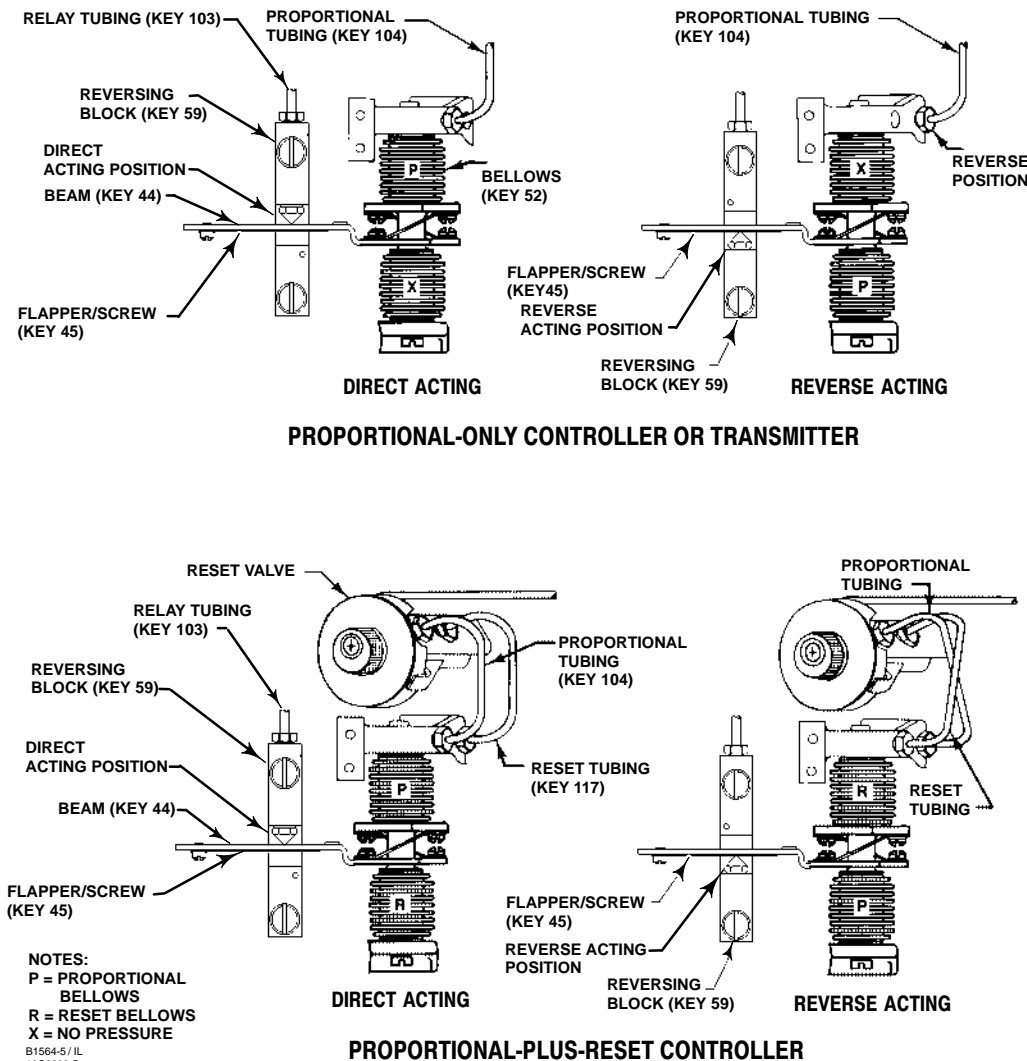


Figure 16. Direct/Reverse Acting Tubing Connections

figure 16). Refer to figure 16 for key number locations.

1. Isolate the controller from process, control, and supply pressure. Vent any trapped pressure from the controller before proceeding with the following steps.
2. Disconnect the proportional tubing (key 104) from the mounting base (key 30, figure 21 or 22) and reinstall it in the other connection in the mounting base.
3. Do not invert the reversing block unless also changing the controller action.
4. Check all connections for leaks with a soap-and-water solution. Perform the appropriate calibration procedure.

### Direct to Reverse Action

Use the numbered steps below to change from direct action (increasing pressure produces increasing output pressure) to reverse action (increasing pressure produces decreasing output pressure), or vice versa. Changing the action is accomplished by reversing the positions of the reversing block and bellows tubing(s). Refer to figure 16 for key number locations unless otherwise directed.

1. Isolate the controller or transmitter from process, control, and supply pressure. Vent any trapped pressure from the controller or transmitter before proceeding with the following steps.
2. Locate the new tubing and reversing block positions for the action desired.

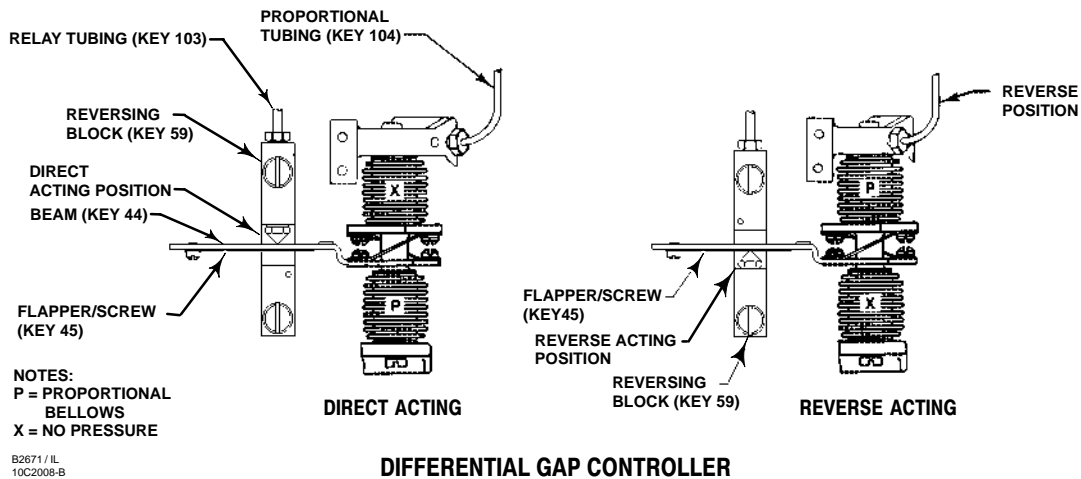


Figure 16. Direct/Reverse Acting Tubing Connections (Continued)

3. Locate the two bellows and the reversing block (key 59, figure 16).
4. Disconnect the tubing:
  - a. **For a proportional-only controller or for a transmitter**, disconnect the proportional tubing (key 104) from the mounting base (key 30, figure 21 or 22) and reconnect it in the opposite hole.
  - b. **For a proportional-plus-reset controller**, disconnect the proportional tubing (key 104) and reset tubing (key 117) from the mounting base (key 30, figure 21 or 22), and reconnect them in the opposite hole.
5. Change the reversing block assembly (key 59):
  - a. Remove the sealing screw (key 56, figure 21 or 22). Inspect the O-ring (key 55, figure 21 or 22) located in the recessed area under the sealing screw head. Replace the O-ring if necessary.
  - b. Remove the reversing block screw (key 61, figure 21 or 22) and reversing block assembly (key 59). Inspect the O-rings (key 55) located in the recessed area under the reversing block screw head and between the reversing block assembly and the calibration adjuster (key 41, figure 21 or 22). Replace these O-rings, if necessary.
  - c. Position the reversing block assembly, with O-ring, on the calibration adjuster (key 41) so that the nozzle is on the opposite side of the beam (key 44, figure 21 or 22) from which it was removed. Properly position the reversing block

assembly so that the alignment pin engages the hole in the calibration adjuster. Install the reversing block screw (key 61) with O-ring (key 55).

d. Install the sealing screw (key 56) with O-ring in the hole previously covered by the reversing block assembly.

6. Check all connections for leaks with a soap-and-water solution. Perform the appropriate calibration procedures.

## Relay Repair

### Replacement

Key numbers used in this procedure are shown in figure 19 or 20 except where indicated.

1. Shut off the supply pressure and process pressure line(s) to the controller or transmitter.
2. Disconnect the tubing (key 103) from the relay.
3. Unscrew the output or supply pressure gauge (key 13).
4. To remove the relay assembly, unscrew two Phillips-head machine screws (key 81, not shown) located behind the relay on the back of the case.
5. Remove the relay gasket (key 7, figure 19).
6. The relay can now be disassembled for cleaning or parts replacement, or a new relay can be installed as a replacement. Refer to the instructions below for relay disassembly. If a new relay is being installed, continue with the next step.



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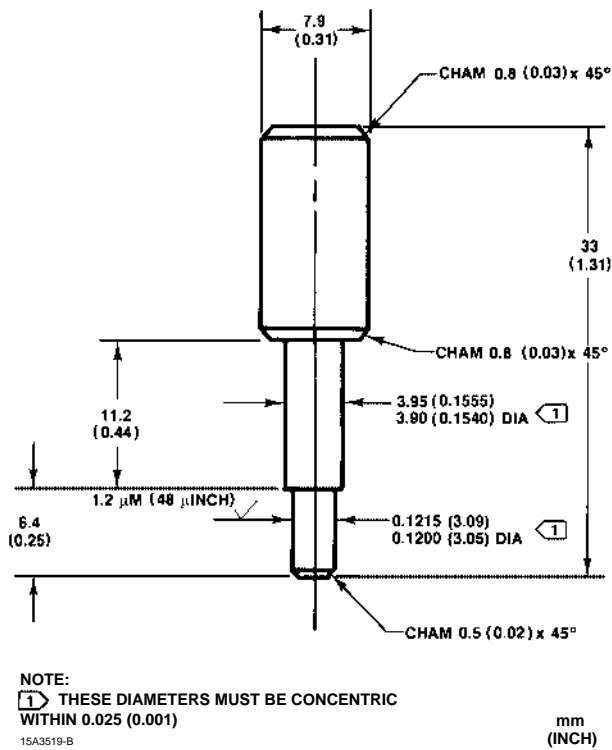


Figure 17. Relay Alignment Tool  
(Part Number 15A3519X012)

7. Attach the replacement relay and new relay gasket with machine screws inserted through the back of the case. Reinstall the output or supply gauge.
8. Connect the tubing, and check all connections for leaks. Perform the appropriate calibration procedures.

## Relay Disassembly

Although the alignment tool shown in figure 17 is not required for assembly of the relay, using the tool will prevent excessive air consumption and dead band. If low air consumption and minimum dead band are required, make or purchase the alignment tool before disassembling the relay. Key numbers are shown in figure 23.

1. Remove the relay from the controller or transmitter case by following steps 1 through 5 of the relay replacement procedure.
2. Unscrew the orifice assembly (key 88). Remove the O-ring (key 90) from the orifice assembly.
3. Remove the casing screws (key 96), casing assembly (key 85), and top diaphragm (key 91). On

a high-temperature relay, also remove the top gasket (key 100) that covers the top diaphragm.

4. Remove the spacer ring (key 84), diaphragm assembly (key 86), and relay spring (key 92) from the relay body (key 83). On a high-temperature relay, also remove the bottom gasket (key 99) from underneath the diaphragm assembly.
5. Remove the screws (key 97), spring plate (key 95), spring plate gasket (key 94), spring (key 93), and valve plug (key 87).
6. Inspect the valve seats for roughness due to corrosion. One seat is located in the diaphragm assembly (key 86), and the other seat is located in the relay body (key 83).

## Relay Assembly

1. Replace the diaphragm assembly or relay body if necessary. Inspect the diaphragms and gaskets, and replace them if necessary. Also replace the spring and valve plug if they show signs of corrosion. The lower diaphragm is part of the diaphragm assembly and must be replaced as an assembly. Clean all parts thoroughly before re-assembling.
2. Place the relay spring in the relay body and, on a high-temperature relay, install a bottom gasket. Install the diaphragm assembly, spacer ring, and top diaphragm on the body so that all flow passage holes are lined up. On a high-temperature relay, also install a gasket over the top diaphragm.
3. Put the casing assembly on the top diaphragm so that the lugs on the casing and spacer ring line up and are also lined up with the body lug.
4. Install the casing screws, but do not tighten.
5. If using an optional alignment tool (figure 17), insert the smaller end of the tool into the opening in the relay body. If the tool does not engage the hole in the diaphragm assembly, move the relay parts slightly to reposition the diaphragm assembly so that the alignment tool engages the hole in the diaphragm assembly. Do not remove the alignment tool until the casing screws have been tightened.
6. Tighten the casing screws (key 96) evenly. Remove the alignment tool if one was used.
7. Install the valve plug, spring, gasket, and cover plate (keys 87, 93, 94, and 95). Secure with the machine screws (key 97).
8. Install the O-ring (key 90) on the orifice assembly (key 88), and install the orifice assembly into the relay casing.
9. Install the relay as described in steps 7 and 8 in the relay replacement section.

## Changing Output Signal Range

Use the following information and subsequent procedures when changing the output signal range of the controller or transmitter. Use the following procedure:

- **For a controller or transmitter**, use this procedure to change from a 0.2 to 1.0 bar (3 to 15 psig) to a 0.4 to 2.0 bar (6 to 30 psig) output signal range or vice versa.
- **For a differential gap controller**, use this procedure to change from a 0 and 1.0 bar (0 and 20 psig) to a 0 and 2.4 bar (0 and 35 psig) output signal range or vice versa.
- When changing the supply pressure source to a new range, refer to table 5 for supply pressure requirements for the output signal range selected.

Also, make appropriate changes to the nameplate of the controller or transmitter, reflecting the new range selections. Refer to figure 21 or 22 for key number locations unless otherwise directed.

1. Shut off the supply pressure and process lines to the controller or transmitter.
2. Disconnect the tubing from the mounting base (key 30) and calibration adjuster (key 41). Disconnect the tubing that connects the pressure block (key 8, figure 19 or 20) to the Bourdon tube or bellows assembly (key 62 or 71), at the pressure block end.
3. Unscrew the machine screws (key 28, figure 19 or 20), and remove the subassembly from the case.
4. If the controller or transmitter uses a Bourdon tube sensing element, disconnect the Bourdon tube from the beam (key 44) by removing the screw (key 63). Be careful to avoid losing the bearing (key 65). Unscrew the machine screws (key 77), and remove the washers and Bourdon tube (keys 76 and 62).
5. Unscrew the bellows screws (key 54) from each end of the mounting base (key 30). [Note: The bellows screws (key 54) have an O-ring (key 55, figure 18) installed beneath the bellows screw head. Remove the O-ring and obtain a replacement when re-assembling the bellows.]
6. Compress the bellows so that the end of the bellows and beam can be removed from the end of the mounting base (key 30) and unscrewed from the stud (key 51, not shown) that connects the bellows.
7. With the stud that connects the two bellows in place in the spacer (key 50), screw the new bellows

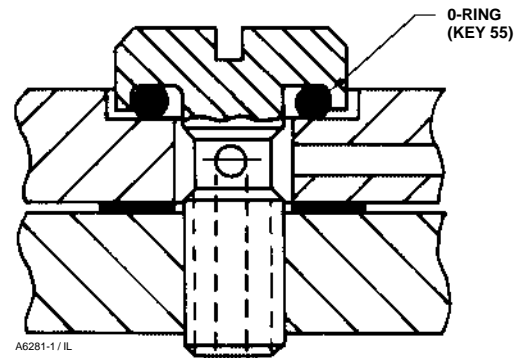


Figure 18. Bellows Screw Detail

onto the stud. Install new gaskets (key 53) on each bellows.

### Note

**The bellows screw (key 54) has an O-ring (key 55) installed beneath the bellows screw head as shown in figure 18. Be sure this O-ring is in place before installing the screw into the mounting base.**

8. Compress the bellows, and install them into the mounting base (key 30). With the beam parallel with the mounting base, secure the bellows with the bellows screws (key 54).
9. After tightening the bellows screws, make sure that the nozzle (key 57) is centered on the flapper (key 45).
10. Replace the subassembly in the case and secure with the machine screws (key 28, figure 19 or 20). Install the Bourdon tube if it was removed; refer to the Replacing Bourdon Tube section if needed. Reconnect all tubing.
11. Unscrew the supply and output gauges (key 13, figure 19 or 20) and install new gauges with correct ranges.
12. Check all tubing connections and the bellows machine screws for leaks, tighten as necessary. Perform the appropriate calibration procedures.

### Note

**Fisher does not assume final responsibility for the selection, use, or maintenance of any product. Final responsibility for the selection, use, and maintenance of any Fisher product remains solely with the purchaser and end-user.**

# 4150K and 4160K Controllers and Transmitters

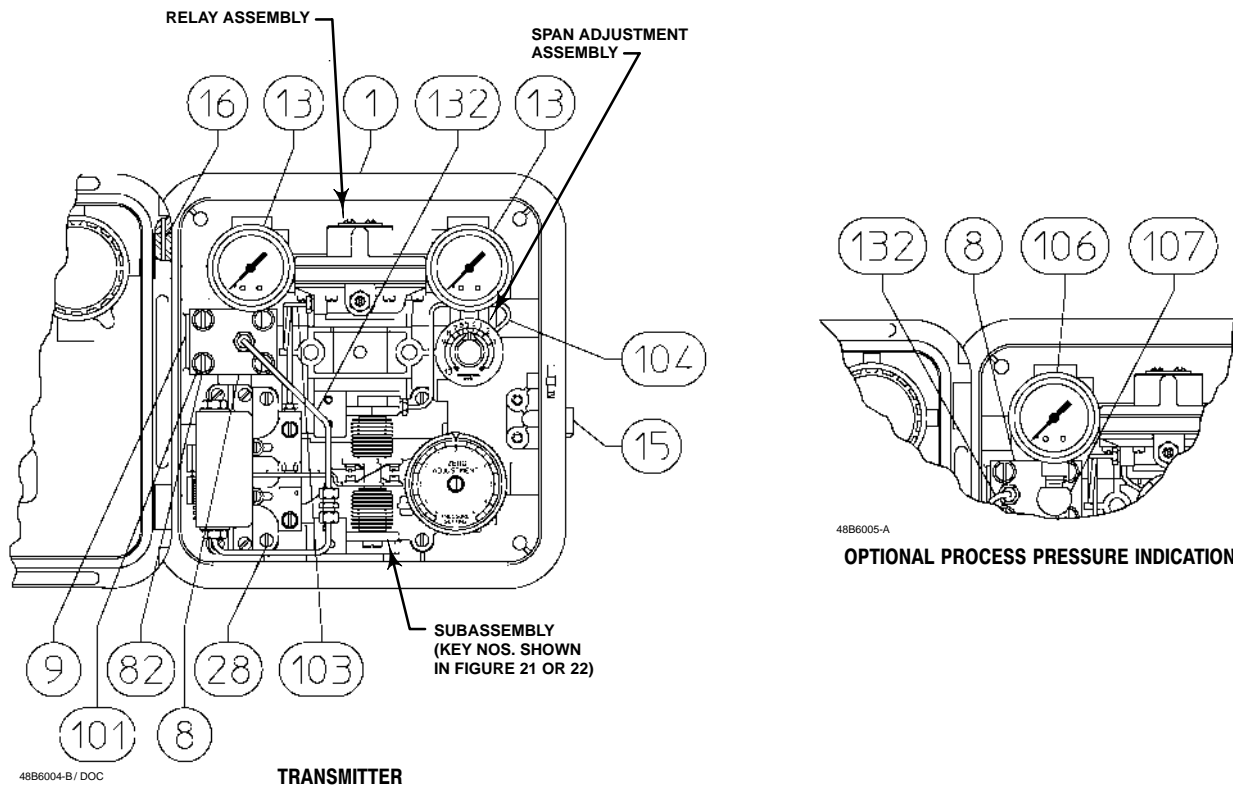
## Parts Ordering

Use only genuine Fisher replacement parts. Components that are not supplied by Fisher should not, under any circumstances, be used in any Fisher instrument, because they will void your warranty, might adversely affect the performance of the instrument, and might jeopardize worker and workplace safety.

Whenever corresponding with your Fisher sales office about this equipment, mention the serial number of the unit. The serial number can be found on the nameplate (key 22, figure 19). When ordering replacement parts, also state the complete 11-character part number of each part required as found in the following parts list.

## Parts Kits

Key	Description	Part Number
	<b>Controller Repair Kits</b>	
	Kit contains keys 5, 9, 10, 21, 24, 45, 46, 53, 55, 56, 57, 58, 59, 60, 61, 63, 64, and 65	
	Standard Temperature	R4150X00L12
	High Temperature	R4150X00H22
	<b>Relay Repair Kits</b>	
	Kit contains keys 7, 85, 86, 87, 88, 90, 91, 92, 93, 94, 99, and 100 (Keys 99 and 100 are included in high temperature relay kits only)	
	Standard Temperature	RRELAYX0L12
	High Temperature	RRELAYX0H12
	<b>Relay Replacement Kits</b>	
	Kit contains key 7 and 43 and the replacement relay	
	Standard Temperature	RRELAYX0L22
	High Temperature	RRELAYX0H22



**NOTE:**  
KEYS 10, 81, 105 AND 108  
ARE NOT SHOWN  
B2651-1 / IL

Figure 19. Typical Direct-Acting 4150K Series Assembly

**Parts List**

Key	Description	Part Number
<b>Assemblies (Figures 19, 20, and 23)</b>		
	Case and Cover Assembly, includes keys 1, 2, and 16	
	Std	47B9501X012
	0.14 bar (2 psig) pressure tested case and cover	47B9501X022
	For converting controllers w/remote set point to new case and cover assembly	
	Type 4151K, 4153K, and 4159K	17B9974X012
	Case and Cover Assembly with anti-reset windup assembly, Use for converting existing Type 4160KF and 4162KF controllers to new anti-reset windup assembly includes keys 1, 2, 16, 127, 129, 186, and 367 thru 369	
	-40 to 71° C (-40 to 160° F)	27B9511X012
	-40 to 104° C (0 to 220° F)	27B9511X022
	Proportional Band Valve or Span Adjustment Assembly	
	Std and High Temperature, aluminum	10A9122X032
	Stainless steel construction	10A9122X082
	Reset Restriction Valve Assembly	
	Standard Temperature	
	For all except Type 4160KF and 62KF	19A4361X012
	Reset Restriction Valve Assembly	
	Standard Temperature	
	For Type 4160KF and 62KF	19A4363X012

Key	Description	Part Number
	Relay Assembly	
	(Refer to relay section of list for individual parts)	
	Standard Temperature	22B0463X012
	High Temp, Type 4150K, 50KS, 52K, 52KS, 57K, 60K, 62K, and 64K	22B0462X012
	w/sst instrument construction	
	Standard Temp	22B0463X032
	High Temp, Type 4150K, 50KS, 57K, 60K	22B0462X022

**Common Parts (Figures 19 through 22)**

1	Case Ass'y, aluminum For all 4150K and 4160K Series, std or 0.14 bar (2 psi) pressure tested case and cover	47B9513X012
2	Cover, Ass'y aluminum Std For 0.14 bar (2 psi) pressure tested case and cover	47B9512X012 47B9512X022
7*	Relay Gasket, for all series Std Temp, neoprene High Temp, silicone	1C897403012 1N873804142
8	Control Pressure Block For gauge pressure instruments, sst w/o process pressure gauge w/process pressure gauge For differential pressure instruments, sst	16A0979X012 1J251035072 1H673035072

\*Recommended spare parts

# 4150K and 4160K Controllers and Transmitters

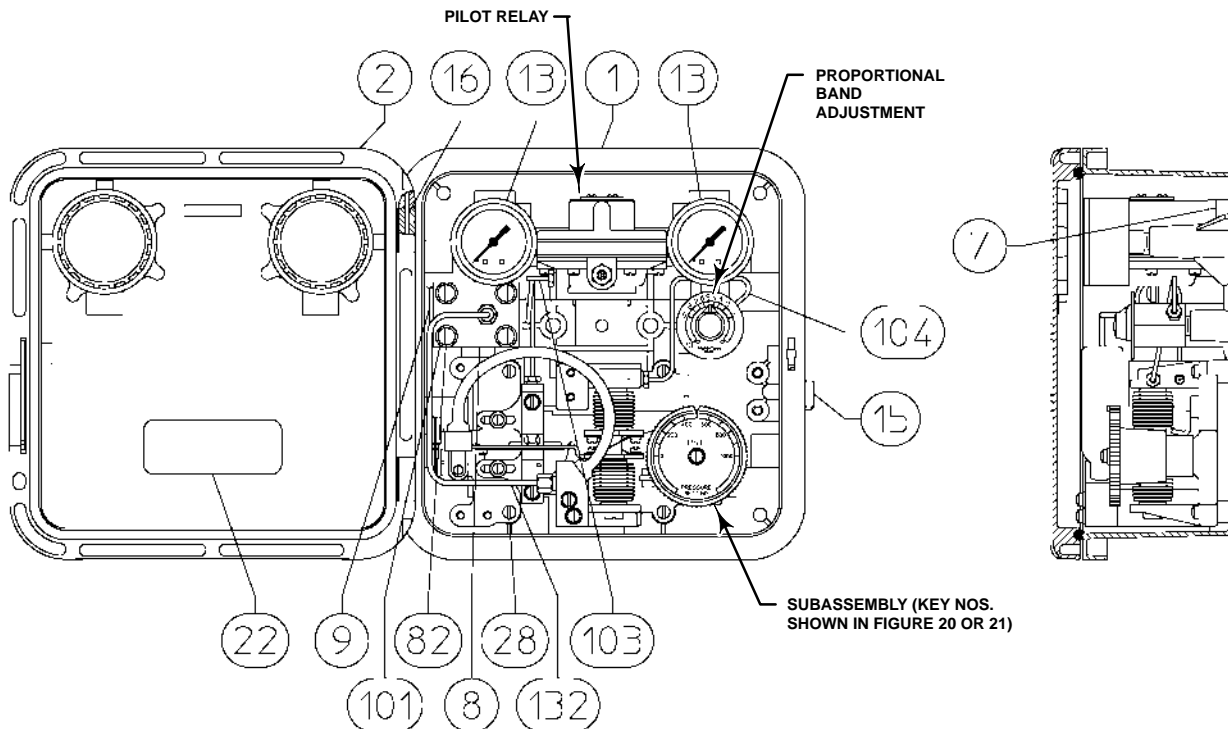
Key	Description	Part Number	Key	Description	Part Number
9*	O-Ring, nitrile, for all series	1C376206992	38	Dial, aluminum	
10*	Gasket, neoprene, for all series (not shown)	1C328603012		For Bourdon tube controllers (continued)	
11*	Sealing Washer (not shown) Use w/0.14 bar (2 psi) pressure-tested case and cover (2 req'd)	1J186999012		0-10,000 psig	16A7662X122
				0-200 kPa	16A7662X142
				0-400 kPa	16A7662X152
				0-700 kPa	16A7662X162
				0-1400 kPa	16A7662X172
				0-2000 kPa	16A7662X182
				0-4000 kPa	16A7662X192
				0-7000 kPa	16A7662X202
				0-10,000 kPa	16A7662X212
				0-20,000 kPa	16A7662X222
				0-35,000 kPa	16A7662X232
				0-55,000 kPa	16A7662X242
				0-70,000 kPa	16A7662X252
				0-100%	16A7662X272
				0-2 bar	16A7662X482
				0-4 bar	16A7662X442
				0-7 bar	16A7662X472
				0-14 bar	16A7662X462
				0-20 bar	16A7662X492
				0-40 bar	16A7662X452
				0-70 bar	16A7662X502
				0-100 bar	16A7662X512
				0-200 bar	16A7662X522
				0-350 bar	16A7662X532
				0-550 bar	16A7662X542
				0-700 bar	16A7662X552
				For bellows sensing element controllers	
				Gauge pressure	
				0-60 inches wc	16A7662X282
				0-140 inches wc	16A7662X292
				0-5 psig	16A7662X302
				0-10 psig	16A7662X312
				0-15 psig	16A7662X322
				0-20 psig	16A7662X332
				0-30 psig	16A7662X012
				0-200 kPa	16A7662X142
				0-10 inches Hg vacuum	16A7662X342
				0-30 inches Hg vacuum	16A7662X352
				30-0-30 inches wc compound	16A7662X362
				15 in. Hg vacuum-0-7.5 psig compound	16A7662X372
				30 in. Hg vacuum-0-15 psig compound	16A7662X382
				0-60 inches wc vacuum	16A7662X392
				Differential pressure	
				0-80 inches wc	16A7662X402
				0-10 psig	16A7662X312
				0-20 psig	16A7662X332
				0-30 psig	16A7662X012
				0-200 kPa	16A7662X142
				0-2 bar	16A7662X482
				For all Type 4155K, 57K, and 58K transmitters	16A7664X012
				0-30 psig	16A7662X012
				0-60 psig	16A7662X022
				0-100 psig	16A7662X032
				0-150 psig	16A7662X412
				0-200 psig	16A7662X042
				0-300 psig	16A7662X052
				0-600 psig	16A7662X062
				0-1000 psig	16A7662X072
				0-1500 psig	16A7662X082
				0-3000 psig	16A7662X092
				0-5000 psig	16A7662X102
				0-8000 psig	16A7662X112
				39 Washer, steel pl	1R982025072
				40 Machine Screw, steel pl	1E175828982
				41 Calibration Adjuster, steel pl	2H266244012
				42 Washer, steel (2 req'd)	1E873028992
				43 Machine Screw, steel pl (2 req'd)	1A5733X0012
				44 Beam, steel	1H266825072
				45 Flapper, Invar	1H266941132
				46 Machine Screw, steel pl	1B275128992
				47 Cross Spring, sst (2 req'd)	1H266037032
				48 Washer, steel pl (4 req'd)	1H267128982
				49 Machine Screw, steel pl (4 req'd)	1A346128982

**Note**

Key 13 is used as both a supply gauge and an output gauge on units without a process pressure gauge. A quantity of 2 is required for these units. On units with a process pressure gauge (key 106), key 13 is used for the output gauge. A quantity of 1 is required for these units.

Use key 14 for supply pressure indication when a process pressure gauge is installed. Key 14 installs on the supply pressure regulator.

13*	Supply and Output Pressure Gauge, w/o process pressure gauge (1/8-inch connecting stem), ABS plastic, black enamel/polycarbonate/nitrile (2 req'd)	
	Dual scale	
	0-2.0 kg/cm <sup>2</sup> and -30 psig	11B8577X042
	0-4.0 kg/cm <sup>2</sup> and -60 psig	11B8577X052
	Triple scale	
	0-2.0 bar, 0-0.2 MPa, and 0-30 psig	11B8577X012
	0-4.0 bar, 0-0.4 MPa, and 0-60 psig	11B8577X022
13*	Output Pressure Gauge, w/process pressure gauge (1/8-inch connecting stem) (1 req'd)	
	Triple scale	
	0-2.0 bar, 0-0.2 MPa, and 0-30 psig	11B8577X012
	0-4.0 bar, 0-0.4 MPa, and 0-60 psig	11B8577X022
14*	Supply Pressure Gauge, w/process pressure gauge (1/4-inch connecting stem), ABS plastic, black enamel/polycarbonate/nitrile	
	Triple scale	
	0-2.0 bar, 0-0.2 MPa, and 0-30 psig	11B8579X022
	0-4.0 bar, 0-0.4 MPa, and 0-60 psig	11B8579X032
15	Vent Ass'y	27A5516X012
16	Roll Pin, sst (2 req'd)	1H288828992
22	Plate, Instruction, aluminum	12B6338X0A2
28	Machine Screw, steel pl (4 req'd)	1E985428982
30	Mounting Base, aluminum	26A7668X012
31	Flexure Strip, sst	1C897836012
32	Flexure Strip Washer, steel pl (2 req'd)	16A7671X012
33	Machine Screw, steel pl (4 req'd)	14B4995X012
34	Pressure Set Arm, steel pl	36A7669X012
35	Rotary Spring, sst	1J423437022
36	Knob, Ryton	36A7670X012
37	Knob Spring, steel pl	1C221527022
38	Dial, aluminum	



NOTE:  
KEYS: 10, 81, 105 NOT SHOWN  
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PROPORTIONAL-ONLY CONTROLLER

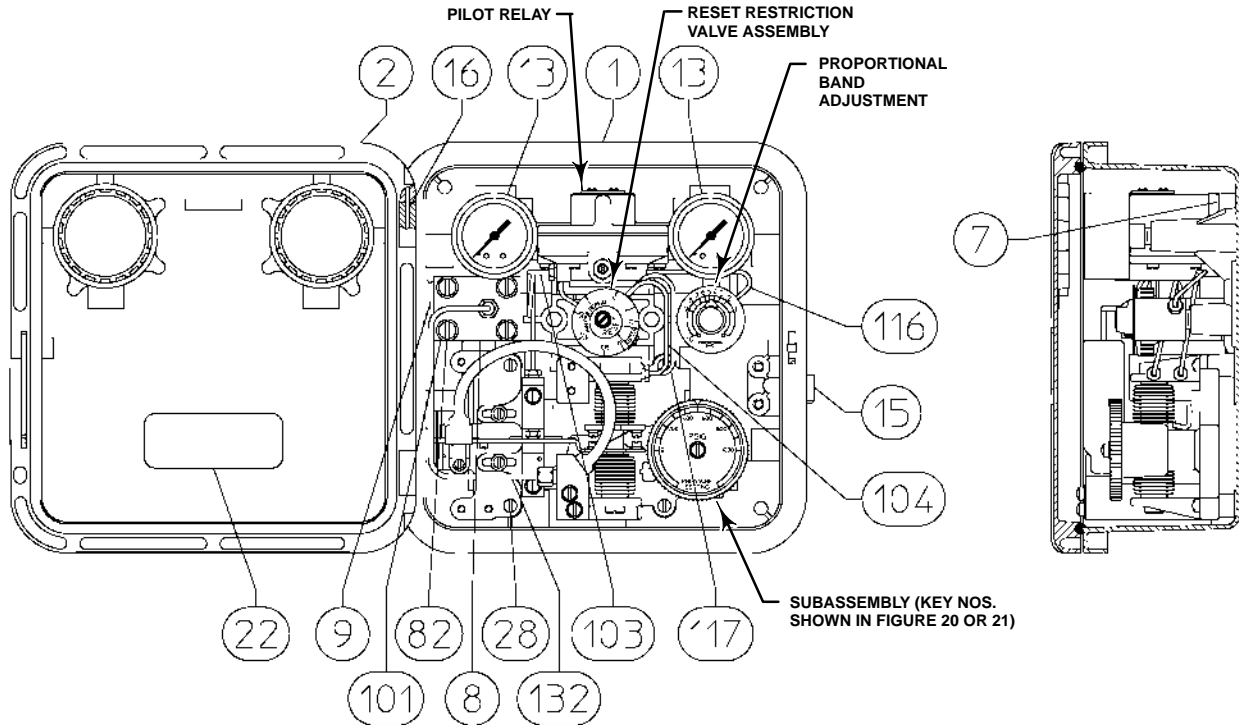
Figure 19. Typical Direct-Acting 4150K Series Assembly (Continued)

Key	Description	Part Number	Key	Description	Part Number
50	Spacer, zinc	1H265944012	55*	O-Ring, Std Temp, nitrile (5 req'd)	1D687506992
51	Bellows Stud, brass (not shown)	1H265814012		High Temp, fluoroelastomer (5 req'd)	1N430406382
52*	Feedback Bellows Ass'y Brass		56	Sealing Screw, sst	14A5721X012
	0.2-1.0 bar (3-15 psig) (2 req'd)	14A5726X012	57*	Nozzle, sst	1U639135132
	0.4-2.0 bar (6-30 psig) (2 req'd)	14A5726X032	58*	Nozzle O-Ring, Std Temp, nitrile	1E222606992
	Stainless steel			High Temp, fluoroelastomer	1N838706382
	0.2-1.0 bar (3-15 psig) (2 req'd)	14A5726X022	59	Reversing Block, steel pl	26A0975X012
	0.4-2.0 bar (6-30 psig) (2 req'd)	14A5726X042	60	Sleeve, Delrin	16A0976X012
53*	Gasket		61	Reversing Block Screw, sst	24A5720X012
	Std Temp, neoprene (2 req'd)	1D397003012	62*	Bourdon Tube	See following table
	High Temp, silicone (2 req'd)	1N873604142	63	Machine Screw, steel pl	
54	Bellows Screw (2 req'd)			Bourdon tube instruments only (2 req'd)	1A331928982
	Brass	22B8036X012	64*	Connecting Link, Bourdon tube instruments only	
	Stainless steel	22B8036X022		Std., Monel	1L379641012
				Bourdon tube w/optional travel stop, Stainless steel	1L611235022
			65*	Link bushing, sst	
				Bourdon tube instruments only (2 req'd)	1L379546202
			66	Travel Stop Assembly, steel	
				optional w/Bourdon tube	1H7793000A2
			67	Lockwasher, steel pl (2 req'd)	
				Use w/optional Bourdon tube travel stop	1H267228982
			68	Machine Screw, steel pl (2 req'd)	
				Use w/optional Bourdon tube travel stop	1H267628982
			69	Cap Screw, steel pl	
				Use w/optional Bourdon tube travel stop	1H779232982

Note

A total of 5 O-rings (key 55) are used. 1 O-ring is used under the sealing screw (key 56), 1 O-ring is used under the reversing blockscrew (key 61), 1 O-ring is used between the reversing block ass'y (key 59) and the calibration adjuster (key 41), and 1 O-ring is used in the recessed area under the head of each of the bellows screws (key 54).

# 4150K and 4160K Controllers and Transmitters



NOTE:  
KEYS: 10, 81, 105, 115 NOT SHOWN

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B2653-17/IL

## PROPORTIONAL-PLUS-RESET CONTROLLER WITHOUT ANTI-RESET WINDUP

Figure 20. Typical Direct-Acting 4160K Series Assembly

Key	Description	Part Number	Key	Description	Part Number
70	Bellows Yoke, zinc Use w/gauge and differential pressure bellows 2H453844012		71*	Differential-Pressure Bellows (input) Brass	
71*	Gauge Pressure Bellows (input) <sup>(2)</sup> Brass			0-200 mbar (0-80 inches wc)	2L3790000A2
	0-150 mbar (0-60 inches wc) positive, 0-150 mbar (6-60 inches wc) vacuum, and 75-0-75 mbar (30-0-30 inches wc) compound	1L3780000A2		0-0.7 bar (0-10 psi)	2L3791000A2
	0-250 mbar (0-100 inches wc) positive, Type 4158K only	1L3788000A2		0-1.4 bar (0-20 psi)	2L3792000A2
	0-0.35 mbar (0-5 psig) positive and for 0-350 mbar (0-10 inches Hg) vacuum	1L3781000A2		Stainless steel, 0-2.0 bar (0-30 psi)	2L3793000A2
	0-0.5 bar (0-7.5 psig) positive, 4158K only	1L3789000A2	71K	Machine Screw, steel pl <sup>(3)</sup> bellows sensing instruments only (2 req'd)	1A331928982
	0-0.7 bar (0-10 psig) positive	1L3782000A2	71L*	Bearing <sup>(3)</sup> bellows sensing instruments only (2 req'd)	1L379546202
	0-1.0 bar (0-15 psig) positive, 0-1.0 bar (0-30 inches Hg) vacuum, and 500-0-500 mbar (15-0-7.5 psig) compound	1L3783000A2	71M*	Link <sup>(3)</sup> bellows sensing instruments only	1L379641012
	0-1.4 bar (0-20 psig) positive	1L3784000A2	72	Jam Nut, steel pl Gauge pressure bellows instruments only	1A946324122
	0-2.0 bar (0-30 psig) positive and 1.0-0-1.0 bar (30-0-15 psig) compound	1L3785000A2	73	Washer, steel pl Gauge pressure bellows instruments only	1B865928982
	Stainless steel, 0-1.0 bar (0-15 psig) positive, 0-1.0 bar (0-30 inches Hg) vacuum, and 500-0-500 mbar (15-0-7.5 psig) compound	1L3786000A2	74	Spring Seat, pl brass Gauge pressure bellows instruments only	1H453214022
	0-2.0 bar (0-30 psig) positive, 1.0-0-1.0 bar (30-0-15 psig) compound	1L3787000A2	75	Machine Screw, steel pl Gauge and differential pressure bellows instruments (4 req'd)	1H267628982
			76	Washer, steel pl for Bourdon tube instruments (2 req'd) for bellows sensing instruments (4 req'd)	1H267228982 1H267228982
			77	Machine Screw, steel pl Bourdon tube instruments only (2 req'd)	1H267728982
			79	Screw, nylon Transmitters only	1A3461X0042

\*Recommended spare parts

2. If ordering the bellows (key 71) to change the range of a gauge pressure controller, also order the appropriate bellows spring (key 80). Also order keys 72, 73, and 74, if you do not have them.

3. This part is part of the bellows assembly, key 71

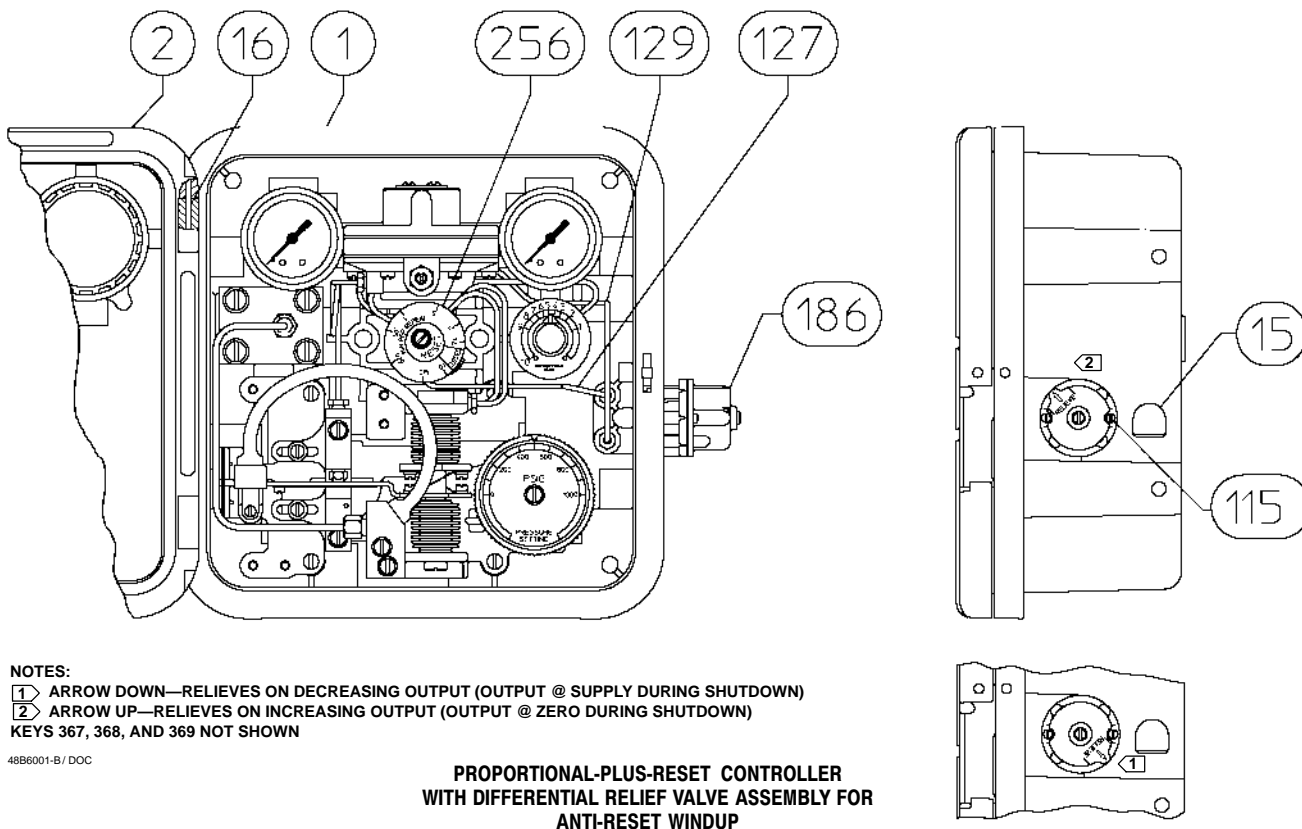


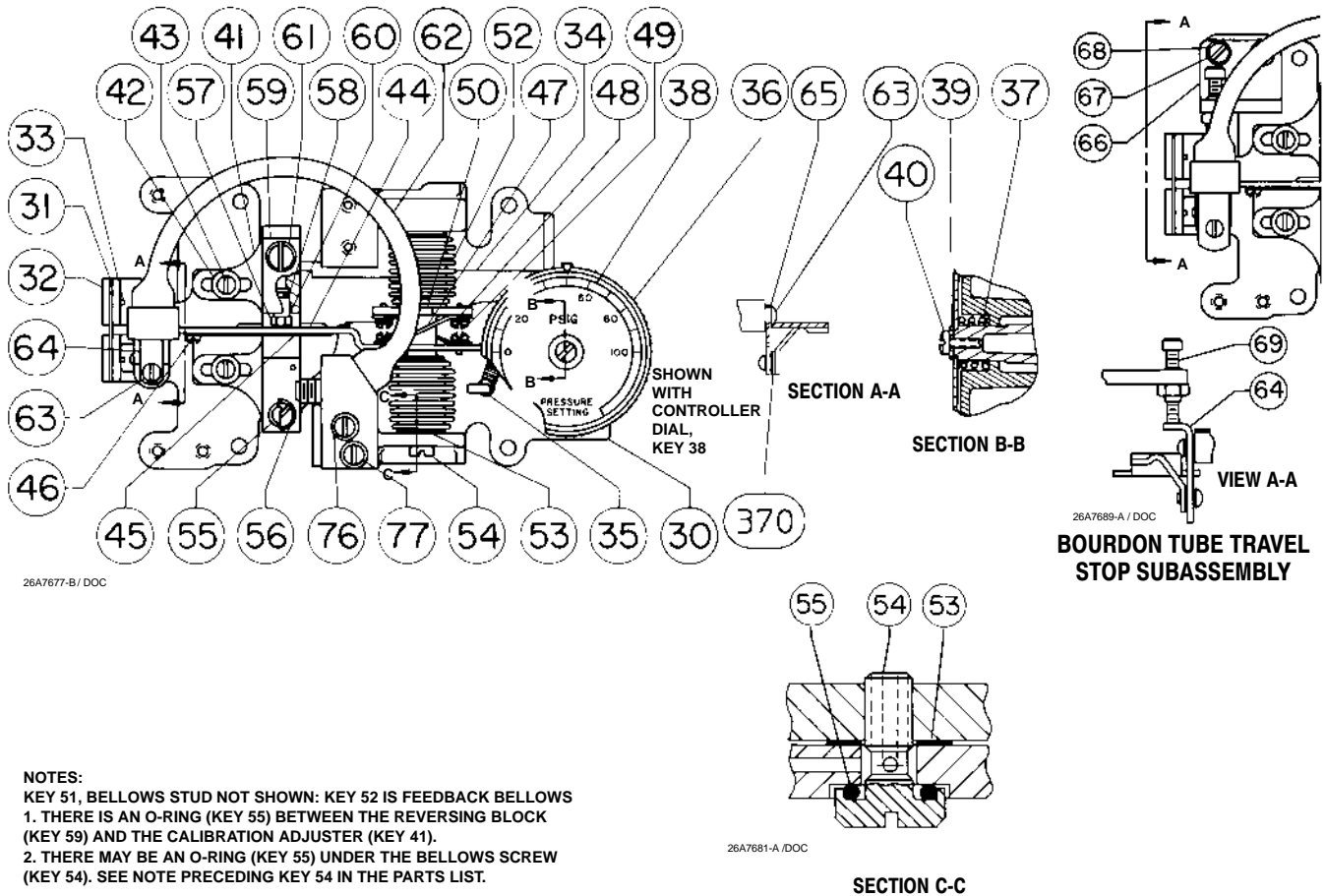
Figure 20. Typical Direct-Acting 4160K Series Assembly (Continued)

Key	Description	Part Number	Key	Description	Part Number
80	Spring, gauge pressure bellows instruments only Steel pl 0-150 mbar (0-60 inches wc) positive, 0-150 mbar (0-60 inches wc) vacuum, 75-0-75 mbar, and (30-0-30 inches wc) compound 0-250 mbar (0-100 inches wc) positive, 0-0.35 bar (0-5 psig) positive, and 0-350 mbar (0-10 inches Hg) vacuum 0-0.5 bar (0-7.5 psig) positive 0-0.7 bar (0-10 psig) positive 0-1.0 bar (0-15 psig) positive, 0-1.0 bar (0-30 inches Hg) vacuum, 500-0-500 mbar (15-0-7.5 psig) compound 0-1.4 bar (0-20 psig) positive 0-2.0 bar (0-30 psig) positive, 1.0-0-1.0 bar (30-0-15 psig) compound 316 SST 0-1.0 bar (0-15 psig) positive, 0-1.0 bar (0-30 inches Hg) vacuum, 500-0-500 mbar (15-0-7.5 psig) compound 0-2.0 bar (0-30 psig) positive, 1.0-0-1.0 bar (30-0-15 psig) compound	1J729227022 1H448227022 1K525727022 1K493427022 1H448327022 1K525927022 1H448427022 1H641137012 1H641237012	104	Compensator Tubing Assembly, sst Types 4150K, 50KS, 52K, 52KS, 54K, 55K, 57K, and 58K Types 4160K, 60KF, 62K, 62KF and 64K	1H6864000A2 1H6870000A2
81	Machine Screw, steel pl (not shown) (2 req'd)	1H527128982	105	Plug, S31600 (316 SST), (not shown) used with gauge pressure only	1A767535072
82	Machine Screw, steel pl (4 req'd)	1C333328982	<b>Note</b>		
101	Lockwasher, steel pl (4 req'd)	1C225628982	<b>Controllers with bellows sensing element use only the 2.0 bar, 0 to 0.2 MPa, and 0 to 30 psig triple scale brass and stainless steel process pressure gauges. Differential pressure controllers do not use a process pressure gauge.</b>		
103	Relay Tubing Assembly, sst	1H6861000A2	106*	Process Pressure Gauge (use only when specified) Triple scale ABS plastic/Brass 0-2.0 bar, 0-0.2 MPa, and 0-30 psig 0-4.0 bar, 0-0.4 MPa, and 0-60 psig 0-11 bar, 0-1.1 MPa, and 0-160 psig 0-20 bar, 0-2.0 MPa, and 0-300 psig 0-40 bar, 0-4.0 MPa, and 0-600 psig 0-69 bar, 0-6.9 MPa, and 0-1000 psig ABS plastic/Stainless steel 0-2.0 bar, 0-0.2 MPa, and 0-30 psig 0-20 bar, 0-2.0 MPa, and 0-300 psig 0-69 bar, 0-6.9 MPa, and 0-1000 psig	11B8578X012 11B8578X022 11B8578X032 11B8578X042 11B8578X052 11B8578X062 11B8584X022 11B8584X012 11B8584X032

\*Recommended spare parts



# 4150K and 4160K Controllers and Transmitters



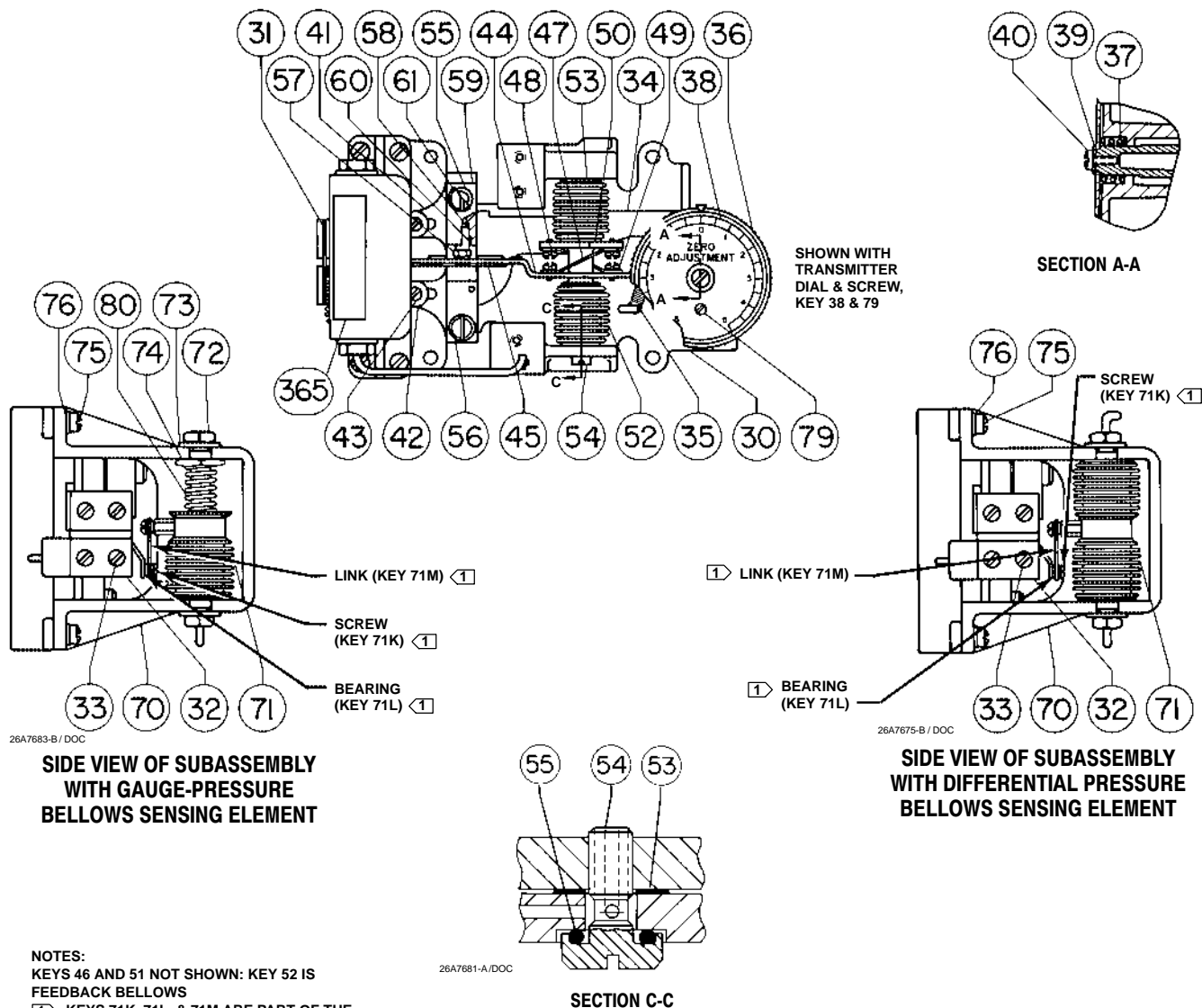
**NOTES:**  
KEY 51, BELLOWS STUD NOT SHOWN: KEY 52 IS FEEDBACK BELLOWS  
1. THERE IS AN O-RING (KEY 55) BETWEEN THE REVERSING BLOCK (KEY 59) AND THE CALIBRATION ADJUSTER (KEY 41).  
2. THERE MAY BE AN O-RING (KEY 55) UNDER THE BELLOWS SCREW (KEY 54). SEE NOTE PRECEDING KEY 54 IN THE PARTS LIST.

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SECTION C-C

Figure 21. Controller Subassembly with Bourdon Tube Sensing Element

Key	Description	Part Number	Key	Description	Part Number
107	Pressure Connection, sst Use w/process gauge	1J251235162	132	Control Tubing Assembly (continued) w/process pressure gauge	1J2553000A2
108	Pipe Plug, steel pl (not shown) Use w/process gauge, not used w/Bourdon tube protector	1E823128982		For differential-pressure bellows instruments, sst	1H4526000A2
115	Mounting Screw for reset restriction valve Type 4160K, 60KF, 62K, 62KF, and 64K 1/4-20 UNC, steel pl (not shown)	1H527028982	133	Control Tubing Assembly, sst For differential-pressure instruments only	1H6732000A2
116	Reset Tubing Ass'y, sst Type 4160K, 60KF, 62K, 62KF, and 64K	1H6866000A2	167	Label, Use w/2 psi (0.14 bar) pressure-tested case and cover	12A9842X012
117	Compensator Tubing Ass'y, sst	1H6868000A2	186	Anti-Reset Windup Ass'y For Type 4160KF and 4162KF	21A6447X0A2
127	Tubing Assembly, sst Type 4160KF and 4162KF only	27B9975X012	365	Label, bellows sensing instruments only Gauge pressure instruments	
129	Tubing Assembly, sst Type 4160KF and 4162KF only	27B9976X012		0-60 inches wc	11B5655X062
132	Control Tubing Assembly For Bourdon tube instruments w/o process pressure gauge			0-100 inches wc	11B5655X272
	Stainless steel	1H3011000A2		0-140 inches wc	11B5655X082
	K-Monel (not used on Type 4151K)	1H3011X0022		0-5 psig	11B5655X012
	w/process pressure gauge, sst	1J2530000A2		0-7.5 psig	11B5655X262
	For gauge-pressure bellows instruments, sst			0-10 psig	11B5655X022
	w/o process pressure gauge	1H4526000A2		0-15 psig	11B5655X032
				0-20 psig	11B5655X042
				0-30 psig	11B5655X052
				Differential pressure instruments	
				0-80 inches wc	11B5655X222

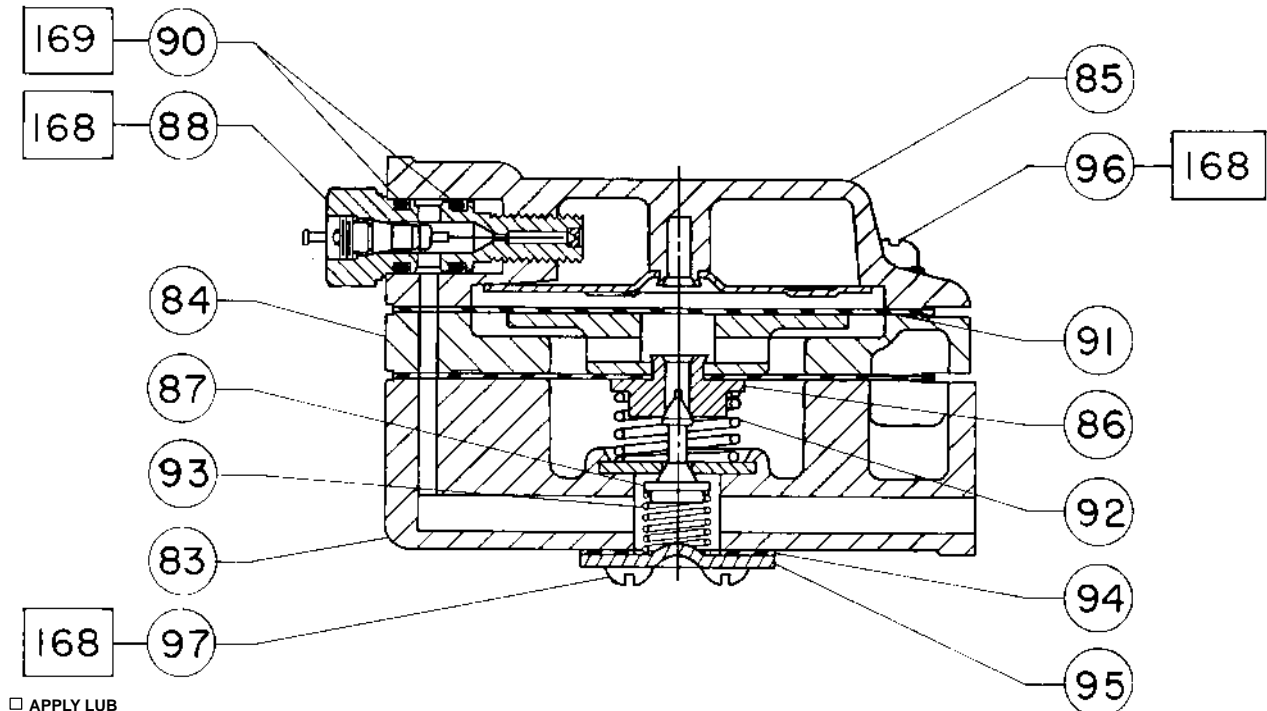


NOTES:  
KEYS 46 AND 51 NOT SHOWN: KEY 52 IS  
FEEDBACK BELLOWS  
KEYS 71K, 71L, & 71M ARE PART OF THE  
BELLOWS ASSEMBLY (KEY 71)

Figure 22. Controller Subassembly with Either Gauge-Pressure Bellows or Differential-Pressure Bellows Sensing Element

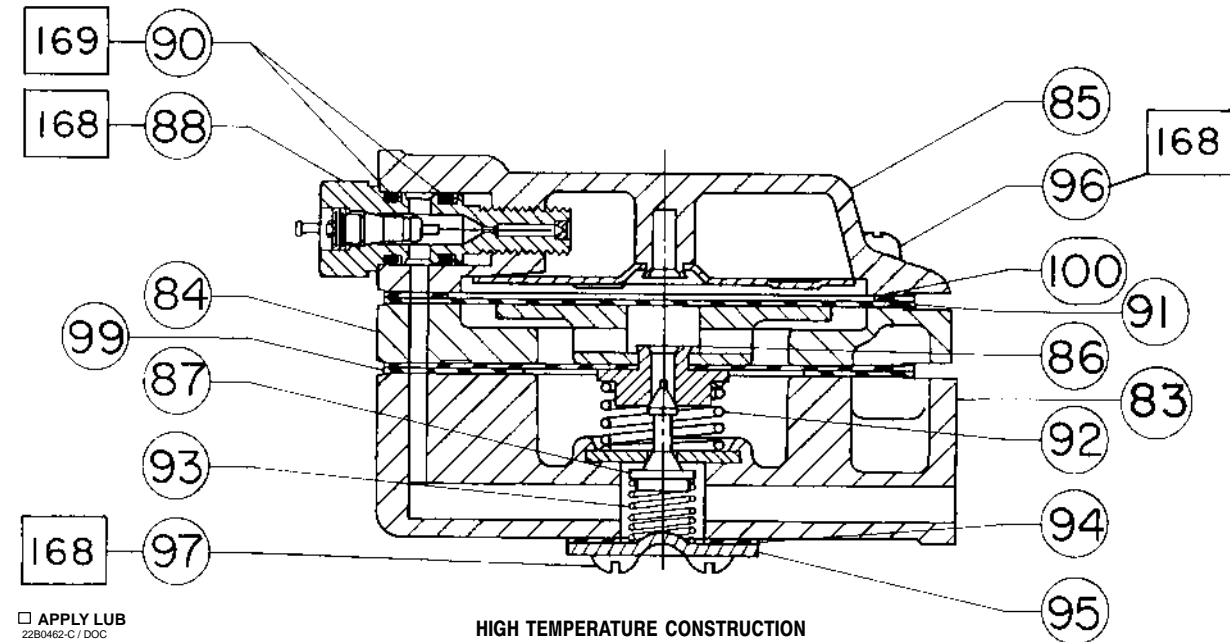
Key	Description	Part Number	Key	Description	Part Number
365	Label, bellows sensing instruments only Differential pressure instruments (continued) 0-60 inches wc 0-10 psi 0-20 psi 0-30 psi	11B5655X062 11B5655X232 11B5655X242 11B5655X252	<b>Relay Assembly (figure 23)</b>		
366	Pipe Plug, Use w/0.14 bar (2 psi) pressure-tested case and cover (2 req'd)	1P2796X0012	83	Relay Body, Aluminum/brass Use w/sst construction	48A3776X012 48A3776X032
367*	O-Ring (not shown) Type 4160KF and 4162KF only (2 req'd)	1C853806992	84	Spacer Ring, zinc	38A3778X012
368	Machine Screw (not shown) Type 4160KF and 4162KF only (2 req'd)	1U8842X0012	85	Diaphragm Casing Ass'y zinc/steel	12B0460X012
369	Anti-Reset Windup Cover (not shown) Type 4160KF and 4162KF only (2 req'd)	2V597308012	86*	Diaphragm Ass'y Std Zinc/brass/rubber High Temp Zinc/brass/rubber Std or High Temp w/sst construction Zinc/sst/rubber	18A2451X012 18A2451X092 18A2451X042
370	Plain Washer, brass	1H339718992	87*	Valve Plug Brass (For std or high temp) For use w/sst construction	0Y061714012 0Y0617X0022
			88*	Reset Plug and Wire Assembly	12B0468X012

\*Recommended spare parts



□ APPLY LUB  
22B0463-C / DOC

STANDARD CONSTRUCTION



□ APPLY LUB  
22B0462-C / DOC

HIGH TEMPERATURE CONSTRUCTION

Figure 23. Relay Assemblies

Key	Description	Part Number	Key	Description	Part Number
90*	O-Ring Std Temp, nitrile (2 req'd) High Temp, fluoroelastomer	1D687506992 1N430406382	92	Relay Spring, steel pl	1C896127012
91*	Top Diaphragm Std Temp, nitrile High Temp, poly-dacr	1L555602042 1K6999X0012	93	Valve Spring, SST	0X083637022
			94*	Plate Gasket Std Temp, neoprene High Temp, silicone	1H269603012 1K700004142
			95	Spring Plate, steel pl	1H269725072

Key	Description	Part Number	Key	Description	Part Number
96	Machine Screw, steel pl (6 req'd)	12B6351X012	228	Spacer Spool, steel (specify quantity req'd)	
97	Machine Screw, steel pl (4 req'd)	1A8664X00A2		Types 470, 472, 480, 513, 656, 657, 667, pipe stand 1051, 1052 and 1061	1F906724092
99*	Bottom Gasket, silicone			Type 115	
	High Temp construction only	1K700104142		W/o regulator or w/one regulator	1K153424092
100*	Top Gasket, silicone			W/two regulators	1K414424092
	High Temp construction only	1K700204142		Type 115C	1K654724092
168	Lubricant, Lubriplate, not furnished with controller		229	Cap Screw, steel pl (not shown) (specify quantity req'd)	
169	Lubricant, DOW Corning 111, not furnished with controller			Type 115	
				W/o regulator or w/one regulator	1F960324052
				W/two regulators	1C870224052
				Type 115C	1D770424052
				Types 126 and 127	1B227524052
				Types 1051 and 1052 casing-mounted controller	1A582824052
			230	Cap Screw, steel pl (not shown)	
				Types 126 and 127	1C595824052
			231	Pipe Nipple, steel (not shown) (specify quantity req'd)	
				For casing mounting on Types 126 and 127 W/Types 67FR, 67R, 254, 254F and 1301	11A3740X012
			232	Pipe Tee, steel (not shown)	
				For casing mounting on Types 126 and 127 W/Types 67R, 254 and 1301	1B8606X0012
			238	Mounting Plate, steel	
				For yoke-mounted filter regulator Types 1051, 1052 and 1062 sizes 40 and 60 Types 1061 size 30	1C221825022 23A8891X012
			240	Cap Screw, steel	
				For yoke-mounted filter regulator on Types 1051 and 1052 sizes 40 and 60 (2 req'd)	1A553424052
			241	Spacer Spool, steel	
				For yoke mounted filter regulators on Types 1051 and 1052 sizes 40 and 60 (2 req'd)	1C559024092
			242	Spacer Spool, steel (not shown)	
				For yoke mounting on Types 1051 and 1052 size 40 (2 req'd) Type 1061 sizes 30, 80 and 100 (2 req'd)	1V102624092 1J830724092
			243	Street Elbow, pl galvanized malleable iron (not shown)	
				For mounting on Types 470, 472, 480, 513, 656, 657, 667, panel, pipe stand, 1051, 1052 and 1061 w/nipple-mounted filter regulator	1A913221992
			244	Pipe Nipple, pl galvanized steel (not shown)	
				For mounting on Types 470, 472, 480, 513, 656, 657, panel, pipe stand, 1051, 1052 and 1061 w/nipple-mounted filter regulator	1D239726232
			250	Clamp, Steel	
				For pipe stand mounting (2 req'd)	1P427028982
			251	Bracket Assembly, steel	
				For panel or wall mounting (2 req'd)	1H2892000A2
			252	Cap Screw, steel pl	
				For panel or wall mounting (4 req'd)	1B848024052

**Note**

**Specify quantity of fittings.**

Connector, Brass	1/8 inch NPT X 1/4 inch od tubing	1A395914012
	1/4 inch NPT X 1/4 inch od tubing	1A636814012
	1/4 inch NPT X 3/8 inch od tubing	1B885618992
Elbow, Brass	1/8 inch NPT X 1/4 inch od tubing	1A685018992
	1/4 inch NPT X 1/4 inch od tubing	1A397118992
	1/4 inch NPT X 3/8 inch od tubing	1B884618992

**Mounting Parts for Panel, Wall,  
Pipestand, or Actuator Mounting  
(Figures 3 and 4)**

213	Mounting Plate, steel	
	For yoke mounting on Types 470, 472, 513, 656, 657 and 667	1C221825022
	For yoke mounting on Type 480	
	Vertical	3L276725092
	Horizontal	3J854725012
	For yoke mounting on Types 1051 and 1052 Size 40, positions 1 and 3 w/switch and Size 60, position 1 w/switch	23A8891X012
	All others	1C221825022
	For yoke mounting on Type 1061 Size 30, positions 1 and 3 w/switch and position 1 w/o switch, Size 40, position 1 w/switch and Sizes 80 and 100, position 3 w/o switch	23A8891X012
	All others	1C221825022
	For pipe stand mounting	3N975725092
	For mounting on Type 115	3J779825012
	For mounting on Type 115C	2K654825022
215	Machine Screw, steel pl (specify quantity req'd)	
	5/16 UNC X 1 inch	1C639128982
	5/16 UNC X 1-1/2 inches	1H304728982
	5/16 UNC X 2 inches	1B762424052
216	Hex Nut, steel pl (specify quantity req'd)	
	For casing mounting on Types 126 and 127 and for filter regulator mounting on Types 1051, 1052 and 1061	1A352724122
	All other types and mountings	1C332828982
220	Mounting Bracket, steel pl (not shown)	
	For casing mounting on Types 126, 127, 657, 667, 1051 and 1052 and for casing-mounted filter regulator on Types 1051 and 1052	1F401225072
221	Lockwasher, steel pl (specify quantity req'd)	1C225728982
222	Cap Screw, steel pl (specify quantity req'd)	
	5/16 UNC X 3/4 inch	1A381624052
	5/16 UNC X 1 inch	1A352624052
	5/16 UNC X 1-1/8 inches	1C379124052
	5/16 UNC X 1-1/4 inches	1B787724052
	5/16 UNC X 1-3/4 inches	1A553424052
	5/16 UNC X 2-1/2 inches	1C870224052
	5/16 UNC X 3-5/8 inches	1C398824052
	3/8 UNF X 1-1/8 inches	1A582824052
223	Cap Screw, steel pl	
	Types 1051 and 1052 with either case or yoke mounted regulator and Type 1061 with yoke mounted regulator (2 req'd)	T14109T0012

# 4150K and 4160K Controllers and Transmitters

Key 62\* Bourdon Tube

PRESSURE RANGE		MATERIAL	
kPa	Psig	Stainless Steel	K-Monel <sup>(NO TAG)</sup>
0-200	0-30	32B1243X012	---
0-400	0-60	32B1243X022	---
0-700	0-100	32B1243X032	---
0-1400	0-200	32B1243X042	---
0-2000	0-300	32B1244X052	---
0-4000	0-600	32B1244X062	32B1244X202
0-7000	0-1000	32B1244X072	32B1244X212
0-10,000	0-1500	32B1245X082	32B1245X222
0-20,000	0-3000	32B1245X092	---
0-35,000	0-5000	32B1245X102	---
0-55,000	0-8000	32B1245X112	---
0-70,000	0-10,000	32B1245X122	---

1. For NACE applications.

A subassembly with Bourdon tube sensing element as shown in figure 21 contains the following key numbers: 30 through 37, 39 through 61, 63, 65, 76, and 77. When ordering the subassembly as

indicated by the table below, one of each of the following key numbered parts must also be ordered to complete the subassembly: dial, key 38; Bourdon tube, key 62; and connecting link, key 64.

Subassemblies with Bourdon Tube Sensing Element

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Bar	Psig			
0.2 to 1/0 or 0 and 1.4 differential gap	3 to 15 or 0 and 20 differential gap	Brass	26A7677X012	26A7677X022
		Stainless steel	26A7677X052	26A7677X062
0.4 to 2.0 or 0 and 2.4 differential gap	6 to 30 or 0 and 35 differential gap	Brass	26A7677X032	26A7677X042
		Stainless steel	26A7677X072	26A7677X082

A subassembly with gauge pressure bellows sensing element as shown in figure 22 contains the following key numbers: 30 through 37, 39 through 61, 71K, and 71L. The machine screws, key 77, quantity of 2, and washers, key 76, quantity of 2, also come with the subassembly. The two washers, key 76, may be used with the machine screws, key 75, but four washers and machine screws are required so two more washers must be ordered. The machine screws, key 77, are not used on subassemblies with bellows input so they may be discarded. Although two machine screws, key 71K, and two bearings, key 71L, are included with the subassembly, they

are also included with the bellows assembly, key 71. When ordering the subassembly as indicated by the table below, one of each of the following key numbered parts, unless other quantities are indicated, must also be ordered to complete the subassembly: dial, key 38; bellows yoke, key 70; bellows assembly, key 71; jam nut, key 72; washer, key 73; spring seat, key 74; machine screw, key 75, quantity of 4; washer, key 76, quantity of 2; and spring, key 80. The link, key 71M, is included with the bellows assembly, key 71. If ordering parts for a transmitter, a screw, key 79, must also be ordered.

**Subassemblies with Gauge-Pressure Sensing Element**

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Bar	Psig			
0.2 to 1/0 or 0 and 1.4 differential gap	3 to 15 or 0 and 20 differential gap	Brass	26A7677X012	26A7677X022
		Stainless steel	26A7677X052	26A7677X062
0.4 to 2.0 or 0 and 2.4 differential gap	6 to 30 or 0 and 35 differential gap	Brass	26A7677X032	26A7677X042
		Stainless steel	26A7677X072	26A7677X082

A subassembly with differential pressure bellows sensing element as shown in figure 22 contains the following key numbers: 30 through 37, 39 through 61, 71K, and 71L. The machine screws, key 77, quantity of 2, and washers, key 76, quantity of 2, also come with the subassembly. The two washers, key 76, may be used with the machine screws, key 75, but four washers and machine screws are required so two more washers must be ordered. the machine screws, key 77, are not used on subassemblies with bellows input so they may be discarded. Although two machine screws, key 71K,

and two bearings, key 71L, are included with the subassembly, they are also included with the bellows assembly, key 71. When ordering the subassembly as indicated by the table below, one of each of the following key numbered parts, unless other quantities are indicated, must also be ordered to complete the subassembly: dial, key 38; bellows yoke, key 70; bellows assembly, key 71; machine screw, key 75, quantity of 4; and washer, key 76, quantity of 2. The link, key 71M, is included with the bellows assembly, key 71. If ordering parts for a transmitter, a screw, key 79, must also be ordered.

**Subassemblies with Differential-Pressure Bellows Sensing Element**

OUTPUT PRESSURE RANGE		FEEDBACK BELLOWS MATERIAL	STANDARD	HIGH TEMPERATURE
Bar	Psig			
0.2 to 1/0 or 0 and 1.4 differential gap	3 to 15 or 0 and 20 differential gap	Brass	26A7677X012	26A7677X022
		Stainless steel	26A7677X052	26A7677X062
0.4 to 2.0 or 0 and 2.4 differential gap	6 to 30 or 0 and 35 differential gap	Brass	26A7677X032	26A7677X042
		Stainless steel	26A7677X072	26A7677X082

# 4150K and 4160K Controllers and Transmitters

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**Instruction Manual**

Form 5177

February 2003

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# Series 101/121 Differential Pressure Switches

## General Instructions



### General

These instructions provide information for installation, electrical connection, process connection and calibration of Series 101/121 Differential Pressure Switches.

**NOTE:** SOR discourages field modifications and field repair. Products should be returned to SOR for inspection and necessary repair work. Contact the factory for a return authorization number. Any field work should be performed by qualified instrument technicians using factory authorized procedures.

### Principle of Operation

Process pressure is sensed by a diaphragm and piston assembly. The piston responds to differential pressure and moves a shaft that actuates (deactuates) an electrical switching element. Low side pressure and an adjustable range spring oppose high side pressure. Adjustment of the range spring determines the set point. (See Calibration.)

**CAUTION:** Use care during installation to avoid moving the electrical switching element or its housing. Movement of either could change calibration or render the device inoperative.

*Design and specifications are subject to change without notice.*

### Installation

1. Secure the housing to a bulkhead, panel rack or pipe stanchion with suitable bolts.

**IMPORTANT:** When bolting housings with integral mounting pads to irregular or uneven surfaces, install rubber washers between the housing and the mounting surface to prevent deformation of the housing.

**CAUTION:** Failure to mount the housing on a flat mounting surface may result in torsional forces on the housing that could cause false trips or render the pressure switch inoperative.

- Line mounting by either process connection or electrical conduit connection is **not** recommended for housings with integral mounting pads.
- Suggested mounting orientation is high side process pressure port at 6 o'clock. However, the device can be mounted in any position. Optional breather drains should be positioned to allow moisture to escape from the housing interior. *Breather drains must be kept clear of paint and foreign matter.*

### Process Connection

Connect the process lines to the pressure ports using two wrenches: one to hold the hex flats on the pressure port, the other to tighten the process pipe or tube fitting. The high pressure side (stamped HI) and the low pressure side (stamped LO) have 1/4" NPT(F) or 1/4" BSP(F) process connections as standard.

**IMPORTANT:** Rigid process piping must be arranged to minimize bending or twisting forces which could disturb the positioning of internal parts and change calibration or render the device inoperative after installation. Use care to avoid loosening the pressure port from the body or the body from the electrical housing.

### Electrical Connection

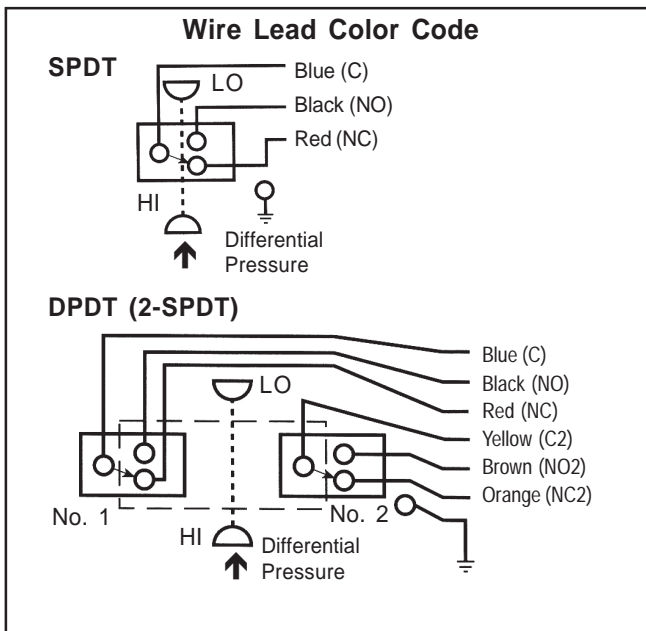
Ensure that wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.

**CAUTION:** Electrical power must be disconnected from explosion proof models before the cover is removed. Failure to do so could result in severe personal injury or substantial property damage.

When making electrical connections, use care to avoid movement of the electrical switching element.

Electrical connections are either screw terminals, terminal blocks or 18-gauge, 18-inch wire leads.

Screw terminal and terminal block points are identified on the insulation card inside the electrical housing. Refer to the wiring schematic in Figure 1 for wire lead color codes.



**FIGURE 1**

**NOTE:** Storing excess wire or making wire lead splices inside the pressure switch housing should not be done and may interfere with the pressure switch operation.

## Calibration

### Mini-Hermet models

Remove the weathertight cap. Use a 1/8" hex Allen wrench to turn the adjusting screw to the desired set point. Turn the adjusting screw clockwise (in) to increase the set point and counterclockwise (out) to decrease the set point. Use either the coarse or the precise set point calibration procedure.

### All Other Models

Use a 3/4-inch open-end wrench to turn hex adjusting nut clockwise to increase set point, and counterclockwise to decrease set point. An approximate set point can be obtained by sighting across top of adjusting nut to the calibration scale on the interior wall of the housing. If coarse or precise set point calibration is required, calibrate according to the appropriate procedure.

### Coarse Calibration Procedure

1. Connect variable pressure source to test gauge and HI side pressure port.
2. Connect test light or ohmmeter across C – Common and NO – Normally Open switching element contacts.
3. Raise pressure and note test gauge reading when circuit closes.
4. Slowly drop pressure and note test gauge reading when circuit opens.
5. Turn set point adjustment clockwise to increase set point, or counterclockwise to decrease set point.

6. Repeat Steps 3, 4 and 5 until contacts change at desired increasing or decreasing differential pressure set point.

### Precise Calibration Procedure

The precise calibration procedure references system (static) pressure. Set point accuracy is enhanced by calibrating the differential pressure switch under simulated service pressure conditions. The following test apparatus is recommended.

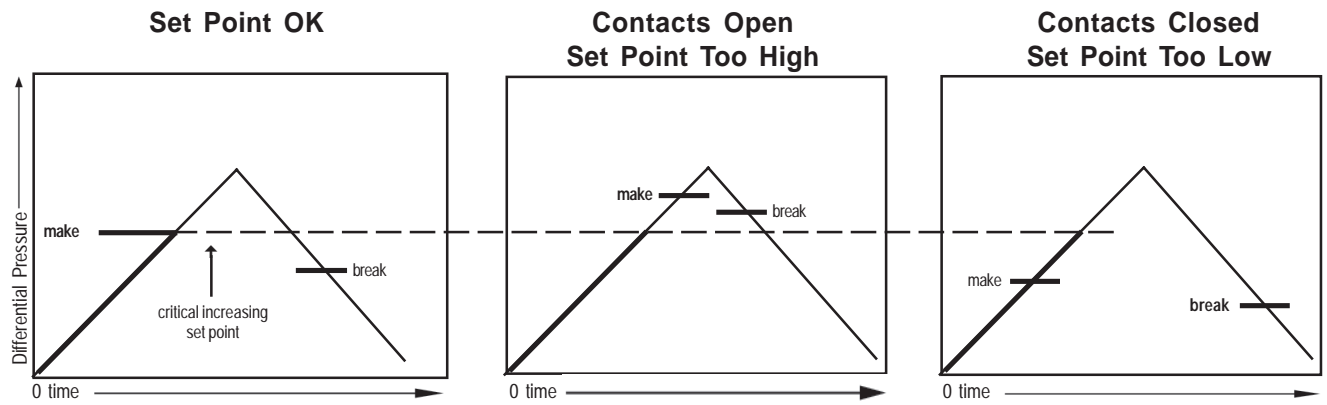
1. Differential pressure gauge
2. Variable pressure source
3. Block/bleed and equalizer valves
4. Test light or ohmmeter

Determine whether the critical set point occurs on increasing or decreasing differential pressure, and calibrate using the appropriate procedure:

### For Critical Set Point on Increasing Differential Pressure

1. Connect the continuity test lamp or ohmmeter across the C - Common and NO - Normally Open switching element / contacts.
2. Close the bleed valve(s), open the equalizer valve and raise pressure equally on both HI and LO sides to the static pressure that the differential pressure switch will see under normal operating conditions.
3. With static pressure stable, close the equalizer valve to isolate the HI side from the LO side.
4. Keeping high side pressure steady, slightly open the LO side bleed valve to reduce the LO side pressure (increase differential pressure) until desired differential pressure set point appears on indicator. Close bleed valve to stabilize differential pressure. Check the status of the electrical contacts against the following differential pressure trend graphs. Follow the instructions under the graph that matches the status of the contacts.

See SOR Form 468 for reference dimension drawings. For certified dimension drawings contact factory.



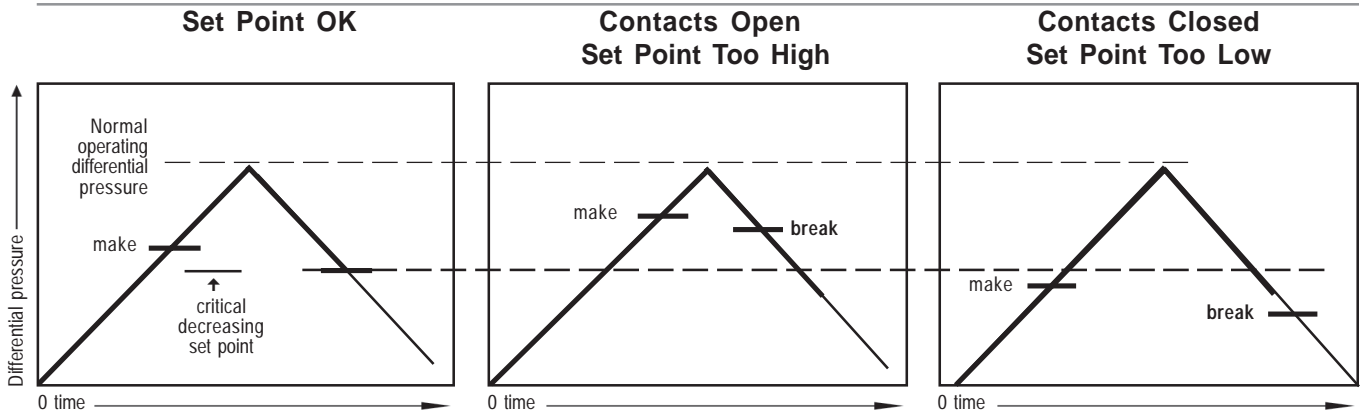
If contacts **make** precisely at critical increasing differential pressure set point, repeat Steps 2 - 4 as desired to verify calibration. Calibration is complete.

If contacts are **open** when critical increasing differential pressure is reached, turn set point adjustment counterclockwise (out) until contacts make. Repeat Steps 2-4.

If contacts are **closed** when critical increasing differential pressure is reached, turn set point adjustment clockwise (in) until contacts break. From this point, turn set point adjustment counterclockwise (out) until contacts make. Repeat Steps 2-4.

### For Critical Set Point on Decreasing Differential Pressure

1. Connect the continuity test lamp or ohmmeter across the C - Common and NO - Normally Open contacts.
2. Close the bleed valve(s), open the equalizer valve, and raise pressure equally on both HI and LO sides to the normal operating *high* side pressure.
3. With normal HI side pressure stable, close the equalizer valve to isolate the HI side from the LO side.
4. Slightly open the LO side bleed valve to reduce LO side pressure (increase differential pressure) *until the normal operating differential pressure appears on the digital indicator*. Close the bleed valve to stabilize differential pressure. Contacts should close (make) by the time normal operating differential pressure is reached. If the contacts are still open at normal operating differential pressure, turn the set point adjustment counterclockwise (out) until the contacts make.
5. Keeping the high side pressure steady, slightly open the equalizer valve to increase LO side pressure (decrease differential pressure) until the desired differential pressure set point appears on the digital indicator. Close the equalizer valve to stabilize differential pressure. Check the status of the electrical contacts against the following differential pressure trend graphs. Follow the instructions under the graph that matches the status of the contacts.



If contacts break precisely at critical decreasing differential pressure set point, repeat steps 2-5 as desired to verify calibration. Calibration is complete.

If contacts are **open** when critical decreasing differential pressure is reached, turn set point adjustment counterclockwise (out) until contacts make. From this point, turn set point adjustment clockwise (in) until contacts break. Repeat Steps 2-5.

If contacts are **closed** when critical increasing differential pressure is reached, turn set point adjustment clockwise (in) until contacts break. Repeat Steps 2-5.





# Pressure Switches for Process Applications

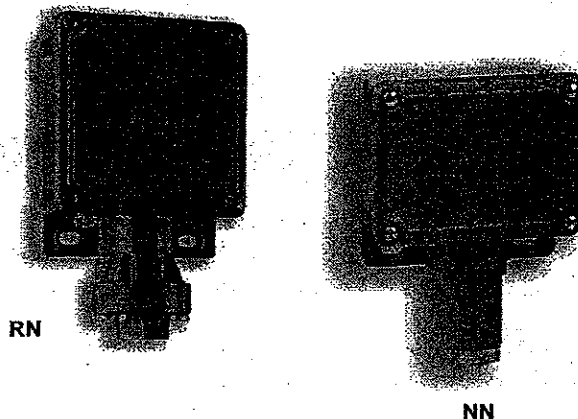
## General Instructions

### General

These instructions provide information for installation, process connection, electrical connection, and calibration. This type is not recommended for high-pressure fluid power applications where high-shock pressure and high cycle rates are expected.

**NOTE:** If you suspect that an instrument is defective, contact the factory or the SOR representative in your area for a return authorization number. If the instrument cannot be returned for service, field work should be performed by a qualified instrument technician using factory authorized procedures. Contact the factory or the SOR representative in your area for technical support.

*Design and specifications subject to change without notice.*

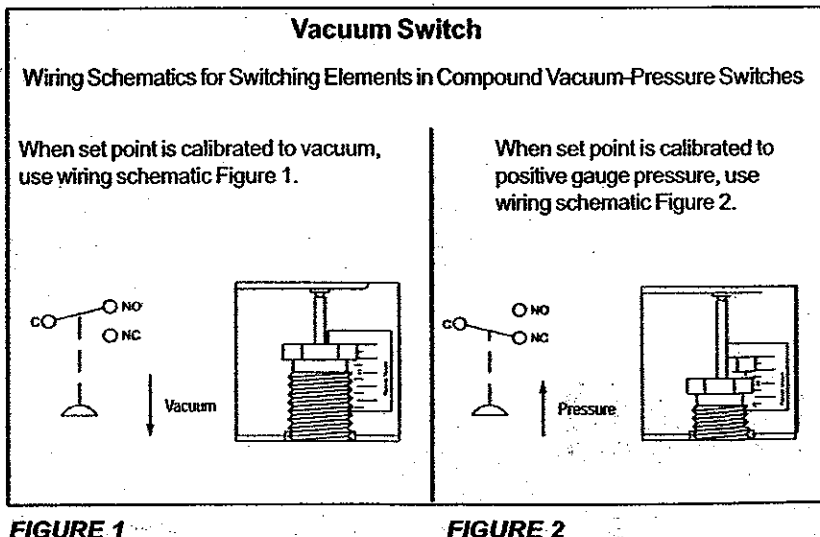
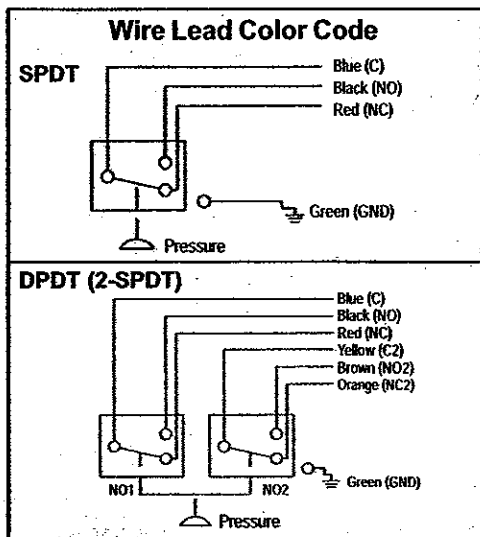


### Electrical Connection

**CAUTION:** Electrical power must be disconnected from explosion proof models before the cover is removed. Failure to do so could result in severe personal injury or substantial plant damage.

Storing excess wire or making wire lead splices inside the pressure switch housing will interfere with pressure switch operation.

Housing Type	Conduit Connection	Contact Termination	Contact Identification
Open bracket	None	Screw terminals	Stamped on insulation
		Wire leads	Color coded and marked
All others	3/4 NPT(F) or M20 x 1.5(F) unless optional adapter is specified	Screw terminals	Stamped on insulation
		Wire leads	Color coded and marked
		Terminal strip	Stamped on insulation



## Installation

1. Secure housing mounting pad to a bulkhead, panel rack or pipe stanchion with two suitable 1/4" bolts.
2. Line mounting by either process connection or electrical conduit connection is **not** recommended.
3. Suggested mounting orientation is electrical conduit connection at 6 o'clock to prevent condensate from collecting in the housing enclosure. However, the device can be mounted in any position.

Ensure that wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.

## Process Connection

Securely connect process line to pressure port using two wrenches: one to hold hex flats on pressure port, the other to tighten process pipe or tube fitting.

**IMPORTANT:** Use care not to loosen pressure port from body or body from housing.

**CAUTION:** Failure to mount the housing on a flat mounting surface may result in torsional forces on the housing that could cause false trips or render the pressure switch inoperative.

## Calibration

**CAUTION:** Switching Element has been precisely positioned in the housing and overtravel adjusted at the factory for optimum performance. Any inadvertent movement or replacement in the field will degrade performance and could render the device inoperative, unless factory authorized procedures are followed.

### Fixed Dead Band Models

Use 3/4" open-end wrench to turn hex adjusting nut clockwise to increase set point; counterclockwise to decrease Set Point. Approximate set point can be obtained by sighting across top of adjusting nut to calibration scale on interior wall of housing. If precise set point calibration is required, it will be necessary to use a regulated pressure source, a suitable continuity tester, and a 1/4% test gauge.

### Adjustable Dead Band Models

Use the fixed dead band procedure (above) to calibrate the desired decreasing pressure set point. The increasing pressure set point can then be adjusted by turning the white thumbwheel on the electrical switching element. Setting A yields the smallest possible dead band. Setting F yields the widest possible dead band. Settings above E may degrade repeatability.

See SOR Catalog (Form 216) for reference dimension drawings. For certified dimension drawings, contact the factory.









PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE CONTROL VALVE PILOTS AND REGULATORS				SHEET 1 OF 3													
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE REGULATORS				NO				SPEC NO		FILE 14.11.P											
				BY				DATE				REVISION		JOB # 054468							
				0				RDD				03/11/05				FOR PURCHASE		DATE 03/11/2005			
																REQ.		BY		CHKD	APPR.
G E N E L	1	TAG NO.		PRV-610				PRV-633				PRV-634				PRV-641					
	2	SERVICE		K-690 HOT GAS BYPASS				DEC2 RBLR FUEL GAS				DEETHANIZER REBOILER				GLYCOL FLSH PRESS					
	3	LINE NO. / VESSEL NO.																			
	4	LINE SIZE / SCHED. NO.		33 MM SCH.80				33 MM SCH.80				33 MM SCH.80				21 MM SCH.80					
	5	FUNCTION		FORWARD PRESSURE				FORWARD PRESSURE				FORWARD PRESSURE				FORWARD PRESSURE					
	6	TYPE OF BODY		MFR STD				MFR STD				MFR STD				MFR STD					
	7	BODY SIZE		PORT SIZE		33 mm		25 mm		33 mm		3.2 mm		33 mm		6.4 mm		14 mm		3.2 mm	
	8	GUIDING		NO. OF PORTS		TOP		ONE		TOP		ONE		TOP		ONE		TOP		ONE	
	9	END CONN. & RATING		33 NPT				33 NPT				33 NPT				14 NPT					
	10	BODY MATERIAL		MI				MI				WCB				AL					
	11	PACKING MATERIAL		STD				STD				STD				STD					
	12	LUBRICATOR		ISOLAT. VALVE																	
	13	SEAL TYPE																			
	14	TRIM FORM		MFR STD				MFR STD				MFR STD				MFR STD					
	15	TRIM MATERIAL		SS				STD				MFR STD				SS					
	16	SEAT MATERIAL		SS				STD				MFR STD				SS					
	17	REQUIRED SEAT TIGHTNESS																			
	18	MAX. ALLOW SOUND LEV. dBA																			
A C T / P I L O T	19	TYPE OF ACTUATOR		SPRING				SPRING				SPRING				SPRING					
	20	PILOT																			
	21	SUPPLY TO PILOT																			
	22	SELF CONT.		EXT. CONN.						X											
	23	DISPHRAGM MATERIAL		MFR STD				MFR STD				NITRILE				MFR STD					
	24	DISPHRAGM RATING		2069 KPA				1034 KPA				21 KPA				1724 KPA					
	25	SPRING RANGE		V: 70-830		kPa		34-138		kPa		7-17		kPa		413-700		kPa			
	26	SET POINT		82		kPa		82		kPa		7		kPa		400		kPa			
	27																				
	A C C E S S	28	FILT REG		SUPPLY GAGE																
29		LINE STRAINER																			
30		HOUSING VENT																			
31		INTERNAL RELIEF																			
32		OPTIONS																			
33																					
S E R V I C E	34	FLOW UNITS		STD M*3/DAY				STD M*3/DAY				STD M*3/DAY				STD M*3/DAY					
	35	FLUID		PROPANE				FUEL GAS				FUEL GAS				FUEL GAS					
	36	QUANT. MAX.		MAX. Cv				700				SMALL									
	37	QUANT. OPER.		OPER Cv		841		5.8		570		7.12				238					
	38	VALVE CV		VALVE FL		10.0				12.5						8.5					
	39	NORM IN PRES		NORM DELTA P		1379 kPa(g)		1297 kPa		700 kPa(g)		600 kPa		82 kPa(g)		75 kPa		700 kPa(g)		210 kPa	
	40	MAX. INLET PRESS.		1724 kPa				1724 kPa				861 kPa				1724 kPa					
	41	MAX.SHUT OFF		MAX.DELTA P		1724 kPa(g)		1724 kPa		1724 kPa(g)		1724 kPa		861 kPa(g)		861 kPa		1724 kPa(g)		1724 kPa	
	42	TEMP. MAX.		OPERATING		66 °C		50 °C		66 °C		37 °C		66 °C		38 °C		66 °C		37 °C	
	43	OPER. SP. GR.		MOL. WT.				44				19.5						19.5			
	44	OPER. VISC.		% FLASH																	
	45	% SUPERHEAT		% SOLIDS																	
	46	VAPOR PRESS		CRIT PRESS		kPag		kPag		kPag		kPag		kPag		kPag		kPag		kPag	
	47	PREDICTED SOUND LEVEL dBA																			
48	MANUFACTURER		REFRIG SPECIALTIES				FISHER				FISHER				FISHER						
49	MODEL NO.		A4A0				627				Y690H				67CFR						
50	P. O. NUMBER																				

NOTES:

AREA. UNIT # :

ISA FORM SM20.51

MPRV.XLT

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE CONTROL VALVE PILOTS AND REGULATORS				SHEET 2 OF 3			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE REGULATORS				NO BY DATE REVISION				JOB # 054468			
				0 RDD 03/11/05 FOR PURCHASE				DATE 03/11/2005			
								REQ.			
								BY CHKD APPR.			
GENERAL	1 TAG NO.	PRV-650			PRV-651			PRV-681		PRV-690	
	2 SERVICE	EG REG FUEL GAS			GLYCOL FLSH PRESS			ACCUMULATOR PRESS		FUEL GAS	
	3 LINE NO. / VESSEL NO.										
	4 LINE SIZE / SCHED. NO.	33 MM SCH.80			21 MM SCH.80			33 MM SCH.80		33 MM SCH.80	
	5 FUNCTION	FORWARD PRESSURE			FORWARD PRESSURE			FORWARD PRESSURE		FORWARD PRESSURE	
	6 TYPE OF BODY	MFR STD			MFR STD			MFR STD		MFR STD	
	7 BODY SIZE	PORT SIZE	33 mm	3.2 mm	14 mm	3.2 mm	33 mm	25 mm	33 mm	4.8 mm	
	8 GUIDING	NO. OF PORTS	TOP	ONE	TOP	ONE	TOP	ONE	TOP	ONE	
	9 END CONN. & RATING	33 NPT			14 NPT			33 NPT		33 NPT	
	10 BODY MATERIAL	MI			MI			CS		STEEL	
	11 PACKING MATERIAL	STD			STD			STD		STD	
	12 LUBRICATOR	ISOLAT. VALVE									
	13 SEAL TYPE										
	14 TRIM FORM	MFR STD			MRF STD			MRF STD		MFR STD	
	15 TRIM MATERIAL	SS			SS			STD		SS	
	16 SEAT MATERIAL	SS			SS			STD		SS	
	17 REQUIRED SEAT TIGHTNESS										
	18 MAX. ALLOW SOUND LEV. dBA										
ACTUATOR	19 TYPE OF ACTUATOR	SPRING			SPRING			SPRING		SPRING	
	20 PILOT										
	21 SUPPLY TO PILOT										
	22 SELF CONT.	EXT. CONN.									
	23 DISPHRAGM MATERIAL	MFR STD			MRF STD			MRF STD		MFR STD	
	24 DISPHRAGM RATING	1034 KPA			1034 KPA			1034 KPA		1034 KPA	
	25 SPRING RANGE	34-138 kPa			20-103 kPa			517-1930 kPa		482-1034 kPa	
	26 SET POINT	82 kPa			14 kPa			700 kPa		700 kPa	
	27										
	ACCESSORIES	28 FILT REG	SUPPLY GAGE								
29 LINE STRAINER											
30 HOUSING VENT											
31 INTERNAL RELIEF											
32 OPTIONS					C/W PRESSURE INDICATOR						
33											
SPECIFICATIONS	34 FLOW UNITS	STD M <sup>3</sup> /DAY			STD M <sup>3</sup> /DAY			KG/HR		STD M <sup>3</sup> /DAY	
	35 FLUID	FUEL GAS			FUEL GAS			PROPANE		FUEL GAS	
	36 QUANT. MAX.	MAX. Cv	300		300				5,000		
	37 QUANT. OPER.	OPER Cv	145	3.09	145		1000		712	1.01	
	38 VALVE CV	VALVE FL	12.5				10		29		
	39 NORM IN PRES	NORM DELTA P	700 kPa(g)	600 kPa	82 kPa(g)	68 kPa	1379 kPa(g)	680 kPa	6780 kPa(g)	6080 kPa	
	40 MAX. INLET PRESS.		1724	kPa	1724	kPa	1724	kPa	8963	kPa	
	41 MAX.SHUT OFF	MAX.DELTA P	66 kPa(g)	1724 kPa	1724 kPa(g)	1724 kPa	1724 kPa(g)	1724 kPa	8963 kPa(g)	8963 kPa	
	42 TEMP. MAX.	OPERATING	66 °C	37 °C	66 °C	37 °C	66 °C	50 °C	66 °C	37 °C	
	43 OPER. SP. GR.	MOL. WT.		19.5		19.5		44		19.5	
	44 OPER. VISC.	% FLASH									
	45 % SUPERHEAT	% SOLIDS									
	46 VAPOR PRESS	CRIT PRESS	kPag	kPag	kPag	kPag	kPag	kPag	kPag	kPag	
	47 PREDICTED SOUND LEVEL dBA										
48 MANUFACTURER	FISHER			FISHER			REFRIG SPECIALTIES		FISHER		
49 MODEL NO.	627			67CFR			A4A0		627		
50 P. O. NUMBER											

NOTES: PRV-690 MAY AFFECT SIZING OF PSV-690 (FUEL GAS SCRUBBER)

AREA. UNIT # :

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE CONTROL VALVE PILOTS AND REGULATORS				SHEET 3 OF 3			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESURE REGULATORS				NO				JOB # 054468			
				BY				DATE		REVISION	
				0				RDD		03/11/05	
								FOR PURCHASE		DATE 03/11/2005	
				REQ.				BY			
								CHKD			
								APPR.			
G	1	TAG NO.	PRV-691								
E	2	SERVICE	FUEL GAS								
N	3	LINE NO. / VESSEL NO.									
E	4	LINE SIZE / SCHED. NO.	33 MM SCH.80								
L	5	FUNCTION	FORWARD PRESSURE								
	6	TYPE OF BODY	MFR STD								
	7	BODY SIZE	PORT SIZE	33 mm	4.8 mm	mm	4.8 mm	mm	mm		
	8	GUIDING	NO. OF PORTS	TOP	ONE		ONE				
B	9	END CONN. & RATING	33 NPT								
O	10	BODY MATERIAL	STEEL								
D	11	PACKING MATERIAL	STD								
Y	12	LUBRICATOR	ISOLAT. VALVE								
	13	SEAL TYPE									
	14	TRIM FORM	MFR STD								
	15	TRIM MATERIAL	STD								
	16	SEAT MATERIAL	STD								
	17	REQUIRED SEAT TIGHTNESS									
	18	MAX. ALLOW SOUND LEV. dBA									
A	19	TYPE OF ACTUATOR	SPRING								
C	20	PILOT									
T	21	SUPPLY TO PILOT									
/	22	SELF CONT.	EXT. CONN.								
P	23	DISPHRAGM MATERIAL	MFR STD								
I	24	DISPHRAGM RATING	1034 KPA								
L	25	SPRING RANGE	482-1034	kPa		kPa		kPa	kPa		
O	26	SET POINT	650	kPa		kPa		kPa	kPa		
T	27										
A	28	FILT REG	SUPPLY GAGE								
C	29	LINE STRAINER									
C	30	HOUSING VENT									
E	31	INTERNAL RELIEF									
S	32	OPTIONS									
S	33										
	34	FLOW UNITS	STD M <sup>3</sup> /DAY								
	35	FLUID	FUEL GAS								
	36	QUANT. MAX.	MAX. Cv	5.000							
S	37	QUANT. OPER.	OPER Cv	712	1.01						
E	38	VALVE CV	VALVE FL	29							
R	39	NORM IN PRES	NORM DELTA P	6780 kPa(g)	6080 kPa	kPa(g)	kPa	kPa(g)	kPa		
V	40	MAX. INLET PRESS.		8963 kPa	kPa	kPa	kPa	kPa	kPa		
I	41	MAX.SHUT OFF	MAX.DELTA P	8963 kPa(g)	8963 kPa	kPa(g)	kPa	kPa(g)	kPa		
C	42	TEMP. MAX.	OPERATING	66 ° C	37 ° C	° C	° C	° C	° C		
E	43	OPER. SP. GR.	MOL. WT.		19.5						
	44	OPER. VISC.	% FLASH								
	45	% SUPERHEAT	% SOLIDS								
	46	VAPOR PRESS	CRIT PRESS	kPag	kPag	kPag	kPag	kPag	kPag		
	47	PREDICTED SOUND LEVEL dBA									
	48	MANUFACTURER	FISHER								
	49	MODEL NO.	627								
	50	P. O. NUMBER									

NOTES:

AREA. UNIT # :

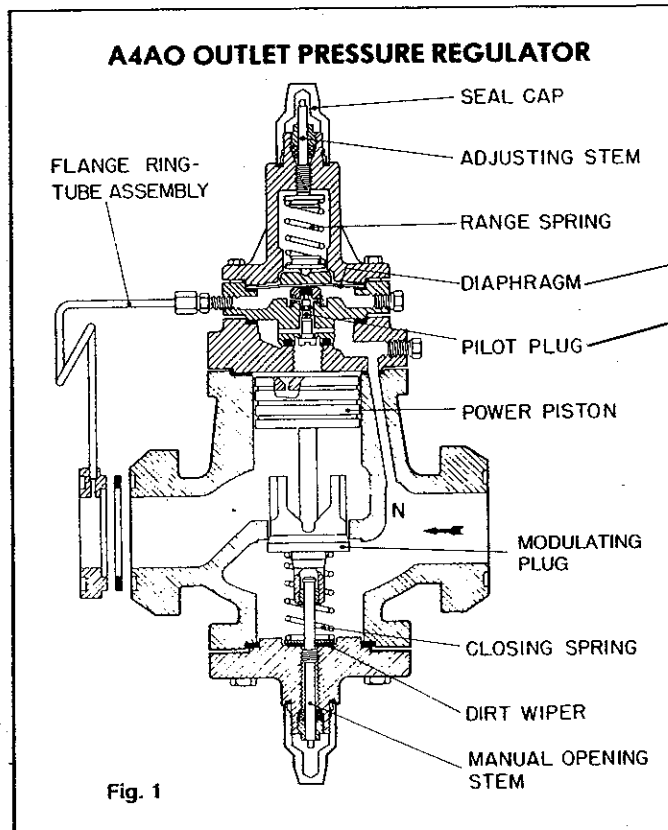
# ADAPTOMODE® OUTLET PRESSURE REGULATORS

Types: A4AO, A4AOE, A4AOS and A4AOSE

Port Size 20 — 100 mm (3/4" - 4")  
For Ammonia, R-12, R-22, R-502  
Other Refrigerants and Oil

## FEATURES

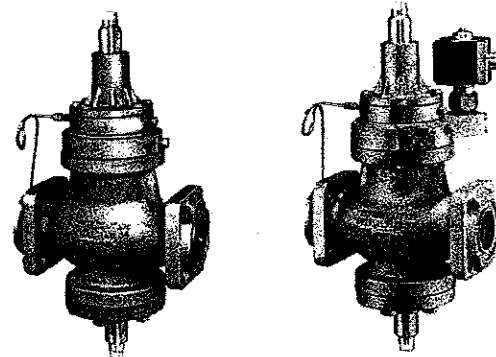
- Pilot operated characterized Modulating Plug precise control
- Suitable for all common refrigerants and oil
- 21 bar (300 psig) design pressure (MRP)
- Flanges for threaded or welded steel pipe and copper tube (copper not for ammonia)
- Interchangeable parts
- Easy to service
- Close coupled strainers, optional
- Many control variations are possible with the use of a few Modules and kits.  
(See Adaptomode Pressure Regulator Bul. 23-06)
- Stainless Steel Diaphragm
- Chrome Plated Pilot Seat
- Manual Opening Stem



## Description

These compact, heavy duty, pilot operated, iron alloy (ASTM A126 Class B) Outlet Pressure regulators are suitable for Ammonia, R-12, R-22, R502 and other common refrigerants and fluids approved for use in refrigerant valves.

BULLETIN 23-07  
TYPES: A4AO, A4AOE, A4AOS, A4AOSE



A4AO

A4AOS

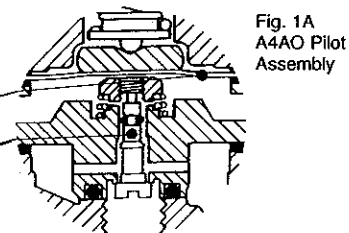
August, 1990

Installation, Service and Parts Information

All A4 Regulators are pilot operated using upstream pressure for the opening force and requires a minimum 0.14 bar (2 psig) pressure drop to fully open.

These valves are generally ordered with close coupled strainer to prevent entrance of foreign material into the valve and the rest of the system. (See current Bulletin 00-10 for strainer information.)

The fluid temperature range for the A4 Series of Regulators is -45C to 105C (-50°F to 220°F).



## Purpose

Modulates flow of refrigerant gas or liquid to maintain a constant downstream pressure as set-for, despite fluctuations in load. The regulator will gradually close when downstream pressure begins to rise above the setting and will gradually open when pressure begins to fall below the setting. The regulator cannot maintain set-for pressure if uncontrolled branch pipe lines feed into the main pipeline downstream of the A4AO Regulator. Typical uses are as follows:

**Protect Compressor Motor from Overload (Hold-back):** See capacity ratings in Condensed Catalog CC-11. Select at design parameters i.e., tons, evaporator temp./press and pressure drop.

**Hot Gas Bypass Capacity Control:** See Bulletin BYG-4, Condensed Catalog CC-11.

**Limit Refrigerant Pressure in a Liquid Line:** Contact factory for selection assistance.

**Prevent Deep Vacuum in Booster Suction:** See capacity ratings Condensed Catalog CC-11 "Compressor Suction Loading". For selections other than those shown, contact factory.

**Prevent Pressure Rise in Suction Main:** Select valve based on mass flow requirements. Valve Cv and pressure drop across regulator. Contact factory for proper selection assistance, if required.

**Hot Gas Defrost Control:** Refer to Condensed Catalog CC-11 and Bulletin 90-10 for ratings and application information.

## Principles of Operation (See Fig. 1 & 1A)

The outlet pressure is sensed under the diaphragm through the sensing tube, which is part of the Flange Ring-tube assembly. When the force created by the outlet pressure acting under the diaphragm is less than the force of the range spring, the pilot is open, allowing pressure to enter on top of the piston. This causes the power piston to force the modulating plug to open to maintain constant outlet pressure. Decrease in the outlet pressure allows the range spring to open the pilot further, allowing more pressure on top of the piston and opening the modulating plug further. An increase in the outlet pressure will lift the diaphragm against the force of the range spring, allowing the pilot plug to start closing. The pressure on top of the power piston is decreased and the closing spring acts to reduce the opening of the modulating plug and the flow of fluid through the regulator. The pressure on top of the power piston is controlled by the flow through the pilot seat and the bleed through a bleed hole in the power piston and through the clearance between the piston and cylinder. A minimum of 0.14 bar (2 PSIG) pressure drop across the regulator is required to open it fully.

The A4AO Outlet Pressure Regulator therefore opens on a drop in the outlet pressure below its set point and closes on a rise in outlet pressure above its set point. The outlet pressure set point is not appreciably affected by variations in the inlet pressure.

## Manual Opening Stem

All Type A4A Regulators are provided with a manual opening stem. To open the regulator manually, back the stem out (turn counter-clockwise) until it stops. To put the regulator into automatic operation, turn the stem in (clockwise) until only the flats on the stem protrude from the packing nut.

## Adjustment

Install a pressure gauge at the regulator gauge port in the A4AO Adapter next to the sensing tube. Back the adjusting stem all the way out to stop (counter-clockwise). This will reduce the set-point to its lowest level and cause the valve to close. Operate the system until the outlet pressure is lower-than desired. Slowly turn in the adjusting stem (clockwise) until the desired outlet pressure is reached.

## A4AO Outlet Pressure Setting Ranges

Set Point Ranges	Approx. Pressure Change per Turn of Adjusting Screw	Factory Set Point (unless otherwise specified)
V:500mm hg to 8.3 bar (20in hg to 120 psig)	1.7 bar (25 psi)	2.8 bar (40 psig)
D:5.2 to 19.3 bar (75 to 280 psig)	3.7 bar (53 psi)	9.7 bar (140 psig)

## TYPE A4AOE (See Fig. 2)

### Description

#### A4AOE Outlet Pressure Regulator, Remote Sensing Connection

This regulator allows control of downstream pressure at a point remote from the outlet of the regulator. The pressure from the desired sensing point is connected directly to the A4AOE adapter at Fitting 7A in place of the Flange Ring-tube Assembly 20 shown for the A4AO. Thus the regulator will control the pressure at the sensing point. The regulator operation and adjustment is the same as for A4AO.

## Type A4AOS (See Figs. 2, 3, and 4)

### Description

#### A4AOS Outlet Pressure Regulator With Electric Shut-Off

The A4AOS Pressure Regulator controls outlet pressure when the modular solenoid is energized, and closes when the solenoid pilot is de-energized regardless of the pressure setting or pressure in the regulator. The Modudapter (Fig. 2, item 28A) is used only with the A4AOS. The Pilot Solenoid is mounted on Pad #1 of the Modudapter along with Moduplate, item #52, mounted on Pad #2 with "S" showing to the outside of the regulator.

Adjustment: With the solenoid energized, proceed as with the A4AO.

## Installation

All regulators are packed for maximum protection. Unpack carefully. Check the carton to make sure all flanges and other items are unpacked. Save the enclosed instructions for the installer and eventual user.

Do not remove the protective coverings from the inlet and outlet of the regulator until the regulator is ready to be installed. Protect the inside of the regulator from moisture, dirt and chips before and during installation. When welded or brazed flange connections are used, all slag, scale and loose particles should be removed from the flange interior before the regulator is installed between the flanges. It is advisable to install a close-coupled companion strainer (RSF) at the inlet of the regulator to help protect it from any foreign material in the system.

The A4A series of regulators will give optimum performance if mounted in a horizontal line in a vertical position with the manual opening stem on bottom. Where other positions are desired, the factory should be consulted, please give application and piping details. The regulator must be installed with the arrow on the valve body pointing in the direction of the fluid flow for the regulator to function properly. Backward flow through the regulator is uncontrolled and will vary with the valve model and the reverse pressure drop encountered. The regulator is not a check valve.

Tighten the flange bolts and nuts evenly to provide proper seating of the flange gasket and to avoid damage to gaskets or flanges. (See Flange Bolt Torque Table, page 12). Avoid using the regulator flange bolts to stretch or align pipe. Even the heavy duty semi-steel body of an A4A can be distorted, causing the precision parts to bind.

The regulator should be installed in a location where it is easily accessible for adjustment and maintenance. The location should be such that the regulator cannot be easily damaged by material handling equipment. When it is necessary to insulate the regulator (and companion strainer), the insulation should be installed to provide access to the regulator (and companion strainer) for adjustment and maintenance. Do not insulate the solenoid coil and coil housing. Proper indicating gauges should be installed to be easily visible to the operating engineer for system checking and adjusting purposes.

## Disassembly and Assembly

Refer to Figs. 2, 3 and 4 in this section.

Before disassembling any A4A type regulator, read the information in this bulletin and Bulletin RSB, Safety Procedures for Refrigerating Specialties Division Refrigeration Control Valves.

Before a regulator is removed from the line or disassembled in the line, make sure that all refrigerant has been removed from the regulator, including the bonnet where applicable, and the close coupled strainer. The regulator must be isolated from the rest of the system in a safe manner. When pumping down to remove the refrigerant, the manual opening stem 33A must be turned out (counter-clockwise) to make sure the valve is open.

## All A4A Regulators General Procedure

The construction of the regulator and the method of disassembly are relatively simple, but some procedures must be followed to avoid damage. The following describes the procedure for the basic A4A; special instructions for other types are included in other appropriate sections.

## Disassembly and Assembly (continued)

**Disassembly** – Take care when removing Seal Caps 1 and 44 in case some refrigerant may be trapped inside. Back the Adjusting Stem 6 all the way out to remove any pressure from Range Spring 13 otherwise damage to Diaphragm 17 or Pilot Seat 18 may occur. Remove Bonnet 8 by carefully removing Cap Screws 11. Take care not to damage Diaphragm Follower 15. Remove Adapter 28 by removing Cap Screws 31. Turn the Manual Opening Stem 33A all the way in until the flats on the stem barely protrude from the stuffing box nut. Push Piston 30 down against the spring force. The piston should move freely down and be returned by the spring force. If the piston is jammed or sticky, remove Bottom Cap Assembly which includes Items 33 through 42 by removing Cap Screws 39 or unscrewing Bottom Cap, 20mm through 32mm (3/4" through 1-1/4"). Using a hard wood dowel rod inserted through the bottom of the valve, tap the piston upward and out. Thoroughly clean all parts. If jamming has taken place and the piston and bore are scored, remove all burrs by polishing the piston, bore and modulating plug with fine crocus cloth. Inspect the seating area of the Modulating Plug 33 for damage or erosion. If damaged it should be replaced. It would be advisable to replace the entire bottom cap assembly. Inspect all gaskets and "O" rings for damage and replace where necessary.

**Assembly** – When reassembly the valve, all internal parts should be clean, dry and lightly oiled with refrigerant oil, except "O" rings. Apply silicone grease to the "O" rings. Care must be taken especially when the parts are cold since moisture can condense on parts and cause rapid rusting. When replacing gaskets, they should be oiled very lightly with refrigerant oil before assembly. Install bottom cap assembly first and tighten in place. Carefully replace the piston; never try to force it in

place. Align the Adapter Gasket 29 carefully with the proper holes in the adapter and valve body and fasten adapter in place. Before assembling the bonnet be sure the Adjusting Stem 6 is turned all the way out and that the Bonnet 8 and Diaphragm Follower 15 are properly aligned, otherwise damage to the diaphragm and pilot seat may occur. Place Gasket 19 in the adapter and align Gasket 16 and Diaphragm 17 to the center of the bonnet. The raised center of the diaphragm must be towards the bonnet. For range "D" use two diaphragms. Tighten Cap Screws 11 evenly. The ideal tightening torque is 1.5 Kg-m (11 ft. lbs.). Valve is now ready to be adjusted for normal operation.

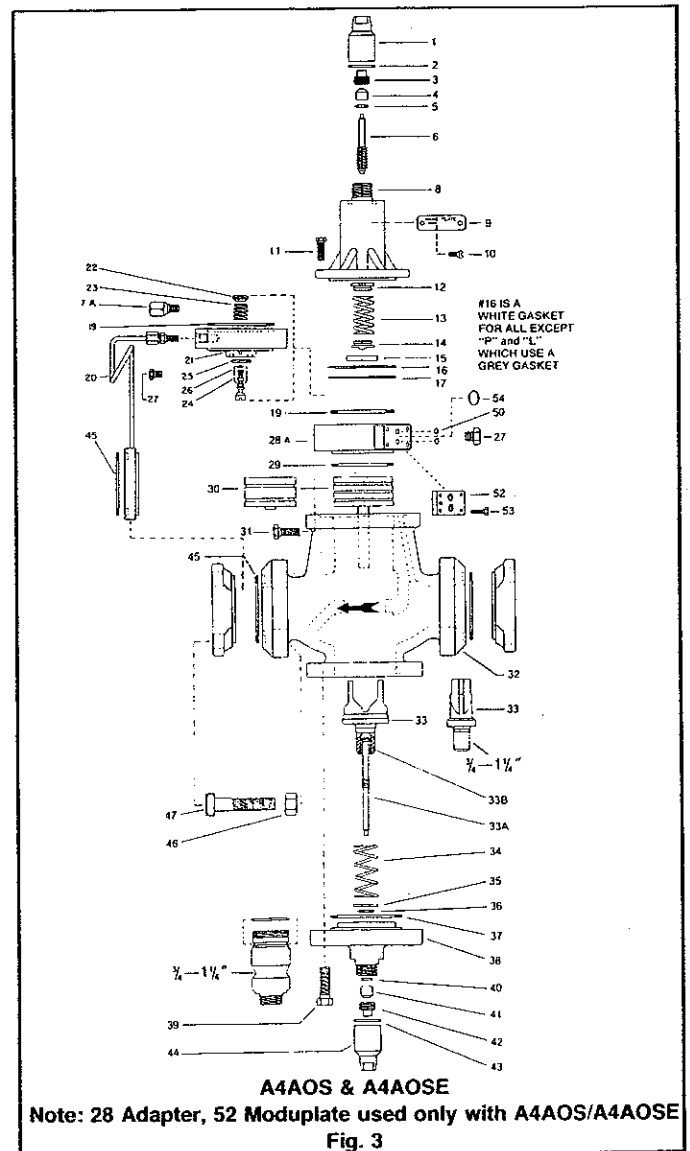
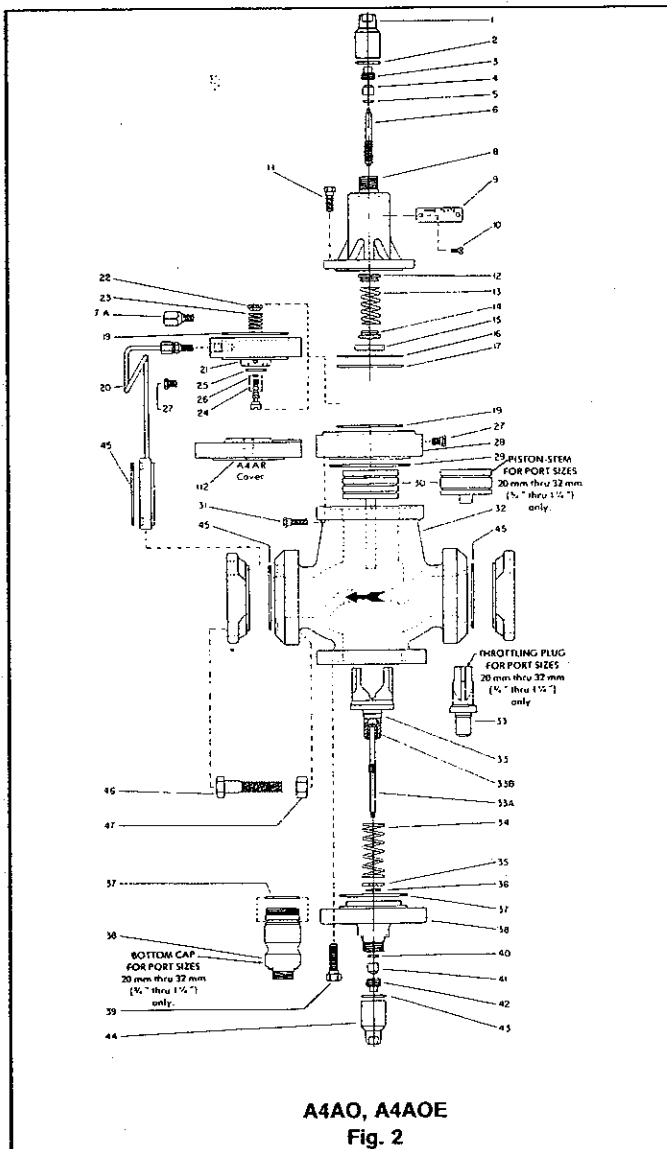
If close coupled strainer is used, it may be cleaned before putting the valve back in operation. The regulator must be tested for leaks with refrigerant gas or other appropriate gas before the system is put into operation.

## Basic Modules (Used on A4AOS/A4AOSE)

### Disassembly and Assembly

Refer to exploded views (Figs. 3 and 4), illustrating the Modular Solenoid Pilot and Moduplate. These modules are used only with the A4AOS/A4AOSE Outlet Pressure Regulator with Electric Shut Off. The Moduadapter, Item #28 (Fig. accommodates these modules. The Pilot Solenoid is mounted on Pad #1 of the Moduadapter along with the Moduplate, item #52, mounted on Pad #2 with the "S" showing to the outside of the regulator.

Before disassembling and assembling any modules, refer to page 2 of this bulletin and to Bulletin RSB, Safety Procedure for Refrigerating Specialties Division Refrigeration Control Valves.



## Disassembly and Assembly (continued)

### Modudapter (See Figs. 1, 2 and 3)

The Modudapter 28 will accommodate the Modular Pilot Solenoid and Moduplate. When assembling make sure the Modudapter gauge port is directly lined up with the inlet of the regulator. Passage N must communicate upstream pressure through the hole in the Adapter Gasket 29 as well as into Modudapter 28 and thence to the pilot modules. It is imperative that proper alignment of these items be made to assure regulator function.

Before disassembly, make sure all refrigerant has been removed from the regulator and strainer, if used.

Protect the surfaces of Pads 1 and 2 of the Modudapter at all times since these surfaces determine the sealing tightness of the "O" Rings.

### S6A Modular Solenoid Pilot (Fig. 4)

This solenoid pilot is mounted on Pad 1. Before working on any solenoid pilot, make sure the coil is de-energized and will remain so during the servicing period. Refer to page 10 for Repair Parts Kit details of S6A Solenoid Pilot.

**Disassembly (Fig. 4)** – Remove Coil Housing Screw 55 and pull entire Coil and Housing Assembly, 56 through 60, upward and off of Bonnet-Tube Assembly 61. Carefully remove Bonnet-Tube Assembly. Lift out Plunger-Needle Assembly 63, avoid damaging the needle. Remove Seat Assembly 64 by using a 7/16" (11 mm) socket wrench. Inspect all parts, clean or replace as needed.

**Assembly (Fig. 4)** – Reinstall the Seat Assembly and tighten (no gasket needed). Carefully insert the Plunger Needle Assembly. Replace the Gasket 62 and re-install Bonnet-Tube Assembly. Replace entire Coil and Housing Assembly and tighten Coil Housing Screw.

Make sure the solenoid coil is of the proper voltage and frequency.

When mounting the solenoid pilot, place the "O" Rings 50 into the proper grooves and tighten the Cap Screws 66, evenly. The ideal tightening torque is 1.1 kg-m (8 ft. lbs.).

### Moduplate (Fig. 2)

The Moduplate Item #52 is used to stop the flow through the flow path of the Modudapter. Protect the "O" Ring surfaces at all times. When mounting the Moduplate, place "O" Rings 50 into the grooves (lubricate with silicone grease) and tighten the Cap Screws 53 evenly to avoid distortion and assure proper sealing. The ideal tightening torque is 1.1 Kg-m (8 ft. lbs.).

## Maintenance and Service

### General Procedure:

Before disassembly of regulator, make certain that all refrigerant has been removed (pumped out) from the regulator and its companion strainer where one is used. Read Safety Bulletin RSB.

Dirt in the system is the greatest single cause of regulator malfunction. All screens or filters must be cleaned or replaced when they become dirty. At start up it is especially important that these items are cleaned or changed frequently. When the RSF close-coupled companion strainers are used, maintain according to instructions in Bulletin 00-10. Moisture in halocarbon systems in particular can cause corrosion or form ice, causing the piston to freeze in position. Filter-driers should be used and maintained for halocarbon systems.

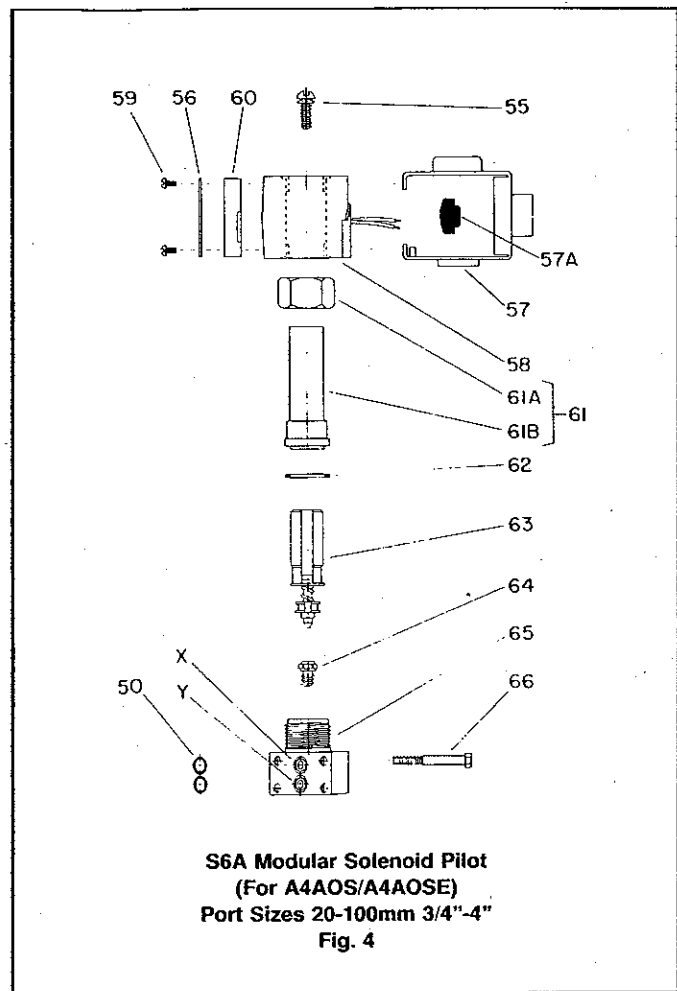
Before deciding to disassemble a regulator for servicing, the following investigations should be made:

Check the manual opening stem; it should be turned in for automatic operation.

Check the regulator setting to make sure it is properly adjusted. Turn adjusting screw slowly to see if regulator responds. Check regulator pressure range; if wrong, range spring must be replaced.

Check other system components for proper operation. Make sure that the regulator receives the proper electrical signal where modular pilot solenoids are used. Make sure they are same as the power supply.

Check hand valves in the system to make sure they are open or closed as required and the system is receiving liquid or gas as the case may be.



## Solenoid Coils and Coil Housing

The solenoid coils and coil housing, identified and described on page 8 for the Type S6A Solenoid Pilot, are an improved design which provide a higher MOPD and a cooler coil resulting in longer life. The new coil and its heavily plated, rust resisting housing are interchangeable with the obsolete coil and cast iron housing as follows: The new coil, which has its Part Number stamped on the side, can be used in both the old and new coil housing; the old coil which has its 30-0030-XX Series Part Number stamped on one end, can be used in the old, cast iron housing only. There is no bottom marking on the new coil; either end may be positioned up. The color coding of lead wires for various voltage and frequencies has not been changed. The fuses used with the old coils are suitable for the new coils; the new coil power consumption is 33 Watts instead of 37.

The S6A pilot solenoid valve is also available with a coil using a quick electrical connector or plug, permitting easy wiring connection with an exposed rubber covered cable instead of a rigid or flexible conduit and enclosed wiring. This type of coil cannot be used with the old, cast iron housing.

The new coils and new housing described above for the S6A valve are also used with Solenoid Valve Types S4, S5, S6N, S7, S8 and S9.

## Maintenance and Service (continued)

### Electrical

The Refrigerating Specialties Division molded water resistance Class "B" solenoid coil is designed for long life and powerful opening force. The standard coil housing meets NEMA 3R and 4 requirements. This sealed construction can withstand direct contact with moisture and ice. The coil housing far exceeds the requirements of NEMA Standard ICS, 1-110.57 salt spray test for rust resistance.

By definition, Class "B" coil construction will permit coil temperatures, as measured by resistance method, as high as 130°C (266°F). Final coil temperatures are a function of both fluid and ambient temperatures. The higher fluid temperatures require lower ambient temperatures so the maximum coil temperature is not exceeded. Conversely, low fluid temperatures permit higher ambient temperatures.

The molded Class "B" coil is available from stock with most standard voltages. However, coils are available for other voltages and frequencies, as well as for direct current. Coils are also available as transformer type with a 6 volt secondary winding for use with the Refrigerating Specialties Division Pilot Light Assembly (see current copy of Bulletin 60-10, "Pilot Light Assembly and Solenoid Transformer Coil").

The solenoid coil must be connected to electrical lines with volts and Hertz same as stamped on coil. The supply circuits must be properly sized to give adequate voltage at the coil leads even when other electrical equipment is operating. The coil is designed to operate with line voltage from 85% to 110% of rated coil voltage. Operating with a line voltage above or below these limits may result in coil burn-out. Also, operating with line voltage below the limit will definitely result in lowering the valve opening pressure differential. Power consumption during normal operation will be 33 watts or less.

Inrush and running current is listed below:

Standard Coil Volts/Hertz	Part Number	Inrush Current (Amps)	Running Current (Amps)	Fuse Size (Amps)
120/60 (Blue leads)	201401	1.60	0.52	1
208/60 (Blue & Red leads)	201405	0.88	0.28	1
240/60 (Red leads)	201402	0.86	0.26	1
440/60 (Yellow & Red leads)	201411	0.39	0.13	1
115/50 (Yellow & Blue leads)	201409	1.50	0.46	1
230/50 (Yellow leads)	201406	0.92	0.26	1
Other				(Contact Factory)

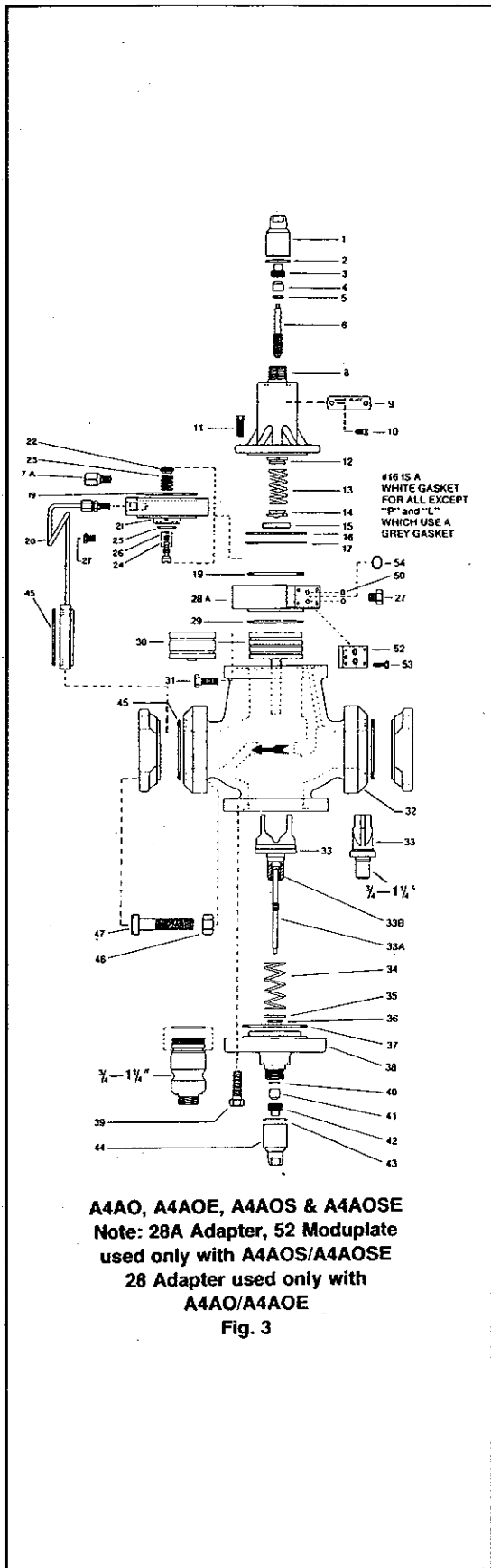
On transformer coil the 6 volt leads are always black.

### SERVICE POINTERS (Check General Procedure)

SYMPTOM	PROBABLE REASON	CORRECTION
Regulator does not shut off flow.	Diaphragm or seat dirty, damaged or frozen.	Clean or replace. Clean strainer.
	Diaphragm follower stuck or damaged.	Clean or replace. Install follower carefully.
	Piston jammed with excess dirt.	Remove and polish piston and bore with crocus cloth. Clean valve and strainer.
	Modulating plug leaking due to excess dirt or damage.	Clean or replace. If used on liquid, check for erosion due to excessive flash gas. Reduce flash gas by subcooling or by reducing pressure drop across valve by providing restriction at valve outlet.
	Diaphragm ruptured or badly deformed.	Replace. If Range "D" make sure has 2 diaphragms.
	A4AOS/A4AOSE Modular Solenoid Pilot Seat leaking.	Check seat and needle. Replace as needed.
	Diaphragm and seat eroded due to flash gas.	Replace. Reduce flash gas by subcooling or by reducing pressure drop across regulator by providing restriction at valve outlet.
Regulator does not open.	Modular Solenoid Pilot not closing.	Check power at leads, make sure coil is de-energized.
	Pressure Regulator Diaphragm ruptured or badly deformed.	Replace. If Range D make sure has 2 diaphragms.
	Diaphragm follower stuck, damaged or frozen.	Clean or replace. Install follower carefully.
	A4AOS/A4AOSE Modular Solenoid Pilot not opening.	Pressure drop across valve too high; over 21 bar (300 psig). Lower pressure drop. Improper power supply. Correct. Replace solenoid coil.
	Piston worn, too much clearance.	Replace piston. Check for reason. If used on liquid, check for flash gas.
Regulator Operation erratic.	Piston jammed with excess dirt.	Remove and polish piston and bore with crocus cloth. Clean valve and strainer.
	Diaphragm or seat dirty or damaged.	Clean or replace. Clean strainer.
	Diaphragm follower has dirt on the outside diameter or outside diameter is damaged.	Clean or replace.
	Other system components, line controllers, thermostats, etc., erratic.	Adjust, repair or replace.
Pressure drop across regulator too high.	Regulator too far oversized.	Check load. Replace with smaller regulator or investigate use of reduced capacity plug.
	Inlet or outlet restricted.	Check for restriction. Clean strainer.
	Regulator too small.	Open manually to be sure valve is full open. Replace with proper size regulator.
	Large amount of flash gas in liquid line.	Reduce flash gas by subcooling. Reduce line restriction by increasing line size, particularly at the regulator outlet. Replace with larger regulator.
	High pressure drop causes high rate of expansion gas at regulator outlet.	Increase pipe size at the outlet of the regulator.
Regulator does not open all the way.	Check piston for wear. Replace, if needed.	



# Repair Kits for A4AO, A4AOE, A4AOS and A4AOSE

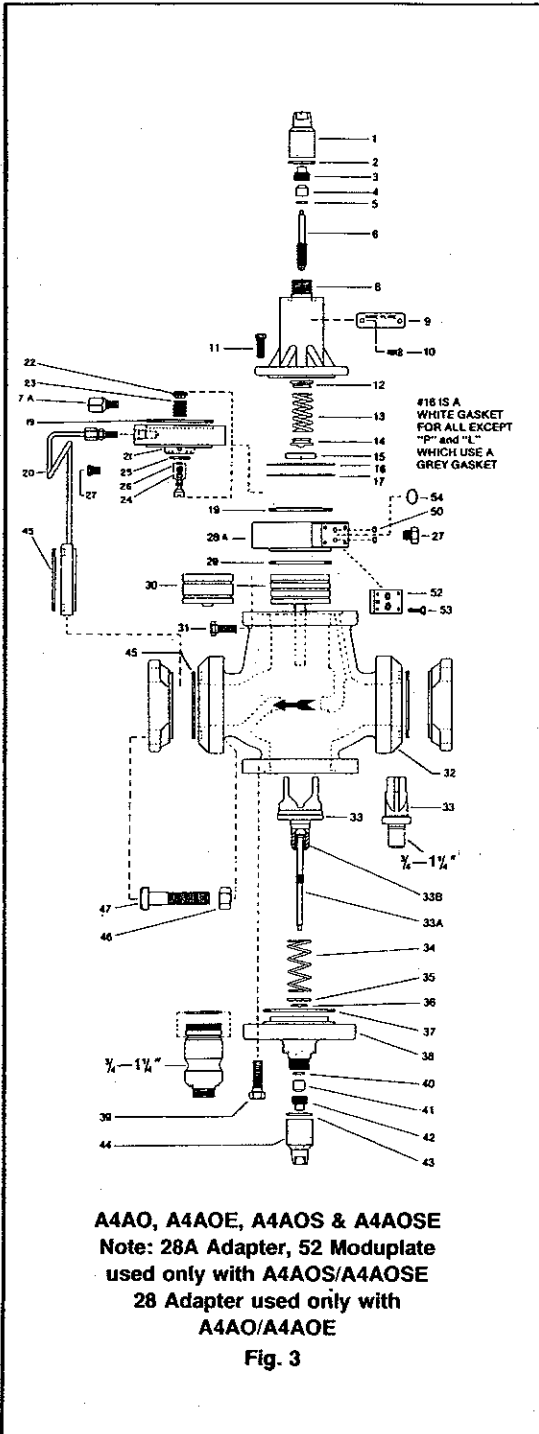


**A4AO, A4AOE, A4AOS & A4AOSE**  
**Note: 28A Adapter, 52 Moduplate used only with A4AOS/A4AOSE**  
**28 Adapter used only with A4AO/A4AOE**  
**Fig. 3**

Item No.	Description	20mm (3/4")		25mm (1")	
		Kit No.	Qty	Kit No.	Qty
1	Seal Cap	Only Avail. with Kit	1	Only Avail. with Kit	1
2	Seal Cap Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
1-2	Cap Kit, Seal	202110	1	202110	1
3	Nut, Packing	Only Avail. with Kit	1	Only Avail. with Kit	1
4	Packing, Stem	Only Avail. with Kit	1	Only Avail. with Kit	1
5	Washer, Flat	Only Avail. with Kit	1	Only Avail. with Kit	1
3-5	Packing Kit, Stem	202100	1	202100	1
6	Stem, Adjusting	Only Avail. with Kit	1	Only Avail. with Kit	1
4-6	Stem Kit, Adjusting	202120	1	202120	1
12	Plate, Spring, Upper	Only Avail. with Kit	1	Only Avail. with Kit	1
13	Spring, Comp.	Only Avail. with Kit	1	Only Avail. with Kit	1
14	Plate, Spring, Lower	Only Avail. with Kit	1	Only Avail. with Kit	1
15	Follower, Diaphragm	Only Avail. with Kit	1	Only Avail. with Kit	1
3-5, 6,	Spring/ Rge. V	202006	1	202006	1
12-15	Stem Kit Rge. D	202007	1	202007	1
8	Bonnet	Only Avail. with Kit	1	Only Avail. with Kit	1
11	Screw, Hx. Hd.	Only Avail. with Kit	8	Only Avail. with Kit	8
16	Bonnet Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
1-6, 8	Spring Kit Rge. V	202008	1	202008	1
11-16	with Bonnet Rge. D	202009	1	202009	1
12-14,	Spring Kit, Rge. V	202481	1	202481	1
16	less Bonnet Rge. D	202482	1	202482	1
17	Diaphragm	Only Avail. with Kit	1	Only Avail. with Kit	1
19	Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
16, 17, 19	Diaphragm Kit Rge. V	200770	1	200770	1
17	Diaphragms Rge. D	Only Avail. with Kit	2	Only Avail. with Kit	2
16, 17, 19	Diaphragm Kit Rge. D	200771	1	200771	1
19	Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
22	Nut, Retainer	Only Avail. with Kit	1	Only Avail. with Kit	1
23	Spring	Only Avail. with Kit	1	Only Avail. with Kit	1
24	Plug, Pilot	Only Avail. with Kit	1	Only Avail. with Kit	1
25	O-Ring	Only Avail. with Kit	1	Only Avail. with Kit	1
26	O-Ring	Only Avail. with Kit	1	Only Avail. with Kit	1
19, 22-26	Plug Kit, Pilot	200777	1	200777	1
21	Adapter	Only Avail. with Kit	1	Only Avail. with Kit	1
19, 22-26	Plug Kit, Pilot A4AO/A4AOS	Only Avail. with Kit	1	Only Avail. with Kit	1
21, 19, 22-26	Outlet Regulator Kit	OR-50 (200516)	1	OR-50 (200516)	1
	(See List Price Schedule)				
20	Ring/Tube Assbly, Flge.	Only Avail. with Kit	1	Only Avail. with Kit	1
45	Gasket, Flange	Only Avail. with Kit	1	Only Avail. with Kit	1
20, 45	Flge. Ring/Tube Kit A4AO/A4AL	FRT-20 (200439)	1	FRT-25 (200439)	1
27	Plug Pkg. 1/4" NPT	202552	5	202552	5
28	Adapter, A4AO/A4AOE	Only Avail. with Kit	1	Only Avail. with Kit	1
29	Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
19, 28, 29	Adapter Kit A4AO/A4AOE	200703	1	200703	1
28A	Adapter, A4AOS/A4AOSE	Only Avail. with Kit	1	Only Avail. with Kit	1
29	Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
19, 28A, 29	Adapter Kit A4AOS/A4AOSE	MD-25 (200591)	1	MD-25 (200591)	1
	(See List Price Schedule)				
30	Piston/Stem Assembly	Only Avail. with Kit	1	Only Avail. with Kit	1
29, 30	Piston Kit	200760	1	200760	1
32	Valve Body	Not Available		Not Available	
34	Spring, Comp.	Only Avail. with Kit	1	Only Avail. with Kit	1
35	Washer, Flat	Only Avail. with Kit	1	Only Avail. with Kit	1
36	Wiper, Dirt	Only Avail. with Kit	1	Only Avail. with Kit	1
37	"O" Ring	Only Avail. with Kit	1	Only Avail. with Kit	1
34-37	Spring Kit, Closing	202300	1	202300	1



# Repair Kits for A4AO, A4AOE, A4AOS and A4AOSE



Item No.	Description	20mm (3/4")		25mm (1")	
		Kit No.	Qty	Kit No.	Qty
33	Plug/Stem Assembly	Only Avail. with Kit	1	Only Avail. with Kit	1
40	Washer, Flat	Only Avail. with Kit	1	Only Avail. with Kit	1
41	Packing, Stem	Only Avail. with Kit	1	Only Avail. with Kit	1
42	Nut, Packing	Only Avail. with Kit	1	Only Avail. with Kit	1
33, 34-37, 40-42	Full Cap. Plug Kit, Modul.	202021	1	202022	1
33, 34-37, 40-42	50% Cap. Plug Kit, Modul.	202029	1	(*)	
33, 34-37, 40-42	35% Cap. Plug Kit, Modul.	Not Available		Not Available	
33, 34-37, 40-42	17% Cap. Plug Kit, Modul.	202030	1	(*)	
37	"O" Ring	Only Avail. with Kit	1	Only Avail. with Kit	1
38	Cover, Bottom	Only Avail. with Kit	1	Only Avail. with Kit	1
40	Washer, Flat	Only Avail. with Kit	1	Only Avail. with Kit	1
41	Packing, Stem	Only Avail. with Kit	1	Only Avail. with Kit	1
37, 38, 40, 41	Cover Kit	200761	1	200761	1
42	Nut, Packing	Only Avail. with Kit	1	Only Avail. with Kit	1
40-42	Packing Kit, Stem	202100	1	202100	1
43	Gasket	Only Avail. with Kit	1	Only Avail. with Kit	1
44	Seal Cap	Only Avail. with Kit	8	Only Avail. with Kit	8
43, 44	Seal Cap, Kit	202110	1	202110	1
33-38, 40-44	Full Cap. Bottom Assembly Kit	202010	1	202011	1
33-38, 40-44	50% Cap. Bottom Assembly Kit	202347	1	(*)	1
33-38, 40-44	17% Cap. Bottom Assembly Kit	202346	1	(*)	1
3-6, 12-19,	Full Cap. Repair				
29, 30, 33-37	Kit, Req. Rge. V	202040	1	202043	1
40-42	Rge. D	202042	1	202045	1
3-6, 12-19,	50% Cap. Repair				
29, 30, 33-37	Kit, Req. Rge. V	202354	1	(*)	1
40-42	Rge. D	202353	1	(*)	1
3-6, 12-19,	17% Cap. Repair				
29, 30, 33-37	Kit, Req. Rge. V	202351	1	(*)	1
40-42	Rge. D	2023050	1	(*)	1
2, 16(2), 19(2)					
25, 26, 29, 37,	Gasket Kit A4/S4	202112		2021121	
43, 45(3)					
<b>Indv'l Gaskets, "O" Rings &amp; Valve Pkg sold &amp; pkgd in qtls only as indicated</b>					
29	Gasket Pkg. Adapter	202406	5	202406	5
37	"O" Ring/Gasket Pkg. Bottom Cap	202384	3	202384	3
43	Gasket Pkg. Seal Cap (Bottom)	202408	12	202408	12
2	Gasket Pkg. Seal Cap (Top)	202408	12	202408	12
45	Gasket Pkg. Flange	202079	12	202079	12
4	Packing Pkg. Stem (Top)	202478	25	202478	25
41	Packing Pkg. Stem (Bottom)	202478	25	202478	25
<b>Bolt Package Kits</b>					
11	Bolt Package, A4AO Bonnet	202247	8	202247	8
31	Bolt Package, Adapter	202248	8	202249	8
39	Bolt Package, Bottom Cap	Not Required		Not Required	
<b>Flange Bolt Package includes bolts and nuts; no gaskets</b>					
46, 47	Bolt Kit, Flange	201585	1	201585	1

(\*) All Plug Kits and Bottom Assembly Kits for 3/4" Port Size Valves can be used in the 1" Port Size Valves for reducing capacity.

(\*\*) All Plug Kits and Bottom Assembly Kits for 1-5/8" Port Size Valves can be used in the 2" Port Size Valves for reducing capacity.

## Repair Kits for A4AO, A4AOE, A4AOS and A4AOSE

Item No.	32mm (1-1/4")		40mm (1-5/8")		50mm (2")		65mm (2-1/2")		75mm (3")		100mm (4")	
	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty
33	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
40	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
41	202110	1	202110	1	202110	1	202110	1	202110	1	202110	1
42	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
33, 34-37, 40-42	202023	1	202024	1	202025	1	202025	1	202027	1	202028	1
33, 34-37, 40-42	Not Available		Not Available		Not Available		Not Available		Not Available		Not Available	
33, 34-37, 40-42	202031	1	202032	1	(**)		202033	1	202034	1	202035	1
33, 34-37, 40-42	Not Available		Not Available		Not Available		Not Available		Not Available		Not Available	
37	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
38	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
40	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
41	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
37, 38, 40, 41	200761	1	Not Available		Not Available		Not Available		Not Available		Not Available	
42	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
40-42	202100	1	202100	1	202100	1	202100	1	202101	1	202101	1
43	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
44	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1
43, 44	202110	1	202110	1	202110	1	202110	1	202110	1	202110	1
33-38, 40-44	202012	1	202013	1	202014	1	202015	1	202016	1	202017	1
33-38, 40-44	Not Available		Not Available		Not Available		Not Available		Not Available		Not Available	
33-38, 40-44	Not Available		Not Available		Not Available		Not Available		Not Available		Not Available	
3-6, 12-19	202047	1	202050	1	202053	1	202056	1	202059	1	202062	1
29, 30, 33-37	202046	1	202049	1	202052	1	202055	1	202058	1	202061	1
40-42	202048	1	202051	1	202054	1	202057	1	202060	1	202063	1
3-6, 12-19, 29-30, 33-37, 40-42	NOTE: 50% Capacity Repair Kit is not available for port sizes 1-1/4" to 4". Capacity reduction can be obtained through use of field installing "Reduced Capacity Plug Kits". See description and contents of these kits elsewhere in this section.											
3-6, 12-19, 29-30, 33-37, 40-42	NOTE: 17% Capacity Repair Kit is not available for port sizes 1-1/4" to 4". Capacity reduction can be obtained through use of field installing "Reduced Capacity Plug Kits". See description and contents of these kits elsewhere in this section.											
2, 16(2), 19(2),	<b>Gasket Kits (includes complete set of gaskets plus "O" Rings if applicable)</b>											
25, 26, 29, 37,	202113		202114		202114		202115		202116		202117	
43, 45(3)												
<b>Individual Gaskets, "O" Rings and Valve Packing sold and packaged in quantities only as directed.</b>												
29	202407	5	202397	3	202397	3	202396	3	202399	3	202400	3
37	202384	3	202374	6	202374	6	202374	6	202382	3	202383	3
43	202408	12	202408	12	202408	12	202408	12	202404	5	202404	5
2	202408	12	202408	12	202408	12	202408	12	202408	12	202408	12
45	202080	12	202081	12	202081	12	202082	12	202083	12	202084	12
4	202478	25	202478	25	202478	25	202478	25	202478	25	202478	25
41	202478	25	202478	25	202478	25	202478	25	202479	5	202479	5
<b>Bolt Package Kits</b>												
11	202247	8	202247	8	202247	8	202247	8	202247	8	202247	8
31	202248	8	202249	8	202249	8	202249	8	202250	6	202250	6
39	Not Required		202251	6	202251	6	202251	6	202252	6	202252	6
<b>Flange Bolt Package includes bolts and nuts; no gaskets</b>												
46, 47	201595	1	201604	1	201604	1	201611	1	201611	1	201620	1

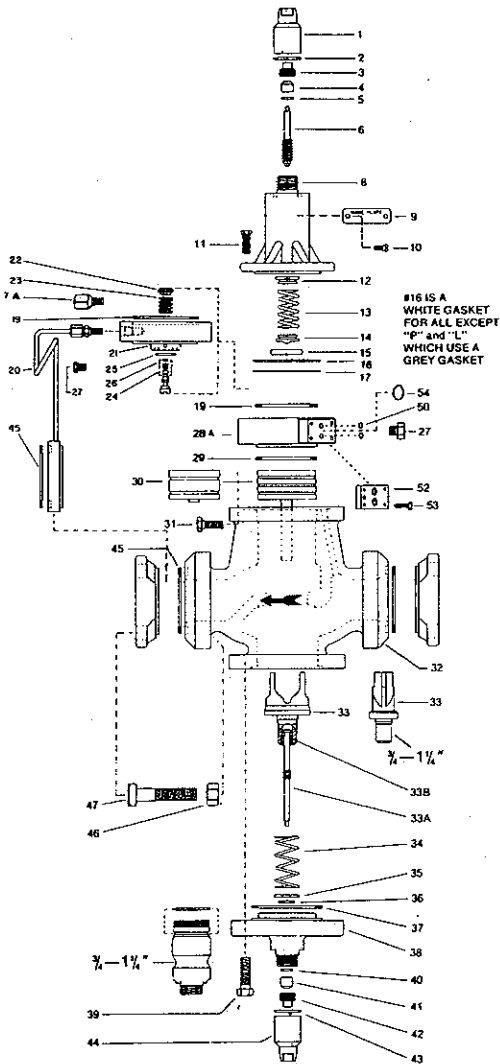
(\*) All Plug Kits and Bottom Assembly Kits for 3/4" Port Size Valves can be used in the 1" Port Size Valves for reducing capacity.

(\*\*) All Plug Kits and Bottom Assembly Kits for 1-5/8" Port Size Valves can be used in the 2" Port Size Valves for reducing capacity.

# Repair Kits for A4AO, A4AOE, A4AOS and A4AOSE

Item No.	Description	20mm (3/4")		25mm (1")	
		Kit No.	Qty	Kit No.	Qty
Flange Bolt Package includes bolts and nuts; no gaskets					
50, 52-54	Moduplate Kit "MP"	200518		200518	
52	Moduplate	Only Avail. with Kit	1	Only Avail. with Kit	1
54	O-Ring, "B"	Only Avail. with Kit	1	Only Avail. with Kit	1
50	O-Ring, "S", "D"	Only Avail. with Kit	2	Only Avail. with Kit	2

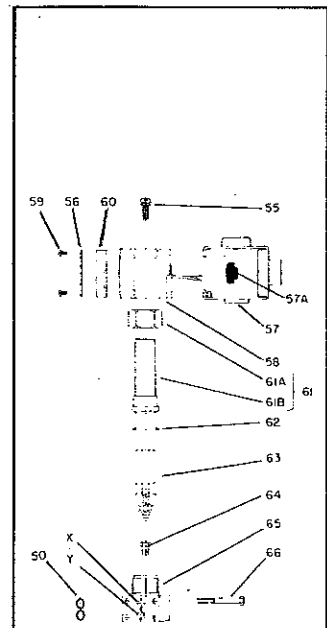
Flange Kit Specify Flange, Style, Connection, Size	FK-20				FK-25			
	FPT, SW, WN		ODS		FPT, SW, WN		ODS	
	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail
Kit includes 2 Flanges only	3/4	1, 1 1/4	7/8	1 1/2, 1 3/4	1	3/4, 1 1/4	1 1/2	1 3/4, 1 3/8



**A4AO, A4AOE, A4AOS & A4AOSE**  
**Note: 28A Adapter, 52 Moduplate used only with A4AOS/A4AOSE**  
**28 Adapter used only with A4AO/A4AOE**  
**Fig. 3**

## Repair Parts Kits for S6A Modular Pressure Pilot Solenoid

Item	Description	Qty	Kit Number
55	Screw	1	Only Available with Kit
57	Housing, Coil	1	Only Available with Kit
57A	Bushing, Seal	1	Only Available with Kit
59	Screw	2	Only Available with Kit
60	Cover, Solenoid	1	Only Available with Kit
55, 57 57A 59, 60	Housing Kit	1	201629
58	Coil Assembly	1	See Part No. Page 8
61B	Tube Assembly, Solenoid	1	Only Available with Kit
61A	Nut, Solenoid Tube	1	Only Available with Kit
62	Gasket	1	Only Available with Kit
61A, 61B 62	Tube Kit, Solenoid	1	201036
50	"O" Ring	2	Only Available with Kit Also available in package. See below.
66	Bolts	4	Only Available with Kit
50, 66	Bolt/"O" Ring Kit	1	201574
62	Gasket	1	Only Available with Kit
63	Plunger/Needle Assembly	1	Only Available with Kit
62, 63	Plunger Kit, Needle	1	202019
62	Gasket	1	Only Available with Kit
63	Plunger/Needle Assembly	1	Only Available with Kit
62, 63	Plunger Kit, Needle (D.C. only)	1	201021
62	Gasket	1	Only Available with Kit
63	Plunger/Needle Assembly	1	Only Available with Kit
64	Seat Assembly	1	Only Available with Kit
62, 63, 64	Plunger Seat Kit	1	201630
50	"O" Ring Pkg., Moduplate	12	202424
65	Body S6A	1	Not Available Separately

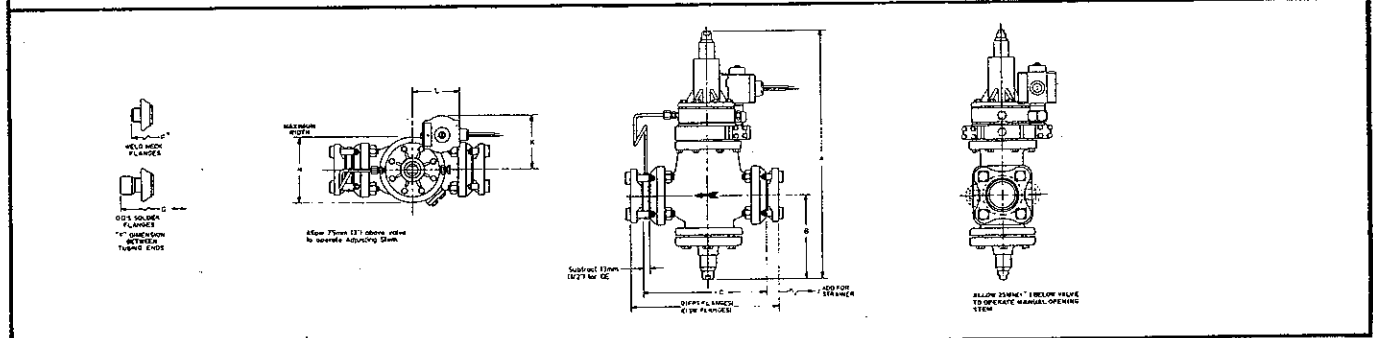
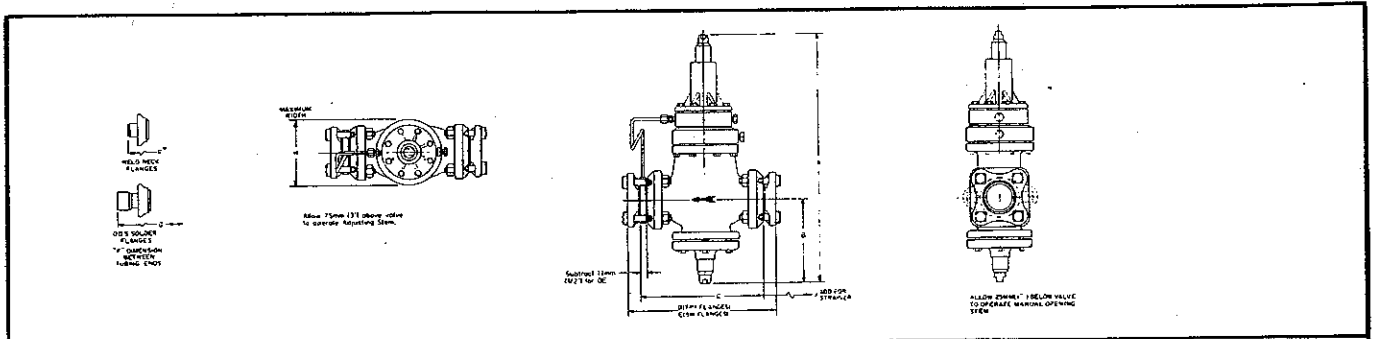


**S6A Modular Solenoid Pilot**  
**(For A4AOS/A4AOSE)**  
**Port Sizes 20-100mm 3/4"-4"**  
**Fig. 4**

# Repair Kits for A4AO, A4AOE, A4AOS and A4AOSE

		32mm (1-1/4")		40mm (1-5/8")		50mm (2")		65mm (2-1/2")		75mm (3")		100mm (4")	
Flange Bolt Package includes bolts and nuts; no gaskets (cont'd from page 9)													
Item No.	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	Kit No.	Qty	
50, 52-54	200518		200518		200518		200518		200518		200518		
52	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	
54	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	
50	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	Only Avail. with Kit	1	

		FK-32				FK-40				FK-50				FK-65				FK-75				FK-100			
		FPT, SW		ODS		FPT, SW		ODS		FPT, SW		ODS		FPT, SW		ODS		FPT, SW		ODS		FPT, SW		ODS	
		Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail	Std	Also Avail		
		1 1/4	1 1/2	1 3/8	1 5/8, 2 1/8	1 1/2	2	1 5/8	2 1/8, 2 3/8	2	1 1/2	2 1/8	2 3/8	2 1/2		2 3/8	3 1/8	3		3 1/8	3 3/8	4		4 1/8	



TYPE	20 mm & 25MM (3/4 & 1")		32mm (1-1/4")		40mm & 50MM (1-5/8 & 2")		65mm (2-1/2")		75mm (3")		100mm (4")							
		mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches					
A		454	17.9"	472	18.6"	525	20.7"	538	21.2"	657	25.9"	710	28.4"					
B		148	5.8"	162	6.3"	177	6.9"	181	7.1"	273	10.7"	292	11.5"					
C		177	6.7"	216	8.5"	264	10.4"	264	10.4"	324	12.7"	352	14.6"					
(D) (F.P.T.) FOR PIPE SIZES SHOWN	1/2"	229	9.0"	1-1/4"	269	10.6"	1-1/2"	320	12.6"	2-1/2"	344	13.5"	3"	402	15.8"	4"	463	18.2"
	3/4"	229	9.0"															
	1"	229	9.0"	1-1/2"	269	10.6"												
	1-1/4"	229	9.0"															
(E) (S.W.) FOR PIPE SIZES SHOWN	1/2"	229	9.0"	1-1/4"	269	10.6"	1-1/2"	320	12.6"	2-1/2"	344	13.5"	3"	402	15.8"	4"	463	18.2"
	3/4"	229	9.0"															
	1"	229	9.0"	1-1/2"	269	10.6"	2"	320	12.6"									
	1-1/4"	229	9.0"															
(F) (W.N.) FOR PIPE SIZES SHOWN	3/4"	267	10.5"	1-1/4"	313	12.3"	1-1/2"	377	14.8"	2-1/2"	414	16.1"	3"	491	19.3"	4"	584	23.0"
	1"	274	10.8"															
	1-1/4"	274	10.8"	1-1/2"	317	12.5"	2"	384	15.1"									
(G) (O.D.S.) FOR TUBE SIZES SHOWN	7/8"	252	9.9"	1-3/8"	282	11.1"	1-5/8"	371	14.6"	2-5/8"	361	14.2"	3-1/8"	427	16.8"			
	1-1/8"	252	9.9"	1-5/8"	292	11.5"	2-1/8"	351	13.8"									
	1-3/8"	244	9.6"	2-1/8"	318	12.5"	2-5/8"	371	14.6"	3-1/8"	402	15.8"	3-5/8"	445	17.5"	4-1/8"	516	20.3"
	1-5/8"	252	9.9"															
H		117	4.6"		117	4.6"		140	5.5"		159	6.2"		178	7.0"		222	8.8"
J		98	3.9"		178	7.0"		251	9.9"		314	12.4"		314	12.4"		363	14.3"
K		112	4.4"		112	4.4"		117	4.6"		124	4.9"		142	5.6"		157	6.2"
L		122	4.8"		122	4.8"		135	5.3"		133	5.2"		122	4.8"		152	6.0"

## FLANGES

VALVE SIZE		① FPT FLANGES		WELDING FLANGES								④ FLANGES				
		Nom. Pipe Size	Flange Pkg. No. (2/Pkg)	Nominal Pipe Size		Socket Weld Socket I.D.		Weld Neck Neck O.D.		Flange Package Number (2/Pkg)		Tubing O.D.		Fitting I.D.		Flg Pkg. No. (2/Pkg)
				Inches	② NW No.	Inches	mm	Inches	mm	Socket Weld	Weld Neck	Inches	③ mm	Inches	mm	
mm	Inches	Inches		Inches		Inches	mm	Inches	mm	Socket Weld	Weld Neck	Inches	mm	Inches	mm	
20	3/4	3/4	200016	3/4	20	1.070	27.81	1.050	26.67	200020	200023	1-1/8	28.57	1.130	28.70	200027
and	and	1	200017	1	25	1.365	34.67	1.315	33.40	200021	200024	1-3/8	34.92	1.380	33.05	200028
25	1	1-1/4	200018	1-1/4	32	1.705	43.31	1.660	42.16	200022	200025	1-5/8	41.27	1.631	41.43	200029
32	1-1/4	1-1/4	200030	1-1/4	32	1.705	43.31	1.660	42.16	200032	200034	1-3/8	34.92	1.380	35.05	200036
		1-1/2	200031	1-1/2	40	1.930	49.02	1.900	48.26	200033	200035	1-5/8	41.27	1.631	41.43	200037
												2-1/8	53.97	2.131	54.13	200038
40	1-5/8	1-1/2	200039	1-1/2	40	1.930	49.02	1.900	48.26	200041	200043	1-5/8	41.27	1.631	41.43	200045
and	and	2	200040	2	50	2.445	62.10	2.375	60.33	200042	200044	2-1/8	53.97	2.131	54.13	200046
50	2											2-5/8	66.67	2.631	66.8	200047
65	2-1/2	2-1/2	200048	2-1/2	65	2.945	—	2.875	73.03	200049	200050	2-5/8	66.67	2.631	66.83	200051
75	3											3-1/8	79.37	3.131	79.53	200052
		3	200053	3	80	3.575	90.81	3.500	88.90	200054	200055	3-1/8	79.37	3.131	79.53	200056
												3-5/8	92.07	3.631	92.23	200057
100	4	4	200062	4	100	4.575	116.20	4.500	114.30	200063	200064	4-1/8	104.77	4.132	104.95	200065

- ① FPT: Internal NPT (USA Standard Taper Pipe Thread).
- ② NW: Metric equivalent nominal size for steel tubing.
- ③ Metric copper tubing used for refrigeration.
- ④ ODS connections to fit copper tubing of given outside diameter. (Not for use with ammonia)

### Definitions:

ODS - Outside Diameter Sweat  
 I.D. - Inside Diameter  
 O.D. - Outside Diameter  
 N.A. - Not Available

### Flange Bolt Torque Requirements

Bolt Diameter	Valve Port Size	Torque
11mm (7/16")	13mm (1/2")	3.9 mkg (28 ft lb)
16mm (5/8")	20-50mm (3/4"-2")	11.8 mkg (85 ft lb)
19mm (3/4")	65-75mm (2-1/2"-3")	14.5 mkg (105 ft lb)
22mm (7/8")	100mm (4")	22.1 mkg (150 ft lb)

## Safe Operation

### (See also Bulletin RSB)

People doing any work on a refrigeration system must be qualified and completely familiar with the system and the Refrigerating Specialties Division valves involved, or all other precautions will be meaningless. This includes reading and understanding pertinent Refrigerating Specialties Division product Bulletins, and Safety Bulletin RSB prior to installation or servicing work.

Where cold refrigerant liquid lines are used, it is necessary that certain precautions be taken to avoid damage which could result from liquid expansion. Temperature increase in a piping section full of solid liquid will cause high pressure due to the expanding liquid which can possibly rupture a gasket, pipe or valve. All hand valves isolating such sections should be marked, warning against accidental closing, and must not be closed until the liquid is removed. Check valves must never be installed upstream of solenoid valves, or regulators with electric shut-off, nor should hand valves upstream of solenoid valves or downstream of check valves be closed until the liquid has been removed. It is advisable to properly install relief devices in any section where liquid expansion could take place.

Avoid all piping or control arrangements which might produce thermal or pressure shock.

For the protection of people and products, all refrigerant must be removed from the section to be worked on before a valve, strainer, or other device is opened or removed.

Flanges with ODS connections are not suitable for ammonia service.

## Warranty

All Refrigerating Specialties Products are warranted against defect in workmanship and materials for a period of one year from date of shipment from factory. This warranty is in force only when products are properly installed, field assembled, maintained and operated in use and service as specifically stated in Refrigerating Specialties Catalogs or Bulletins for normal refrigeration applications, unless otherwise approved in writing by Refrigerating Specialties Division. Defective products, or parts thereof, returned to the factory with transportation charges prepaid and found to be defective by factory inspection will be replaced or repaired at Refrigerating Specialties' option, free of charge, F.O.B. factory. Warranty does not cover products which have been altered or repaired in the field; damaged in transit, or have suffered accidents, misuse, or abuse. Products disabled by dirt, or other foreign substances will not be considered defective.

THE EXPRESS WARRANTY SET FORTH ABOVE CONSTITUTES THE ONLY WARRANTY APPLICABLE TO REFRIGERATING SPECIALTIES PRODUCTS, AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WRITTEN OR ORAL, INCLUDING ANY WARRANTY OR MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE. No employee, agent, dealer or other person is authorized to give any warranties on behalf of Refrigerating Specialties, nor to assume, for Refrigerating Specialties, any other liability in connection with any of its products.

# 627 Series Pressure Reducing Regulators

## Introduction

### Scope of Manual

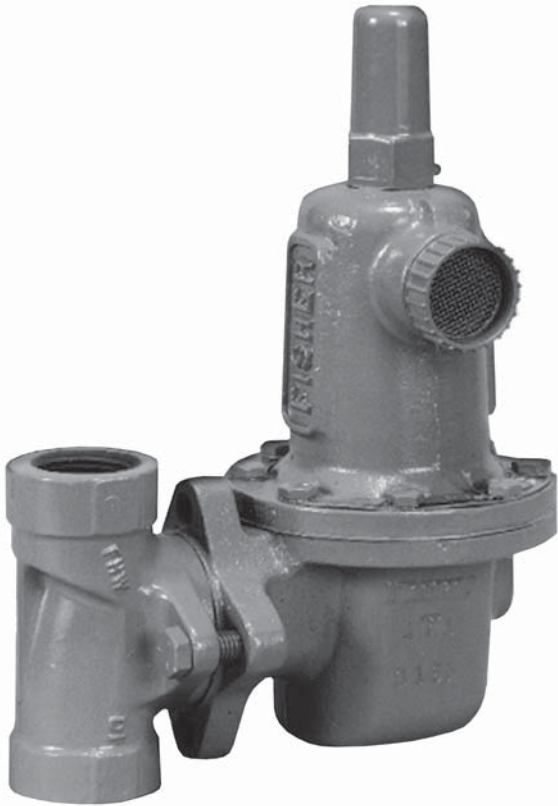
This manual provides instructions for the installation, adjustment, maintenance, and parts ordering for the 627 Series regulators. These regulators usually are shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the instruction manual for the other equipment for installation and operating instructions.

## Description

The 627 Series self-operated pressure reducing regulators (figure 1) are for high and low pressure systems. These regulators can be used with natural gas, air, or a variety of other gases. Performance characteristics vary according to construction (see the AVAILABLE CONFIGURATIONS specification in table 1).

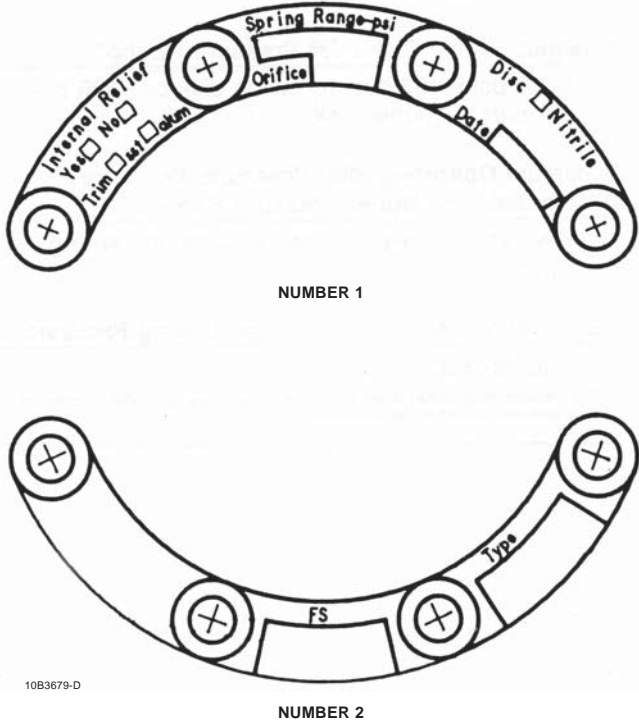
## Specifications

Table 1 gives some general specifications for the 627 Series regulators. The nameplates (figure 2) gives detailed information for a particular regulator as it comes from the factory.



W4793

Figure 1. Typical 627 Series Self-Operated Pressure Reducing Regulator



10B3679-D

NUMBER 2

Figure 2. Nameplates





# 627 Series

Table 1. Specifications

## Available Constructions

**Type 627:** Self-operated pressure reducing regulator equipped with a pitot tube for greater regulated capacities (figure 7)

**Type 627R:** Type 627 with internal relief and with an open throat (figure 8)

**Type 627M:** Type 627 with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4-inch NPT downstream control line connection (figure 9)

**Type 627MR:** Type 627M with internal relief (figure 10)

**Type 627H:** Type 627 with a diaphragm limiter to deliver a higher outlet pressure (figure 11)

**Type 627HM:** Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through two 1/4-inch NPT downstream control line connections (figure 12)

## Body Sizes

3/4, 1, or 2-inch

## End Connection Styles

**3/4, 1, or 2-inch body sizes:** NPT

**1 or 2-inch body sizes:** ANSI Class 300 or 600 RF flanged

## Maximum Inlet Pressure<sup>(1)</sup> (Body Rating)

2000 psig (138 bar) for NPT steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron

## Maximum Valve Disk Inlet Pressure Rating<sup>(1)</sup>

2000 psig (138 bar) for nylon disk or 1000 psig (69 bar) for nitrile disk

## Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges<sup>(1)</sup>

See table 2 for pressures by port and spring range

## Maximum Spring and Diaphragm Casing Pressure<sup>(1)</sup>

See table 3

## Maximum Body Outlet Pressure<sup>(1)</sup> (Type 627M, 627MR, and 627HM Only)

2000 psig (138 bar) for screwed steel, 1480 psig (102 bar) for RF flanged steel, or 1000 psig (69 bar) for ductile iron. (Type 627 and 627R are limited by maximum diaphragm casing pressure)

## Port Diameters

See table 2

## Internal Relief Performance

**Type 627R:** See table 4

**Type 627MR:** Limited by field-installed control line piping

## Temperature Capabilities<sup>(1)</sup>

-20 to 180°F (-29 to 82°C)

## Pressure Registration

**Type 627, 627H or 627R:** Internal

**Type 627M, 627HM or 627MR:** External through 1/4-inch NPT control line connection in the diaphragm casing

## De-Icer System

See figure 3 and Type 627M Regulator De-Icer System Application section

## Relief Indicator

For 627R and 627MR (see figures 8 and 9)

## Spring Case Vent Connection

3/4-inch NPT female with removable screened vent assembly

## Control Line Connection (Type 627M, 627HM or 627MR Only)

1/4-inch NPT female

## Approximate Weight

**Ductile Iron or Steel Casings:** 10 pounds (4,5 kg)

**Aluminum Casings:** 6.3 pounds (2.8 kg)

1. The pressure/temperature limits in this instruction manual or any applicable standard limitation should not be exceeded.

Table 2. Maximum Inlet Pressures, Differential Pressures, and Outlet Pressure Ranges

TYPE NUMBER	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	ORIFICE SIZE, INCHES (mm)	MAXIMUM INLET PRESSURE, PSIG (bar)	MAXIMUM DIFFERENTIAL PRESSURE, PSID (bar)
627 and 627M <sup>(3)</sup>	5 <sup>(2)</sup> to 20 psig (0,34 to 1,4 bar)  10B3076X012 Yellow	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	250 (17,2)	250 (17,2)
	15 to 40 psig (1,0 to 2,8 bar)  10B3077X012 Green	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	1500 (103) <sup>(1)</sup>	1500 (103) <sup>(1)</sup>
		3/16 (4,8)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	500 (34,5)	500 (34,5)
		1/2 (12,7)	300 (20,7)	300 (20,7)
	35 to 80 psig (2,4 to 5,5 bar)  10B3078X012 Blue	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		3/16 (4,8)	1750 (121) <sup>(1)</sup>	1750 (121) <sup>(1)</sup>
		1/4 (6,4)	1500 (103) <sup>(1)</sup>	1500 (103) <sup>(1)</sup>
3/8 (9,5)		1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>	
1/2 (12,7)		750 (51,7)	750 (51,7)	
70 to 150 psig (4,8 to 10,3 bar)  10B3079X012 Red	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>	
	1/8 (3,2)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>	
	3/16 (4,8)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>	
	1/4 (6,4)	1750 (121) <sup>(1)</sup>	1750 (121) <sup>(1)</sup>	
	3/8 (9,5)	1250 (86,2) <sup>(1)</sup>	1250 (86,2) <sup>(1)</sup>	
	1/2 (12,7)	750 (51,7)	750 (51,7)	
627R and 627MR	5 <sup>(2)</sup> to 20 psig (0,34 to 1,4 bar)  10B3076X012 Yellow	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		3/16 (4,8)	750 (51,7)	750 (51,7)
		1/4 (6,4)	500 (34,5)	500 (34,5)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	200 (13,8)	200 (13,8)
	15 to 40 psig (1,0 to 2,8 bar)  10B3077X012 Green	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	1500 (103) <sup>(1)</sup>	1500 (103) <sup>(1)</sup>
		3/16 (4,8)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		1/4 (6,4)	750 (51,7)	750 (51,7)
		3/8 (9,5)	300 (20,7)	300 (20,7)
		1/2 (12,7)	200 (13,8)	200 (13,8)
	35 to 80 psig (2,4 to 5,5 bar)  10B3078X012 Blue	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	1750 (121) <sup>(1)</sup>	1750 (121) <sup>(1)</sup>
		3/16 (4,8)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		1/4 (6,4)	750 (51,7)	750 (51,7)
3/8 (9,5)		300 (20,7)	300 (20,7)	
1/2 (12,7)		200 (13,8)	200 (13,8)	
70 to 150 psig (4,8 to 10,3 bar)  10B3079X012 Red	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>	
	1/8 (3,2)	1000 (69) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>	
	3/16 (4,8)	500 (34,5)	500 (34,5)	
	1/4 (6,4)	300 (20,7)	300 (20,7)	
	3/8 (9,5)	200 (13,8)	200 (13,8)	
	1/2 (12,7)	200 (13,8)	200 (13,8)	
627H and 627MH <sup>(3)</sup>	140 to 250 psig (9,7 to 17,2 bar)  10B3078X012 Blue	3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		3/16 (4,8)	1750 (121) <sup>(1)</sup>	1750 (121) <sup>(1)</sup>
		1/4 (6,4)	1500 (103) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>
		3/8 (9,5)	1000 (69) <sup>(1)</sup>	500 (34,5)
	240 to 500 psig (16,5 to 34,5 bar)  10B3079X012 Red	1/2 (12,7)	750 (51,7)	250 (17,2)
		3/32 (2,4)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		1/8 (3,2)	2000 (138) <sup>(1)</sup>	2000 (138) <sup>(1)</sup>
		3/16 (4,8)	1750 (121) <sup>(1)</sup>	1750 (121) <sup>(1)</sup>
		1/4 (6,4)	1500 (103) <sup>(1)</sup>	1000 (69) <sup>(1)</sup>

1. For inlet pressure in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specification table.  
 2. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.  
 3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627MH should have a 3/8-inch (9,5 mm) or larger orifice when used as a wide-open monitor.

# 627 Series

Table 3. Maximum Spring and Diaphragm Casing Pressure(1)

MAXIMUM PRESSURE DESCRIPTION	SPRING AND DIAPHRAGM CASING STYLE	TYPE 627, PSIG (bar)	TYPE 627R, PSIG (bar)	TYPE 627M, PSIG (bar)	TYPE 627MR, PSIG (bar)	TYPE 627H AND 627HM, PSIG (bar)
Maximum pressure to spring and diaphragm casings to prevent leak to atmosphere other than relief action (internal parts damage may occur)	Die cast aluminum	250 (17,2)	250 (17,2)	Not Available	Not Available	Not Available
	Die cast aluminum	250 (17,2)	250 (17,2)	250 (17,2)	Not Available	Not Available
	Steel	250 (17,2)	250 (17,2)	250 (17,2)	250 (17,2)	800 (55,2)
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375 (25,9)	375 (25,9)	Not Available	Not Available	Not Available
	Ductile iron	465 (32)	465 (32)	465 (32)	465 (32)	Not Available
	Steel	1500 (103)	1500 (103)	1500 (103)	1500 (103)	1500 (103)
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All styles	60 (4,1)	120 (8,3)	60 (4,1)	120 (8,3)	120 (8,3)

1. If the spring case is pressurized, a metal adjusting screw cap is required. Contact your Fisher Sales Representative.

## WARNING

**Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-pressured or is installed where service conditions could exceed the limits given in tables 1, 2, 3, and 4, or where conditions exceed any ratings of the adjacent piping or piping connections.**

**To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits. The Type 627R or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in tables 1, 2, 3 and 4. If these limits are exceeded additional downstream overpressure protection must be provided by the user.**

**Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe location.**

## Installation

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in figures 7 through 12. Ensure that the operating temperature capabilities listed in table 1 are not exceeded.

Like most regulators, 627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure relieving or pressure limiting device must be provided by the user for the Type 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

Type 627R regulators provide internal relief which limits the total outlet pressure buildup over setpoint. Use table 4 to determine the total outlet pressure. This internal relief may be adequate for the application, if not, provide additional pressure relief or a pressure limiting device downstream.

### Note

**If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.**

Perform steps 1 through 6 for all types of regulators:

1. Only personnel qualified through training and experience should install, operate, or maintain this regulator.
2. For a regulator that is shipped separately, make sure that there is no damage to, or foreign material in, the regulator.
3. Ensure that all tubing and piping have been blown free of foreign debris.
4. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body.
5. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the regulator.

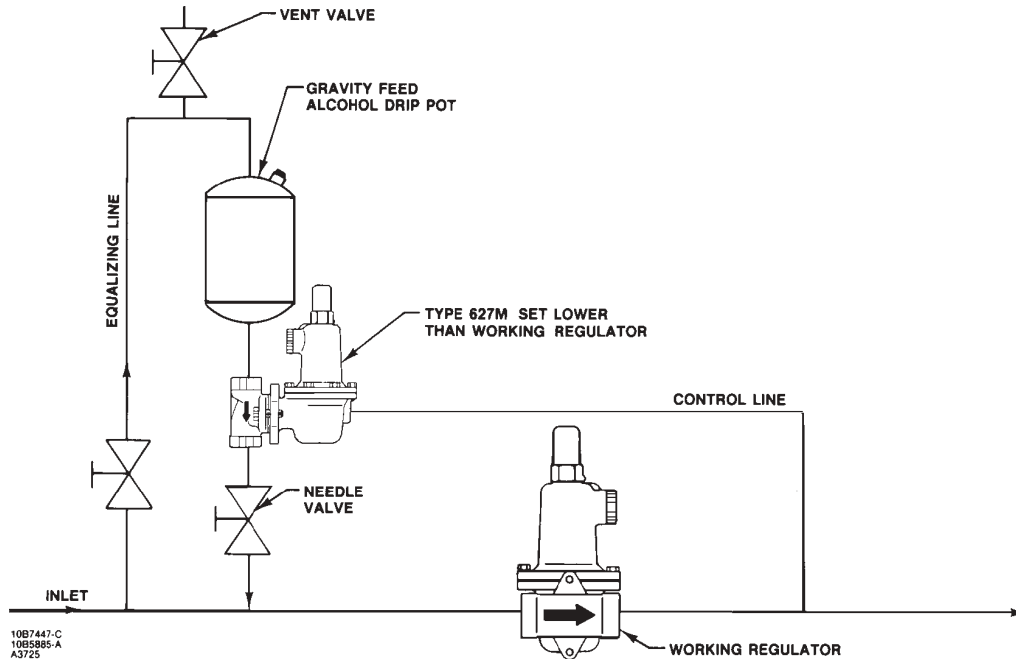


Figure 3. Schematic of De-Icer System



## WARNING

**A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.**

6. Position the body (key 1) and/or diaphragm spring case (key 29) so it will not collect moisture or debris into the screened vent. If the regulator requires repositioning, refer to the body area maintenance procedures and/or the diaphragm case area maintenance procedures in the Maintenance section to reposition the screened vent for the application.

**Perform steps 7 through 9 for Types 627M, 627HM, and 627MR regulators only:**

7. A Type 627M, 627HM, or 627MR regulator requires a downstream control line. Install the control line before putting the regulator into operation.

8. Ensure that the downstream control line piping is at least 3/8-inch or larger outside diameter tubing and

connected to a straight section of outlet piping 10 diameters downstream of the regulator.

9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

## Remote Vent Line Installation

All 627 series regulators have a vent assembly installed in the 3/4-inch NPT spring case vent opening. The vent assembly can be removed to install a remote vent line if necessary. Remote vent lines must have the largest practical diameter. The vent line should be as short as possible with a minimum number of bends or elbows.

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

## Type 627M or 627HM Regulator De-Icer System Application

For the Type 627M or 627HM regulator de-icer system, refer to the application shown in figure 3. With a large pressure drop across the working regulator, ice can

# 627 Series

Table 4. Type 627R Internal Relief Performance<sup>(1)</sup>

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) <sup>(2)</sup>					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	3/8 (9,5)	1/2 (12,7)
5 <sup>(3)</sup> to 20 psig (0,34 to 1,4 bar) 10B3076X012 Yellow	10 (0,69)	60 (4,1)	1250 (86,2)	740 (51,1)	320 (22,1)	190 (13,1)	95 (6,56)	75 (5,18)
		100 (6,9)	2000 (138)	1500 (103)	620 (42,7)	390 (26,9)	180 (12,4)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	830 (57,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
	15 (1,0)	60 (4,1)	1000 (69,0)	620 (42,7)	260 (17,9)	170 (11,7)	90 (6,2)	70 (4,8)
		100 (6,9)	2000 (138)	1400 (96,5)	610 (42,1)	370 (25,5)	170 (11,7)	130 (8,97)
		125 (8,6)	2000 (138)	1900 (131)	810 (55,8)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
15 to 40 psig (1,0 to 2,8 bar) 10B3077X012 Green	20 (1,4)	60 (4,1)	850 (58,6)	490 (33,8)	210 (14,5)	130 (9,0)	80 (5,52)	65 (4,49)
		100 (6,9)	2000 (138)	1300 (89,6)	600 (41,4)	360 (24,8)	170 (11,7)	120 (8,28)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	480 (33,1)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	770 (53,1)	360 (24,8)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	960 (66,2)	450 (31,0)	320 (22,1)
	15 (1,0)	60 (4,1)	1000 (69,0)	380 (26,2)	210 (14,5)	130 (8,97)	80 (5,5)	65 (4,49)
		100 (6,9)	2000 (138)	1300 (89,6)	590 (40,7)	350 (24,1)	170 (11,7)	120 (8,28)
		125 (8,6)	2000 (138)	1800 (124)	800 (55,2)	470 (32,4)	220 (15,2)	160 (11,0)
		175 (12,1)	2000 (138)	2000 (138)	1100 (75,8)	640 (44,1)	320 (22,1)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1300 (89,6)	780 (53,8)	370 (25,5)	260 (17,9)
		250 (17,2)	2000 (138)	2000 (138)	1600 (66,2)	960 (66,2)	450 (31,0)	320 (22,1)
30 (2,1)	100 (6,9)	2000 (138)	950 (65,5)	450 (31,1)	260 (17,9)	140 (9,66)	110 (7,59)	
	125 (8,6)	2000 (138)	1500 (103)	670 (46,2)	400 (27,6)	190 (13,1)	150 (10,3)	
	175 (12,1)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	300 (20,7)	220 (15,2)	
	200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	760 (52,4)	360 (24,8)	260 (17,9)	
	250 (17,2)	2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)	
	40 (2,8)	100 (6,9)	1500 (103)	700 (48,3)	330 (22,8)	200 (13,8)	120 (8,28)	108 (7,45)
125 (8,6)		2000 (138)	1300 (89,6)	560 (38,6)	340 (23,4)	180 (12,4)	140 (9,66)	
175 (12,1)		2000 (138)	1800 (124)	1000 (69,0)	550 (37,9)	290 (20,0)	220 (15,2)	
200 (13,8)		2000 (138)	2000 (138)	1200 (82,7)	730 (50,3)	350 (24,1)	250 (17,2)	
250 (17,2)		2000 (138)	2000 (138)	1600 (110)	970 (66,9)	460 (31,7)	320 (22,1)	

form with in this regulator. The formation of ice decreases the size of the port opening, so the regulator is unable to supply enough flow to satisfy the downstream demand. When the downstream pressure falls below the outlet pressure setting of the Type 627M or 627HM regulator, the disk assembly of the Type 627M or 627HM regulator moves off its seat ring, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flow stream prevents additional ice from forming on the seat ring. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

## Startup and Adjustment

### Startup




**WARNING**

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during startup, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.



Table 4. Type 627R Internal Relief Performance<sup>(1)</sup> (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR	OUTLET PRESSURE SETTING, PSIG (bar)	MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE, PSIG (bar)	MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED, PSIG (bar) <sup>(2)</sup>					
			Orifice Size, Inches (mm)					
			3/32 (2,4)	1/8 (3,2)	3/16 (4,8)	1/4 (6,4)	3/8 (9,5)	1/2 (12,7)
35 to 80 psig (2,4 to 5,5 bar) 10B3078X012 Blue	40 (2,8)	125 (8,6)	2000 (138)	1100 (75,8)	500 (34,5)	300 (20,7)	170 (11,7)	140 (9,66)
		150 (10,3)	2000 (138)	1600 (110)	750 (51,7)	440 (30,3)	230 (15,9)	180 (12,4)
		175 (12,1)	2000 (138)	2000 (138)	980 (67,6)	580 (40,0)	290 (20,0)	220 (15,2)
		200 (13,8)	2000 (138)	2000 (138)	1200 (82,7)	720 (49,6)	340 (23,4)	250 (17,2)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	940 (64,8)	450 (31,0)	320 (22,1)
	50 (3,4)	125 (8,6)	1400 (96,5)	820 (56,5)	400 (27,6)	230 (15,9)	150 (10,3)	140 (9,66)
		150 (10,3)	2000 (138)	1400 (96,5)	650 (44,8)	370 (25,5)	210 (14,5)	170 (11,7)
		175 (12,1)	2000 (138)	1900 (131)	700 (48,3)	530 (36,5)	270 (18,6)	210 (14,5)
		200 (13,8)	2000 (138)	2000 (138)	1100 (75,8)	670 (46,2)	330 (22,8)	240 (16,5)
		250 (17,2)	2000 (138)	2000 (138)	1500 (103)	920 (63,4)	430 (29,6)	320 (22,1)
	60 (4,1)	125 (8,6)	900 (62,1)	450 (31,1)	270 (18,6)	190 (13,1)	140 (9,66)	130 (8,97)
		150 (10,3)	1700 (117)	1100 (75,8)	540 (37,2)	300 (20,7)	190 (13,1)	160 (11,0)
		175 (12,1)	2000 (138)	1700 (117)	780 (53,8)	470 (32,4)	250 (17,2)	200 (13,8)
		200 (13,8)	2000 (138)	2000 (138)	1000 (69,0)	610 (42,1)	310 (21,4)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1400 (96,5)	880 (60,7)	420 (29,0)	310 (21,4)
	70 (4,8)	150 (10,3)	1200 (82,7)	850 (58,6)	430 (29,6)	250 (17,2)	170 (11,7)	160 (11,0)
		175 (12,1)	2000 (138)	1400 (96,5)	670 (46,2)	400 (27,6)	230 (15,9)	190 (13,1)
		200 (13,8)	2000 (138)	2000 (138)	920 (63,4)	550 (37,9)	280 (19,3)	230 (15,9)
		250 (17,2)	2000 (138)	2000 (138)	1300 (89,6)	830 (57,2)	400 (27,6)	310 (21,4)
		150 (10,3)	800 (55,2)	500 (34,5)	300 (20,7)	200 (13,8)	160 (11,0)	150 (10,3)
80 (5,5)	175 (12,1)	1500 (103)	1200 (82,7)	550 (37,9)	330 (22,8)	210 (14,5)	190 (13,1)	
	200 (13,8)	2000 (138)	1700 (117)	800 (55,2)	480 (33,1)	270 (18,6)	220 (15,2)	
	250 (17,2)	2000 (138)	2000 (138)	1200 (82,7)	770 (53,1)	390 (26,9)	300 (20,7)	
	175 (12,1)	1400 (96,5)	250 (17,2)	240 (16,5)	200 (13,8)	190 (13,1)	175 (12,1)	
	200 (13,8)	2000 (138)	960 (66,2)	520 (35,9)	330 (22,8)	240 (16,5)	210 (14,5)	
70 to 150 psig (4,8 to 10,3 bar) 10B3079X012 Red	70 (4,8)	250 (17,2)	2000 (138)	2000 (138)	1100 (75,8)	680 (46,9)	360 (24,8)	290 (20,0)
		175 (12,1)	1400 (96,5)	250 (17,2)	240 (16,5)	200 (13,8)	190 (13,1)	175 (12,1)
	80 (5,5)	200 (13,8)	2000 (138)	2000 (138)	1000 (69,0)	620 (42,7)	350 (24,1)	280 (19,3)
		250 (17,2)	2000 (138)	2000 (138)	1600 (110)	770 (53,1)	520 (35,9)	320 (22,1)
		200 (13,8)	1500 (103)	250 (17,2)	240 (16,5)	230 (15,9)	210 (14,5)	210 (14,5)
100 (6,9)	250 (17,2)	2000 (138)	1600 (110)	770 (53,1)	520 (35,9)	320 (22,1)	270 (18,6)	
125 (8,6)	250 (17,2)	2000 (138)	1000 (69,0)	500 (34,5)	390 (26,9)	290 (20,0)	260 (17,9)	
150 (10,3)	250 (17,2)	1200 (82,7)	260 (17,9)	260 (17,9)	260 (17,9)	260 (17,9)	260 (17,9)	

1. The internal relief performance values are obtained by removing the disk assembly.  
2. For inlet pressures in excess of 1000 psig (69 bar), refer to the maximum body and disk pressure ratings in the specifications table.  
3. For pressure settings under 10 psig (0,69 bar), inlet pressure should be limited to approximately 100 psig (6,9 bar) so the setpoint adjustment can be obtained.  
 - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 6 gives the maximum inlet pressure for normal regulator operation.

**In order to avoid an overpressure condition and possible equipment damage, pressure gauges should always be used to monitor pressures during startup.**

1. Slowly open the upstream shutoff valve.
2. Slowly open the downstream shutoff valve.
3. Check all connections for leaks.
4. Make final control spring adjustments according to the adjustment procedures.

## Adjustment

The range of allowable pressure settings is marked on the nameplate (figure 2). If a pressure setting beyond this range is necessary, substitute the appropriate regulator control spring. Change the nameplate to indicate the new pressure range.

Before increasing the setting, refer to tables 2, 3, or 4. Review the pressure limits for the control spring range being used and be certain that the new pressure setting will not result in an overpressure condition.

# 627 Series

Table 5. Maximum Torque Values

KEY NUMBER <sup>(1)</sup>	DESCRIPTION	MAXIMUM TORQUE, FOOT-POUNDS (N•m)
2	Seat ring	25 (34)
3	Cap screw (w/ aluminum diaphragm casing)	16 (22)
	Cap screw (w/ ductile iron or steel diaphragm casing)	25 (34)
18	Lever cap screw	7 (9)
22	Diaphragm connector nut	17 (23)
26	Guide retainer (for Type 627R and 627MR only)	3 (4)
37	Spring case cap screw (w/ aluminum or ductile iron diaphragm casing)	7 (9)
	Spring case cap screw (w/ steel diaphragm casing)	35 (47)
46	Diaphragm cap screw (w/Type 627 or 627M)	7 (9)
	Diaphragm cap screw (w/Type 627H or 627MH)	14 (19)

1. Refer to figures 7 through 10 for key number locations.

### Note

**Always use a pressure gauge to monitor pressure when making adjustments.**

Refer to figures 7 through 12 for key number locations.

1. Remove the adjusting screw cap (key 36).
2. Loosen the locknut (key 34).
3. Increase the outlet pressure setting by turning the adjusting screw (key 35) clockwise. Decrease the outlet pressure setting by turning the adjusting screw counter-clockwise.
4. When the desired pressure is obtained, hold the adjusting screw (key 35) in place and tighten the locknut (key 34).

## Shutdown



### WARNING

**To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during shutdown, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.**

1. Close the nearest upstream shutoff valve.
2. Close the nearest downstream shutoff valve.

3. Open the vent valve between the regulator and the downstream shutoff valve nearest to it.

4. For a Type 627, 627H, or 627R regulator, the regulator will open to release pressure between the upstream shutoff valve and the regulator.

5. A Type 627M, 627HM, or 627MR regulator requires venting the control line and downstream pressure from the regulator before maintenance. The pressure between these shutoff valves is released through the open regulator because the disk assembly remains open in response to the decrease in control line pressure.

## Maintenance

Unless otherwise specified, the following maintenance procedures apply to all types of regulators. For a summary of maximum torque values required for all types of regulators, refer to table 5.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, seat ring, and diaphragm must be inspected periodically and replaced as necessary to ensure correct performance. The frequency of inspection and replacement depends upon the severity of conditions and the requirements of state and federal laws. Normal wear of the seat ring and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flow stream. Instructions are given below for replacing the disk assembly, seat ring, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.

## Problem Indication for Type 627R and 627MR Regulators



### WARNING

Isolate the regulator from all pressure to avoid personal injury and equipment damage due to explosion or sudden release of process pressure. Cautiously release pressure from the regulator before attempting disassembly.

The vent assembly is equipped with a relief indicator (key 49, figure 4). The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, refer to the shutdown and to the body area maintenance procedures to inspect the disk assembly and seat ring.

If the disk assembly and seat ring are not damaged, refer to the diaphragm and spring case area maintenance procedures in this section.

The disk assembly and seat ring can be inspected, removed, and replaced without removing the regulator body from the line connections. Refer to the body area maintenance procedures.

## Body Area Maintenance Procedures

These procedures are for gaining access to the disk assembly, seat ring, diaphragm casing O-ring and stem assembly. All pressure must be released from the diaphragm casing before the performing these steps.

While using the following procedures, refer to figures 7 through 12 for key number locations.

### Replacing the Disk Assembly or Seat Ring

1. To inspect and replace the disk assembly (key 9) or seat ring (key 2), remove the cap screws (key 3, figure 5), and separate the diaphragm casing (key 5) from the body (key 1).

2. Inspect and, if necessary, remove the seat ring (key 2). If removed, coat the threads of the replacement seat ring with lubricant (key 38) and torque to 25 foot-pounds (34 N•m).

3. Inspect the disk assembly and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.

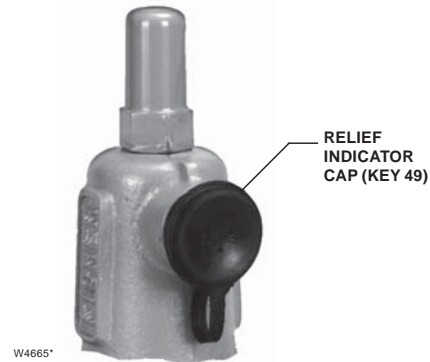


Figure 4. Relief Indicator

### Replacing the Stem Assembly

If it is necessary to perform maintenance on the stem assembly, continue with steps 4 through 8 and 15 through 19 for Type 627, 627H, and 627R regulators, or steps 9 through 19 for Type 627M, 627HM, and 627MR regulators.

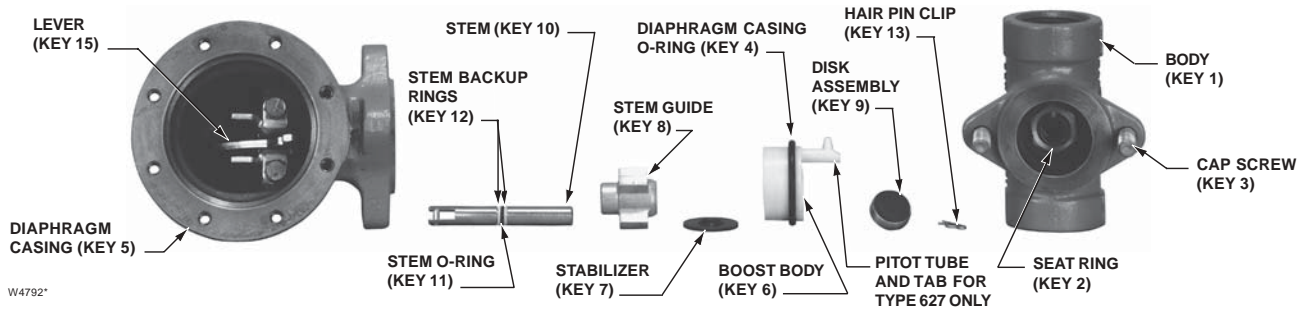
#### Perform steps 4 through 8 for Type 627, 627H, and 627R Regulators only:

4. For Type 627, 627H, and 627R regulators (figure 5), use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).
6. Remove and inspect the diaphragm casing O-ring (key 4, figure 7, 8, or 11) and replace it if necessary.
7. Apply lubricant (key 42) to a replacement diaphragm casing O-ring (key 4, figure 7, 8, or 11) and install it onto the boost body (key 6). Skip to step 14.
8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see figure 7 or 11). Skip to step 14.

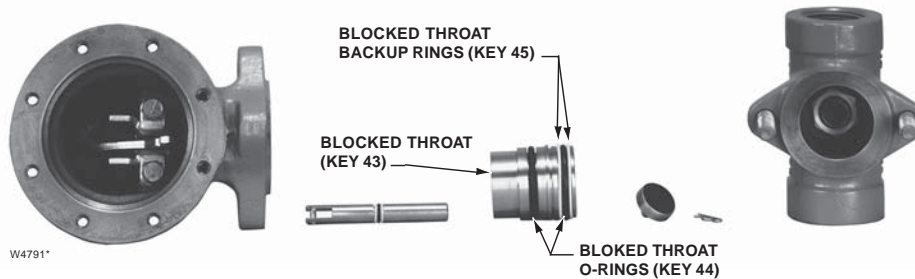
#### Perform steps 9 through 19 for Type 627M, 627HM, and 627MR Regulators only:

9. For Type 627M, 627HM, and 627MR regulators (figure 5), use steps 10 through 14 to remove and replace the stem assembly.
10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.





**Type 627 and 627R**



**Type 627M and 627MR**

*Figure 5. Stem Assemblies*

11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, figure 5) and backup rings (key 45, figure 5).

12. Apply lubricant (key 42) to replacement blocked throat O-rings (key 44) and backup rings (key 45).

13. Apply lubricant (key 42) to the replacement stem O-ring (key 11) and stem backup rings (key 12) and install them on the stem (key 10).

14. For assembly, insert the stem (key 10) into the diaphragm casing (key 5) and hook it on the lever (key 15).

15. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see figure 5).

16. Install the the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).

17. Position the diaphragm casing plus attached parts in relation to the body (key 1) so that they are correct for the application.

18. Secure the diaphragm casing to the body with the cap screws (key 3, figure 5). For an aluminum diaphragm casing (key 5), torque the cap screws (key 3) to 16 foot-pounds (22 N•m). For ductile iron or steel diaphragm casings, torque the cap screws (key 3) to 25 foot-pounds (34 N•m).

19. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the diaphragm and spring case area maintenance procedures, steps 1, 2, and 21 through 25.

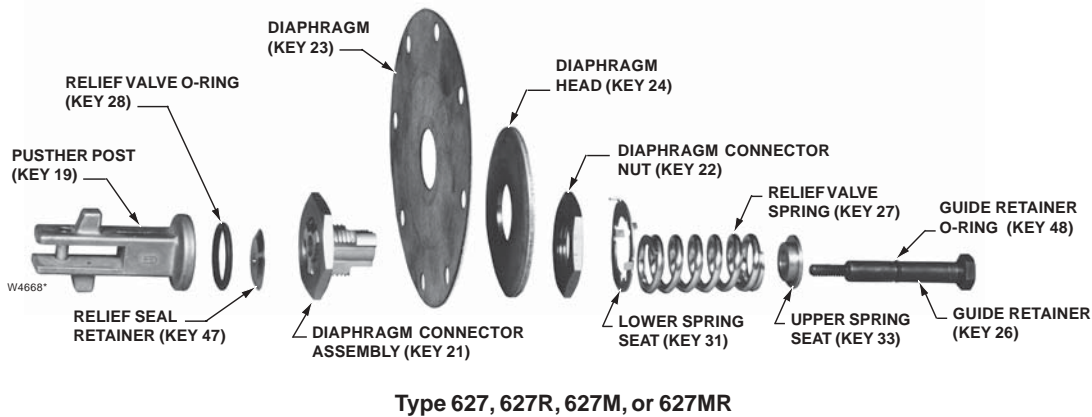
## Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

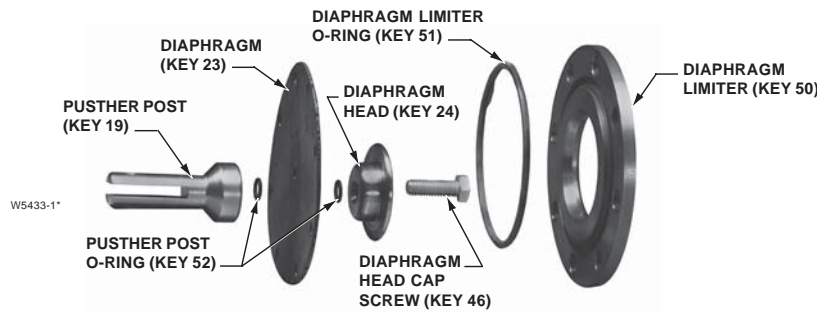
While using the following procedures, refer to figures 7 through 12 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut, and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).

2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.



Type 627, 627R, 627M, or 627MR



Type 627H and 627HM

Figure 6. Diaphragm Assemblies

3. Remove the diaphragm limiter and O-ring (keys 50 and 51, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).

4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).

5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds (9 N•m).

If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Type 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Type 627R and 627MR regulators.

**Perform steps 6 through 11 for Type 627, 627H, 627M, and 627HM Regulators only:**

6. For Type 627, 627H, 627M, and 627HM regulators (figures 5 & 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.

7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the diaphragm cap screw O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).

8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).

9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.

10. Unhook the pusher post from the lever and torque the diaphragm head cap screw (key 46) to 7 foot-pounds (9 N•m) for the Type 627 or 627M. On the Type 627H or 627HM torque the diaphragm head cap screw to 14 foot-pounds (18 N•m).

11. Hook the pusher post on the lever (key 15) and check the hole alignment. If necessary, loosen the cap screw (key 46) and reposition the diaphragm (key 23) on the pusher post (key 19). Retorque the screw (see step 10). Skip to step 20.

# 627 Series

## Perform steps 12 through 19 for Type 627R and 627MR Regulators only:

12. For Type 627R and 627MR regulators (figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly:

13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to figure 6 for the sequence of parts.

14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).

15. Position the replacement diaphragm (key 23) on the connector assembly (key 21), install the diaphragm head (key 24) and connector nut (key 22), then torque to 17 foot-pounds (32 N•m).

16. If necessary, replace the guide retainer O-ring (key 48) and, set the guide retainer (key 26) aside, ready for assembly.

17. On the pusher post (key 19) install the relief seal O-ring (key 28) and lubricate (key 42). Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds (4 N•m).

18. Hook the pusher post (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.

19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).

20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).

21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant (key 38) to the upper spring seat (key 33).

22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates (key 39) over the screw holes, insert the spring case cap screws (key 37), and finger tighten.

23. Screw in the adjustment screw to put slack into the diaphragm (key 23).

24. Using a crisscross pattern, finish tightening the spring case cap screws (key 37) to 7 foot-pounds (9 N•m) of torque.

25. If necessary, refer to the installation and/or the startup and adjustment procedures.

26. Install the adjusting screw cap (key 34) after regulator adjustment.

## Parts Ordering

When corresponding with your Fisher sales office or sales representative about this regulator, always reference the type number which is found on the nameplate (key 39, figures 7 through 12).

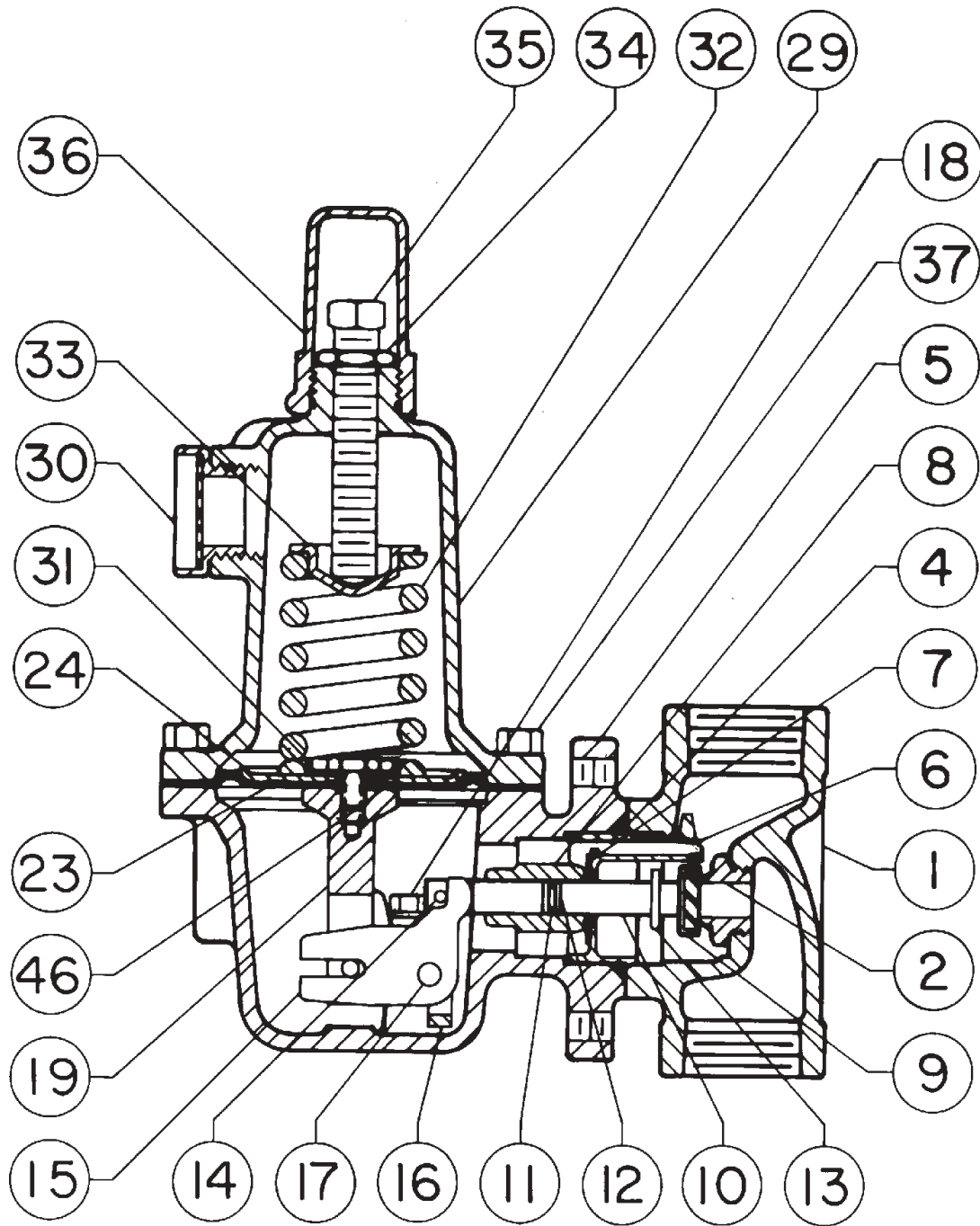
When ordering replacement parts, reference the key number of each needed part as found in the following parts list.

## Parts List

Key	Description	Part Number
	Type 627 Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627R Parts Kit with aluminum/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with stainless steel/nitrile trim (includes keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body	
	Ductile iron	
	1000 psig (69 bar) max inlet pressure	
	3/4-inch NPT size	30B3046X012
	1-inch NPT size	30B3048X012
	2-inch NPT size	30B3096X012
	Steel	
	2000 psig (138 bar) max inlet pressure	
	3/4-inch NPT size	30B3050X012
	1-inch NPT size	30B3051X012
	2-inch NPT size	30B7452X012
	Steel, ANSI Class 600 RF flanged	
	1480 psig (102 bar) max inlet pressure	
	1-inch size	40B6754X012
	2-inch size	40B6756X012
2*	Seat ring	
	Aluminum	
	3/32-inch (2.4 mm) port diameter	0R044109022
	1/8-inch (3.2 mm) port diameter	1A936709012
	3/16-inch (4.8 mm) port diameter	00991209012
	1/4-inch (6.4 mm) port diameter	0B042009012
	3/8-inch (9.5 mm) port diameter	0B042209012
	1/2-inch (12.7 mm) port diameter	1A928809012
	303 Stainless steel	
	3/32-inch (2.4 mm) port diameter	0R044135032
	1/8-inch (3.2 mm) port diameter	1A936735032
	3/16-inch (4.8 mm) port diameter	00991235032
	1/4-inch (6.4 mm) port diameter	0B042035032
	3/8-inch (9.5 mm) port diameter	0B042235032
	1/2-inch (12.7 mm) port diameter	1A928835032

\*Recommended spare part.

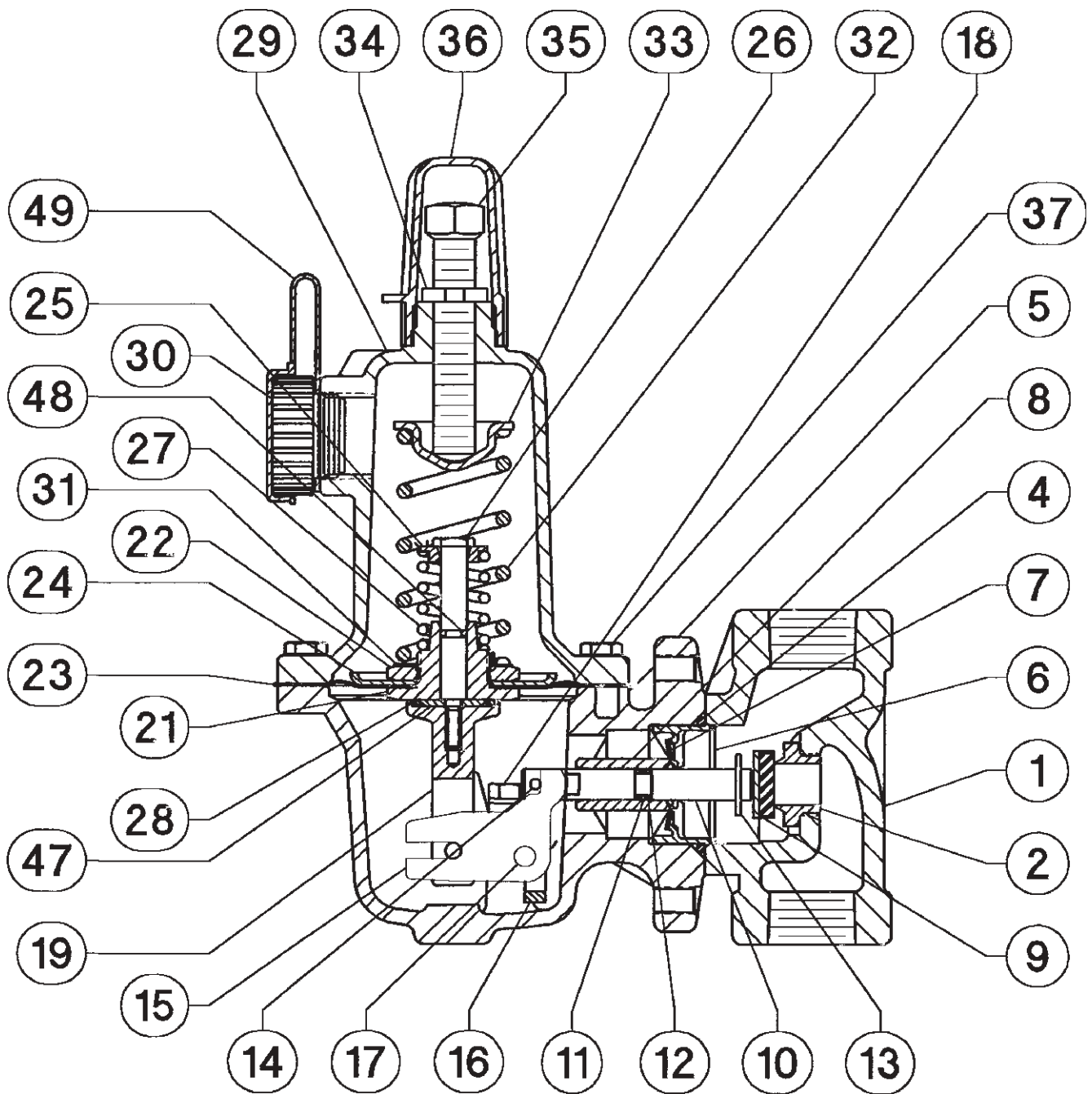
Key	Description	Part Number	Key	Description	Part Number
2*	Seat ring (continued)		23*	Diaphragm, nitrile (continued)	
	316 Stainless steel, NACE <sup>(1)</sup> construction only			For Type 627 or 627M w/steel	
	3/32-inch (2.4 mm) port diameter	0R0441X0012		diaphragm case	10B8735X012
	1/8-inch (3.2 mm) port diameter	1A9367X0022		For Type 627R or 627MR w/aluminum	
	3/16-inch (4.8 mm) port diameter	009912X0012		or ductile iron diaphragm case	10B3068X012
	1/4-inch (6.4 mm) port diameter	0B0420X0012		For Type 627R or 627MR w/steel	
	3/8-inch (9.5 mm) port diameter	0B0422X0012		diaphragm case	10B8736X012
	1/2-inch (12.7 mm) port diameter	1A9288X0012		For Type 627H or 627HM w/steel	
3	Cap Screw (not shown), (2 req'd)		24	Diaphragm Head, plated steel	
	Type 627 and 627R w/aluminum			For Type 627 or 627M, plated steel	1D666428982
	diaphragm case, pl steel	18A1087X012		For Type 627R or 627MR, plated steel	10B3071X012
	All Types w/ductile iron			For Type 627H or 627HM, 416 stainless steel	12B0175X012
	diaphragm case, pl steel	1C403824052			
	or steel diaphragm case, pl steel	1C403024052			
4*	Diaphragm Case O-Ring (Type 627, 627H, or		25	Relief Spring Seat (for Type 627R or	
	627R only), nitrile	17A2325X022		627MR only), steel	10B7446X012
5	Diaphragm Case		26	Guide Retainer (for Type 627R or	
	For Type 627 or 627R			627MR only), stainless steel	10B7450X012
	Aluminum w/o 1/8-inch gauge tap	40B3084X012	27	Relief Spring (for Type 627R or 627MR	
	Aluminum with 1/8-inch gauge tap			only), plated steel	10B6757X012
	for Type 627 only	11B5380X012	28*	Relief Seal O-Ring (for Type 627R or	
	Ductile iron w/o 1/8-inch gauge tap	30B3053X012		627MR only), nitrile	1J108506992
	Ductile iron with 1/8-inch gauge tap		29	Spring Case	
	for Type 627 only	31B0641X012		For Type 627 or 627R	
	Steel	30B3104X012		Aluminum	40B3086X012
	For Type 627M or 627MR			Ductile iron	30B3055X012
	Ductile iron	39A5987X012		Steel	30B3102X012
	Steel	30B8734X012		For Type 627M or 627MR	
	For Type 627H, steel	30B3104X012		Ductile iron	30B3055X012
	For Type 627HM, steel	30B8734X012		Steel	30B3102X012
6	Boost Body (not for Type 627M, 627HM,			For Type 627H or 627HM	
	or 627MR), Delrin <sup>(2)</sup>		30	Screened Vent Assembly, plastic	30B3102X012
	For Type 627 or 627H	30B3056X012	31	Lower Spring Seat, plated steel	10B3093X012
	For Type 627R	30B3057X012		For Type 627 or 627M	1D666625072
7	Stabilizer (for Type 627, 627H, and 627R			For Type 627R or 627MR	20B3073X012
	only), nitrile	10B3060X012	32	Control Spring, pl steel	
8	Stem Guide (for Type 627, 627H, and 627R			5 to 20 psig (0.34 to 1.4 bar), yellow	10B3076X012
	only), powdered metal	20B3061X012		15 to 40 psig (1.0 to 2.8 bar), green	10B3077X012
9*	Disk Assembly (for all port diameters)			35 to 80 psig (2.4 to 5.5 bar), blue	10B3078X012
	Aluminum holder and nitrile disk	1C4248X0212		70 to 150 psig (4.8 to 10.3 bar), red	10B3079X012
	303 Stainless steel holder and nitrile disk	1C4248X0202		140 to 250 psig range (9.6 to 17.2 bar),	
	Aluminum holder and nylon disk	1C4248X00A2		blue, used in a Type 627H or 627HM	10B3078X012
	303 Stainless steel holder and nylon disk	1C4248X0062		240 to 500 psig range (16.5 to 34.5 bar),	
	NACE construction only			red, used in a Type 627H or 627HM	10B3079X012
	Aluminum holder and nitrile disk	1C4248X0212	33	Upper Spring Seat, plated steel	1D667125072
	316 Stainless steel holder and nitrile disk	1C4248X0252	34	Locknut, plated steel	1D667728982
	Aluminum holder and nylon disk	1C4248X00A2	35	Adjusting Screw, pl steel	
	316 Stainless steel holder and nylon disk	1C4248X0262		For Type 627 or 627M	10B3081X012
10	Stem			For Type 627H or 627HM	10B3081X012
	303 stainless steel	10B3059X012		For Type 627R or 627MR	10B3080X012
	316 stainless steel (NACE)	10B3059X022	36	Adjusting Screw Cap, plastic	20B3082X012
11*	Stem O-Ring, nitrile	1D687506992	37	Spring Case Cap Screw, pl steel (8 required)	
12	Stem Backup Ring, TFE (2 required)	1K786806992		For aluminum or ductile iron diaphragm case	1A391724052
13	Hair Pin Clip, stainless steel	10B3058X012		For steel diaphragm case	10B8737X012
14	Drive Pin, plated steel	1A953228982		For Type 627H/HM, steel diaphragm case	1A346424052
15	Lever, plated steel	20B3063X012	39	Nameplate	-----
16	Lever Retainer, plated steel	30B3097X012	43	Blocked Throat (for Type 627M, 627HM or	
17	Lever Pin			627MR only), stainless steel	10B3085X012
	Stainless steel	10B3083X012	44	Blocked Throat O-Ring (for Type 627M,	
	316 stainless steel (NACE)	10B3083X022		627HM, or 627MR only), nitrile (2 required)	1E264306992
18	Lever Cap Screw (2 required)		45	Blocked Throat Backup Ring (for Type 627M,	
	Plated steel	10B7454X012		627HM, or 627MR only), TFE (2 required)	10B3106X012
	316 stainless steel (NACE)	10B7454X022	46	Diaphragm Head Cap Screw, steel	
19	Pusher Post, aluminum			For Type 627 or 627M	1K920724052
	For Type 627 or 627M	10B3098 X012		For Type 627H or 627HM	1C379124052
	For Type 627R or 627MR	10B3098 X022	47	Relief Seal Retainer (for Type 627R or	
	For Type 627H or 627HM,			627MR only), stainless steel	10B7445X012
	416 stainless steel	10B3098 X032	48*	Guide Retainer O-Ring (for Type 627R	
21	Diaphragm Connector (for Type 627R			or 627MR only), nitrile	1D682506992
	or 627MR only), stainless steel	10B6758X012	49	Relief Indicator (for Type 627R or	
22	Diaphragm Connector Nut (for Type			627MR only), rubber (not shown)	30B3100X012
	627R or 627MR only), stainless steel	10B7449X012	50	Diaphragm Limiter	22B0176X012
23*	Diaphragm, nitrile		51*	Diaphragm Limiter O-Ring	1K877606992
	For Type 627 or 627M w/aluminum or		52*	Pusher Post O-Ring (2 required)	1C853806992
	ductile iron diaphragm case	10B3069X012			



30B3092-D

Figure 7. Type 627 Regulator Components





30B3089-D

Figure 8. Type 627R Regulator Components

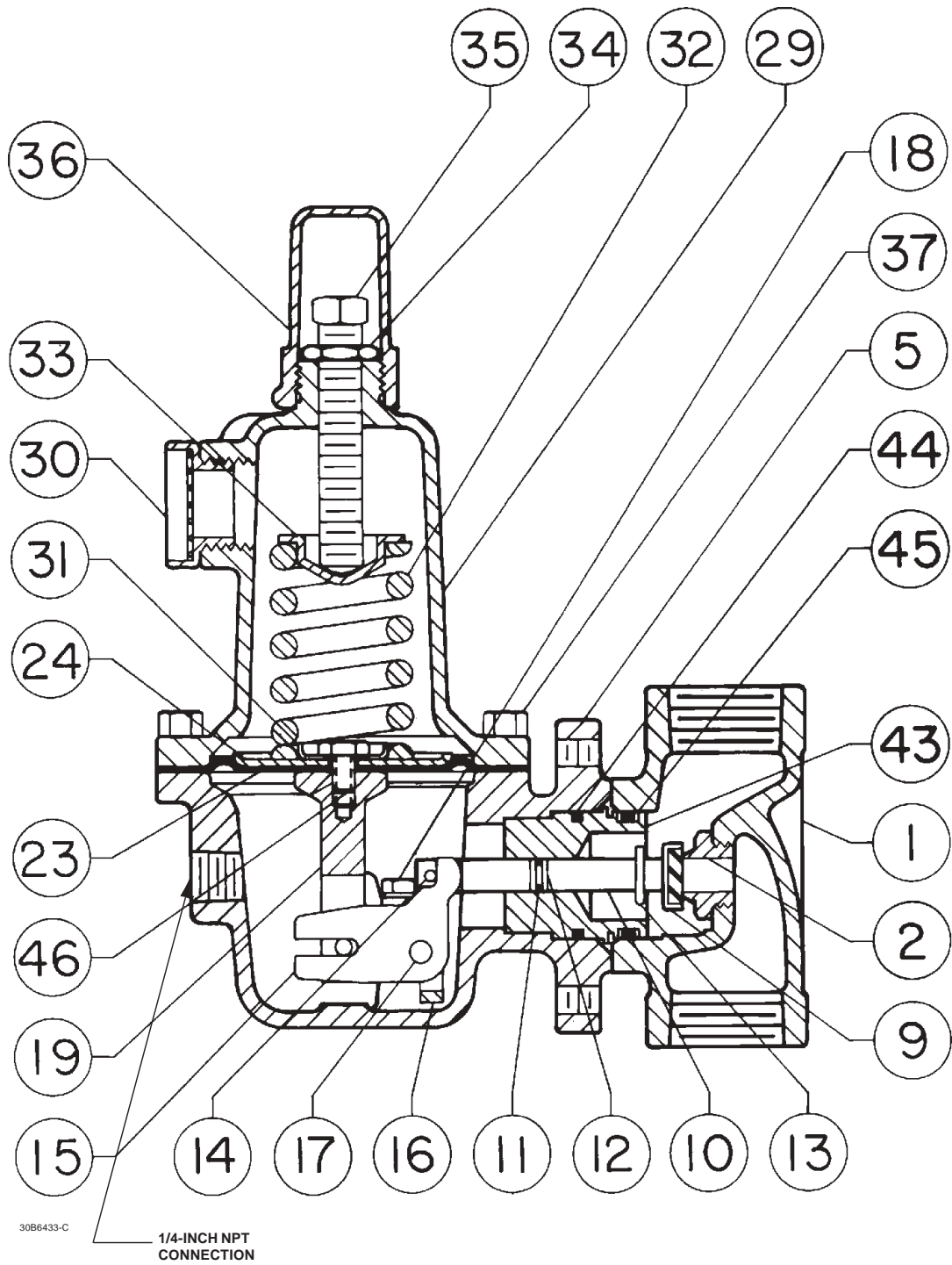
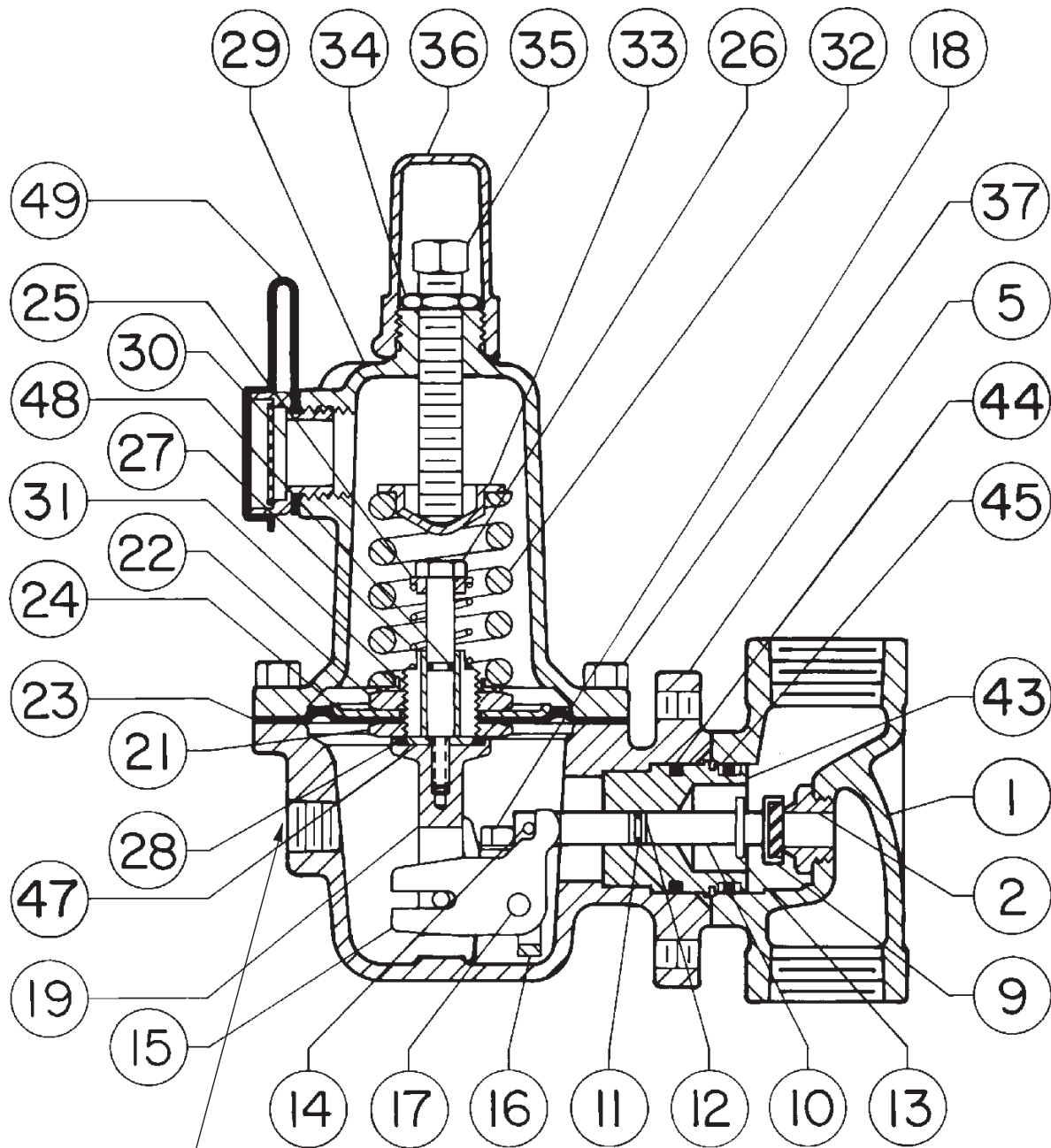


Figure 9. Type 627M Regulator Components

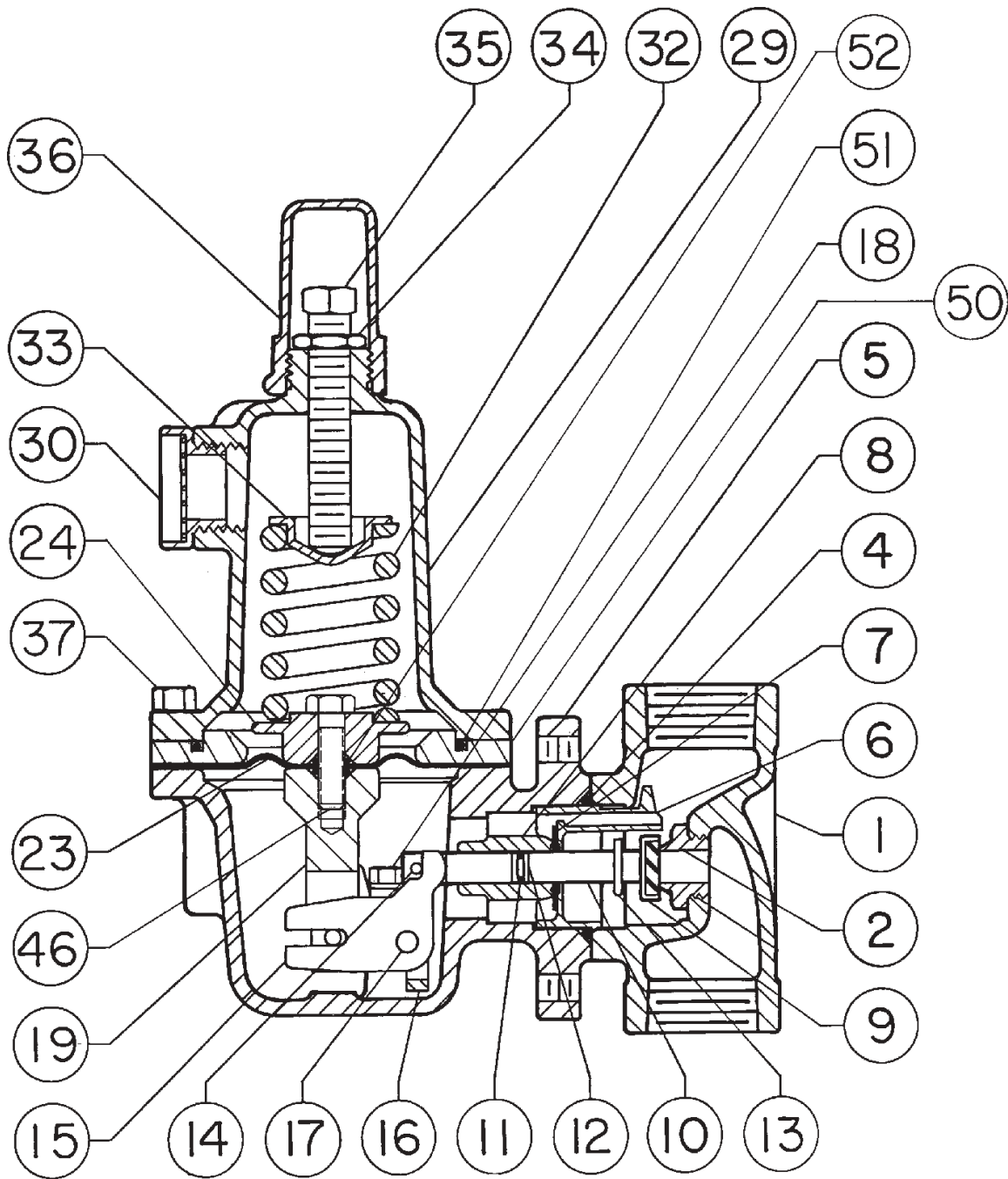


1/4-INCH NPT  
CONNECTION

30B6434-D

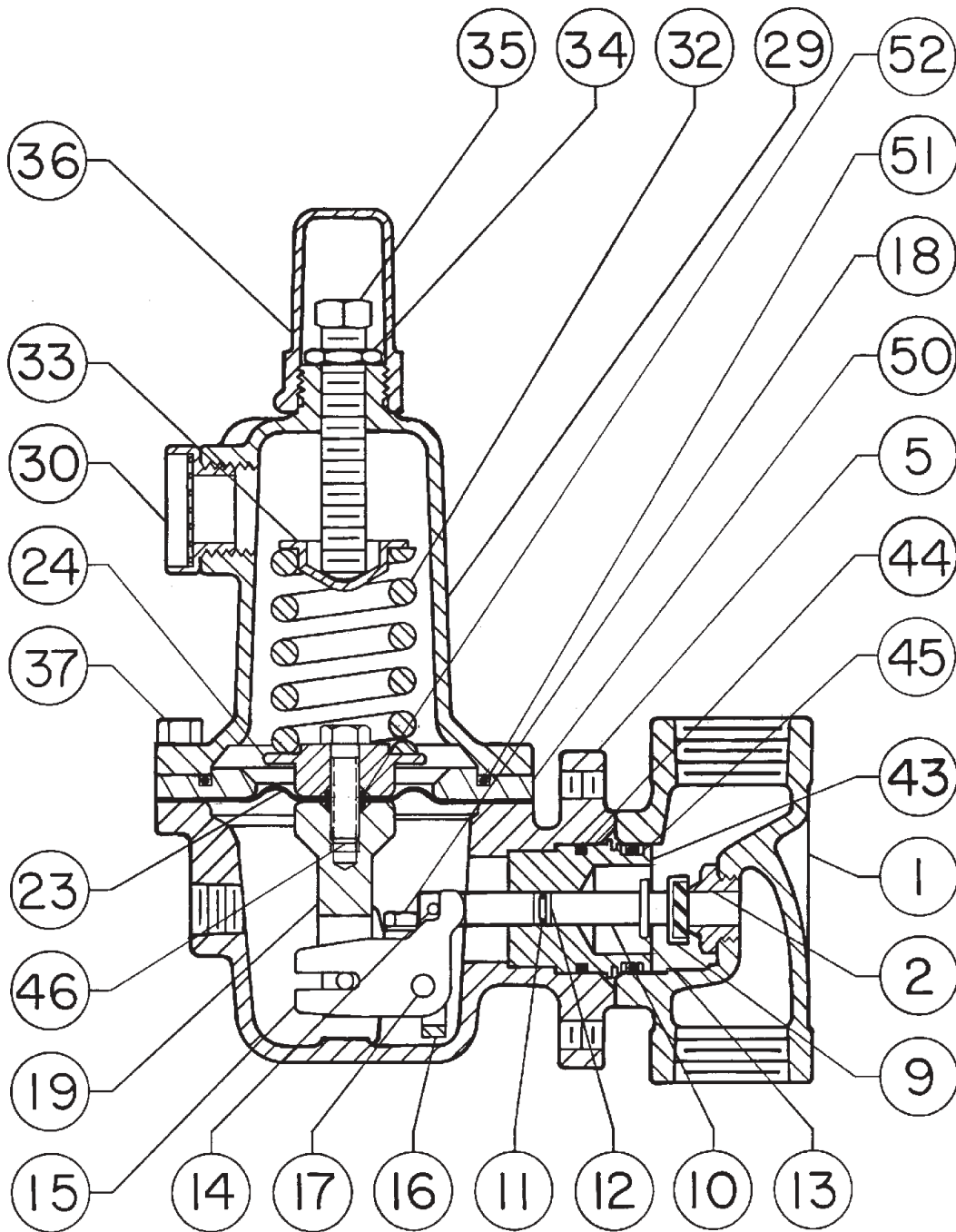
Figure 10. Type 627MR Regulator Components





31B5374-B

Figure 11. Type 627H Regulator Components



3189872-B

Figure 12. Type 627HM Regulator Components

## Errata Sheet for

627 Series  
Form 5252, July 1989

This errata sheet includes information covering the Type 627LB extended body regulator. This new body style is available on all 627 Series configurations and will be an addition to key 1 in the Parts List. The pressure ratings on the Type 627LB bodies will be identical to the existing specifications stated in the current 627 Series Instruction Manual. Each bullet on this errata sheet refers to a section of the 627 Series Instruction Manual (form 5252) where this information needs to be added.

• Add the following to the Available Constructions section of Table 1. Specifications on page 2.

• Add the following figure to the end of page 18.

**Type 627LB:** A 627 Series construction with an extended NPT screwed body. Note: The pressure ratings and capacities for a Type 627LB depend on the 627 Series construction. See the above listed constructions for ratings and specifications.

• Add the following to the Parts List on page 12.

Key	Description	Part Number
1	Body	
	Type 627LB - Ductile iron	
	1000 psig (69 bar) max inlet pressure	
	3/4-inch NPT screwed body	39B2450X012
	1-inch NPT screwed body	39B2451X012
	2-inch NPT screwed body	39B0414X012
	Type 627LB - Steel	
	2000 psig (138 bar) max inlet pressure	
3/4-inch NPT screwed body	39B0411X012	
1-inch NPT screwed body	39B0412X012	
2-inch NPT screwed body	39B0415X012	

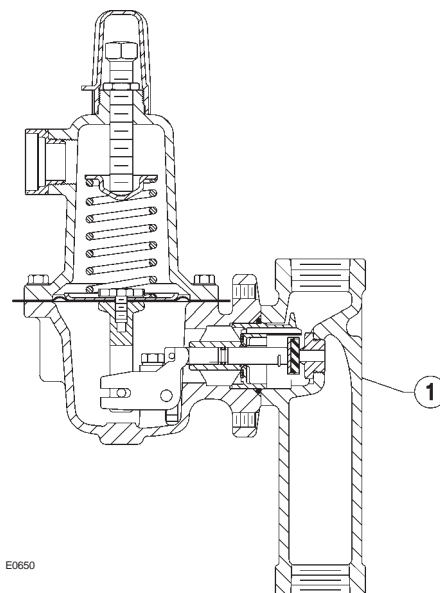


Figure 13. Type 627LB Regulator Body

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**FISHER**  
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# 67CF Series Installation Sheet

## Introduction

This installation sheet covers the installation and startup of the 67CF Series filter regulators. If maintenance is required, refer to the 67CF Series Instruction Manual, form 5469. Contact your Fisher Sales Representative or Sales Office to receive a copy of the instruction manual.

## Specifications

- **Maximum Inlet Pressure:**  
250 psig (17,2 bar)
- **Maximum Outlet Pressure:**  
50 psi (3,4 bar) over outlet pressure setting
- **Outlet Pressure Ranges:**
  - 0 to 35 psig (0 to 1,4 bar)
  - 0 to 60 psig (0 to 2,4 bar)
  - 0 to 125 psig (0 to 8,6 bar)
- **Temperature Capabilities with Nitrile (NBR):**  
-40° to 180°F (-40°C to 82°C)

## Installation

### WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

The internal relief valve in the Type 67CFR regulator does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the Type 67CFR exceeds the maximum pressure ratings of the downstream equipment or exceeds the maximum allowable outlet pressure of the Type 67CFR, additional overpressure protection is required.

1. Regulator operation within ratings does not preclude the possibility of physical damage from external sources

or debris in the lines. Regulators should be inspected for damage periodically and after an overpressure condition.

2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure there is no damage to or foreign material in the regulator and all tubing/piping is free of debris.

3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.

4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).

### WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it. Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4-inch NPT spring case vent may be remotely vented by installing tubing or piping into the vent.

6. For regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures.

7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.

8. Install tubing fitting or piping into the 1/4-inch NPT inlet connection on the body (key 1) and into the 1/4-inch NPT body outlet connection.

9. The second 1/4-inch NPT outlet can be used for a gauge or other use. If not used, it must be plugged.



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**EMERSON**  
Process Management

# 67CF Series

10. When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt. To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

## Startup and Adjustment

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.



### WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counter-clockwise to decrease the outlet pressure setting. Tighten the locknut to maintain the adjustment position.

## Parts List

Key	Description	Key	Description
1	Body	16 <sup>(1)</sup>	Diaphragm Assembly
2	Drain Valve	17	Spring
3	Flange Screw	18	Adjusting Screw
4 <sup>(1)</sup>	O-Ring	19	Locknut
5	Dripwell	20	Upper Spring Seat
6 <sup>(1)</sup>	Filter Element	22	Pressure Gauge
7	Spring Case	23	1/4-Inch Pipe Plug
9	Filter Retainer	24	Tire Valve
10 <sup>(1, 2)</sup>	Valve Cartridge	26 <sup>(1)</sup>	Filter Gasket
11 <sup>(1, 2)</sup>	Valve Plug	31	Panel Mounting Nut
12 <sup>(1, 2)</sup>	Valve Spring	32	Wire Seal
13 <sup>(1, 2)</sup>	Valve Retainer	33	Closing Cap
14 <sup>(1, 2)</sup>	O-Ring	34	Spacer
15 <sup>(1, 2)</sup>	Soft Seat		

1. Recommended Spare Part

2. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, and 15.

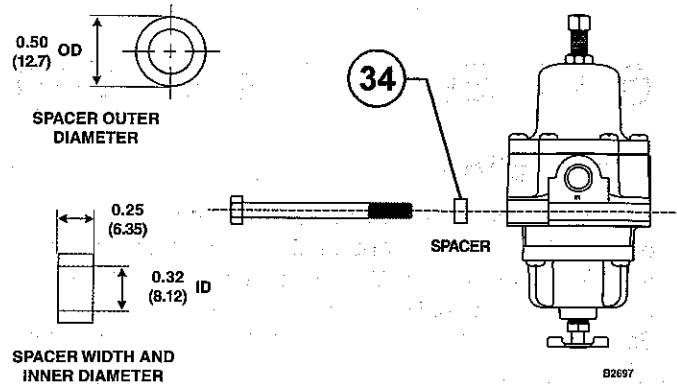


Figure 1. Spacer Diameter and Installation

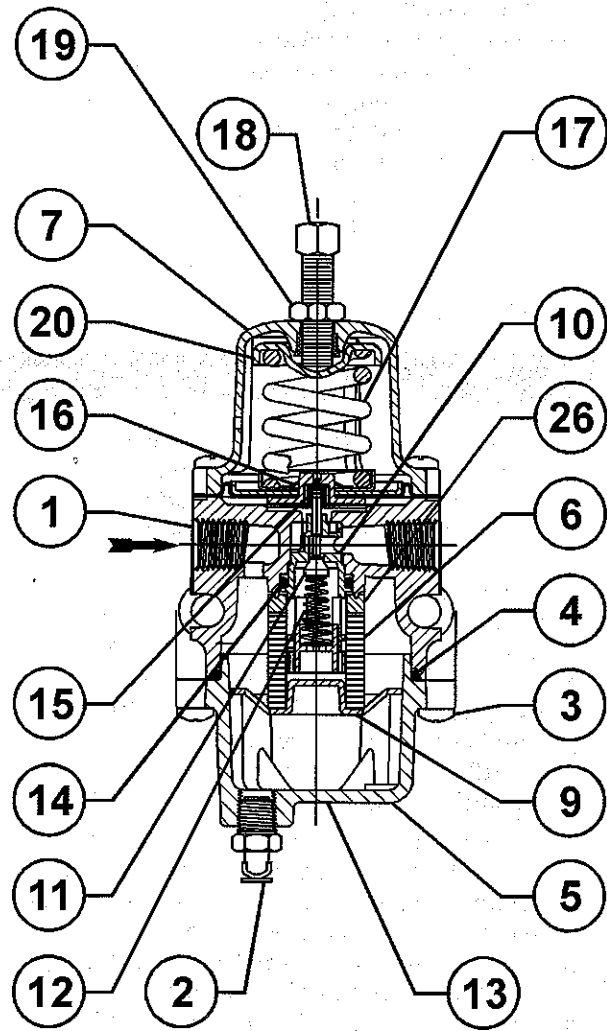


Figure 2. 67CF Series Assembly Drawings

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# 67CF Series Filter Regulators

## Introduction

### Scope of Manual

This manual provides instructions and parts lists for 67CF Series filter regulators. Instructions and parts lists for other equipment mentioned in this instruction manual, as well as for other 67 Series regulators, are found in separate manuals.

### Product Description

The 67CF Series direct-operated regulators are equipped with a filter for removing particles from the supply gas. They are typically used to provide constantly controlled, reduced pressures to pneumatic and electropneumatic controllers and other instruments. These are suitable for most air or gas applications. Other applications include providing reduced pressures to air chucks, air jets, and spray guns.

The Type 67CFR regulator has an integral low-capacity internal relief valve. A downstream pressure increase above the outlet pressure setting moves the diaphragm assembly off the soft seat, venting the excess pressure through a hole or vent in the spring case.

### Specifications

Some general 67CF Series ratings and other specifications are given on page 2. A label on the spring case gives the control spring range for a given regulator as it comes from the factory.

### Installation

#### Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.



W7412

Figure 1. Typical Type 67CF Filter Regulator with Optional Gauge



### WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-pressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.



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## Specifications

### Body Size, Inlet and Outlets Connection Style

1/4-inch NPT screwed

### Maximum Inlet Pressure (Body Rating)<sup>(1)</sup>

250 psig (17,2 bar)

### Outlet Pressure Ranges

OUTLET PRESSURE RANGES, PSIG (bar)	CONTROL SPRING DATA		
	Part Number	Color	Wire Diameter, Inch (mm)
0 to 20 (0 to 1,4)	T14130T0012	green stripe	0.135 (3,43)
0 to 35 (0 to 2,4)	T14059T0012	silver	0.156 (3,96)
0 to 60 (0 to 4,1)	T14058T0012	blue stripe	0.170 (4,32)
0 to 125 (0 to 8,6)	T14060T0012	red stripe	0.207 (5,26)

### Maximum Emergency Outlet Pressure<sup>(1)</sup>

50 psi (3,4 bar) over outlet pressure setting

### Wide-Open Flow Coefficients

Main Valve:  $C_g$ : 11.7;  $C_v$ : 0.36;  $C_i$ : 32.2

Internal Relief Valve:  $C_g$ : 1.45;  $C_v$ : 0.045;  $C_i$ : 32.8

### Pressure Registration

Internal

### Accuracy

**Inlet Sensitivity:** Less than 0.2 psig (0,014 bar) change in outlet pressure for every 25 psig (1,72 bar) change in inlet pressure

**Repeatability:** 0.1 psig (0,0069 bar)<sup>(2)</sup>

**Air Consumption:** testing repeatedly shows no discernible leakage

### Regulator Temperature Capabilities

**With Nitrile (NBR):** -40° to 180°F (-40° to 82°C)

**With Fluoroelastomer (FKM):**

0° to 300°F (-18° to 149°C)

**With Silicone (VMQ)<sup>(3)</sup>:** -60° to 180°F (-51° to 82°C)

### Drain Valve and Spring Case Vent Location

Aligned with inlet, other positions optional

### Type 67CFR Internal Relief Performance

Low capacity for minor seat leakage only; other overpressure protection must be provided if inlet pressure can exceed the maximum pressure rating of downstream equipment or exceeds maximum outlet pressure rating of the Type 67CFR

### Filter Capabilities

**Free Area:** 12 times pipe area

**Micron Rating:**

*Cellulose Element:* 40 microns

*Glass Fiber Element:* 10 microns

*Stainless Steel Element:* 40 microns

### Approximate Unit Weight

1 pound (0,5 kg)

### Options

- Handwheel adjusting screw
- NACE (MR0175) compliant construction
- Ammonia service construction
- Panel mount (includes spring case with 1/4-inch vent, handwheel, and panel mounting nut)
- Closing cap (available on spring case with 1/4-inch NPT vent)
- Aluminum or stainless steel drain valve
- Fluoroelastomer (FKM) elastomers for high temperatures and/or corrosive chemicals
- Silicone (VMQ) elastomers for cold temperatures
- Triple scale outlet pressure gauge (brass or stainless steel)
- Stainless steel stem on the valve plug
- Fixed bleed restriction mounted in the side outlet
- Tire valve in second outlet
- Pipe plug in second outlet

1. The pressure/temperature limits in this bulletin and any applicable standard or code limitation should not be exceeded.

2. Repeatability is the measure of the regulator's ability to return to setpoint consistently when traveling from steady state to transient to steady state.

3. Silicone is not compatible with hydrocarbon gas.



## WARNING

**The internal relief valve of the Type 67CFR regulator does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the Type 67CFR exceeds maximum pressure ratings of the downstream equipment or exceeds maximum allowable outlet pressure of the Type 67CFR, additional overpressure protection is required.**

1. Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. Regulators should be inspected for damage periodically and after any overpressure condition.

2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure that there is no damage to or foreign material in the regulator. Also ensure that all tubing and piping is free of debris.



3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.

4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).



## WARNING

**A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.**

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it.

Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4-inch NPT spring case vent may be remotely vented by installing obstruction-free tubing or piping into the vent. Protect the remote vent by installing a screened vent cap on the remote end of the vent pipe.

6. For use in regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures. Install a pressure gauge to monitor instruments on startup.

7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.

8. Install tubing fitting or piping into the 1/4-inch NPT inlet connection on the body (key 1) and into the 1/4-inch NPT body outlet connection.

9. The second 1/4-inch NPT outlet can be used for a gauge or other use. If not used, it must be plugged.

## Installing a 67CF Series Regulator in an Existing Installation

When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers (key 34, figure 6) to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt (see figure 6). To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

## Startup and Adjustment

Key numbers are referenced in figure 2.

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.



## WARNING

**To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm parts maintenance procedure.**

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Retighten the locknut to maintain the adjustment position.

## Shutdown

First, close the nearest upstream block valve and then close the nearest downstream block valve (when used). Next, open the downstream vent valve. Since the regulator remains open in response to the



# 67CF Series

decreasing downstream pressure, pressure between the closed block valves will be released through the open vent valve.

## Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions and upon applicable codes and government regulations. Open the drain valve (key 2) regularly to empty accumulated liquid from the dripwell (key 5).

### Note

**If sufficient clearance exists, the body (key 1) may remain mounted on other equipment or in a line or panel during maintenance unless the entire regulator will be replaced.**



### WARNING

**To avoid personal injury, property damage, or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.**

## Filter Element and Trim Maintenance

Key numbers are referenced in figures 2 and 3.

1. Remove four dripwell screws (key 3) from the dripwell (key 5) and separate the dripwell and O-ring (key 4) from the body (key 1). The filter retainer (key 9), filter element (key 6), and gasket (key 26) may come off with dripwell. If not, remove these parts.
2. Inspect the removed parts for damage and debris. Replace any damaged parts. If a replacement is not available, the filter element may be cleaned.
3. To remove the valve cartridge assembly, grasp the end of cartridge and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge

assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.

4. Apply lubricant to the O-ring (key 14), then align cartridge key to keyway in body and insert. Reinstall the gasket (key 26), filter (key 6), and filter retainer (key 9). Reinstall the O-ring (key 4), secure the dripwell with screws (key 3), and torque to 24 to 36 inch-pounds (2,7 to 4,1 N·m).

## Diaphragm Maintenance

Key numbers are referenced in figure 2.

1. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).
2. Remove the six spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).
3. Remove the diaphragm assembly (key 16), inspect the diaphragm, and replace the assembly, if necessary.
4. Place the diaphragm assembly (key 16) on the body (key 1) as shown in figure 4. Push down on the diaphragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16-inch (2 mm).

### Note

**In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.**

5. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).
6. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 24 to 36 inch-pounds (3 to 4 N·m).
7. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used, and install the closing cap if used.

## Parts Ordering

When corresponding with the Fisher Sales Office or Sales Representative about this regulator, include the type number and all other pertinent information printed on the label. Specify the eleven-character part number when ordering new parts from the following parts list.

## Parts List

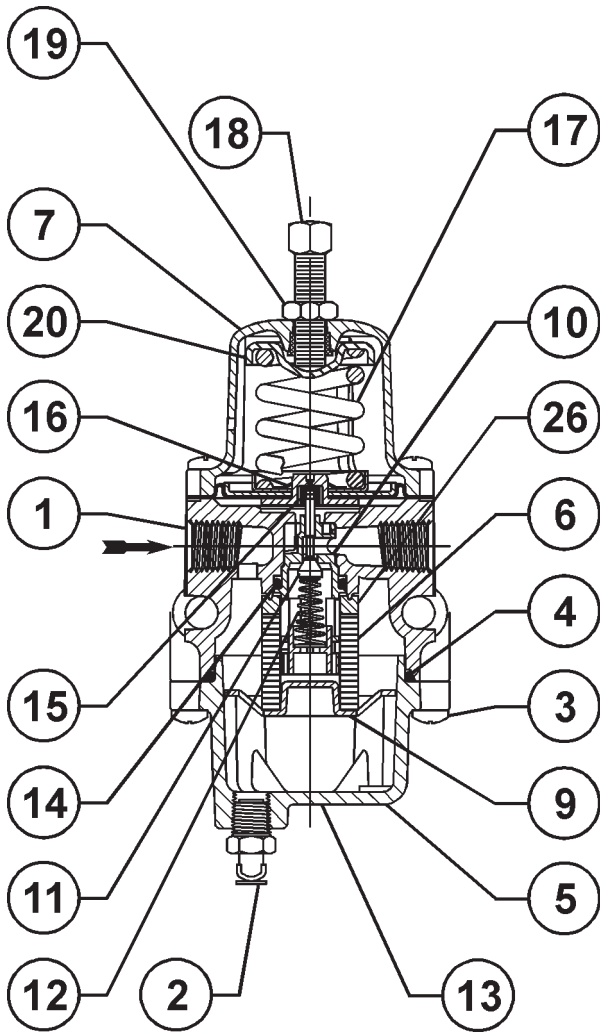
Key	Description	Part Number
	Parts Kit	
	Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14, and 15), diaphragm assembly (key 16), filter element (key 6), filter gasket (key 26), and four screws (key 3)	
	Type 67CF (without relief)	
	Brass stem with nitrile plug	R67CFX00012
	Aluminum stem with nitrile plug (NACE)	R67CFX00N12
	Type 67CFR (with relief)	
	Brass stem with nitrile plug	R67CFRX0012
	Aluminum stem with nitrile plug (NACE)	R67CFRX0N12
	Valve Cartridge Assembly Only	
	Brass stem	
	With nitrile plug	T14121T0012
	With fluoroelastomer plug	T14121T0022
	Aluminum stem	
	with nitrile plug	T14121T0042
	with nitrile plug (NACE)	T14121T0052
1	Body, Aluminum	T80432T0012
2	Drain Valve	
	Brass	1K418918992
	Aluminum	1K4189000B2
	Stainless steel	AH3946X0012
3	Flange Screw	
	Standard spring case and spring case with 1/4-inch NPT vent (10 required)	T13526T0012
	For wire seal	
	Flange Screw (9 required)	T13526T0012
	Flange Screw (1 required)	14B3987X012
4 <sup>(1)</sup>	O-Ring	
	Nitrile (NBR)	T14057T0012
	Fluoroelastomer (FKM)	T14057T0022
	Silicone (VMQ)	T14057T0032
5	Dripwell	T21040T0012
6 <sup>(1)</sup>	Filter Element	
	Cellulose (40 microns) (standard)	1F257706992
	Glass fiber (10 microns)	17A1457X012
	Stainless steel (40 microns)	15A5967X012
7	Spring Case, Aluminum	
	Drilled hole vent (standard)	T14070T0012
	1/4-inch NPT vent	T14070T0022
9	Filter Retainer	T14052T0012
10 <sup>(1,2)</sup>	Valve Cartridge	T80434T0012
11 <sup>(1,2)</sup>	Valve Plug	
	Brass stem, nitrile (NBR) plug	T14053T0012
	Aluminum stem, fluoroelastomer (FKM) plug	T14053T0022
	Aluminum stem, nitrile (NBR) plug	T14053T0032

Key	Description	Part Number
12 <sup>(1,2)</sup>	Valve Spring	
	Stainless steel	T14105T0012
	Inconel (NACE)	T14116T0012
13 <sup>(1,2)</sup>	Valve Retainer	T14071T0012
14 <sup>(1,2)</sup>	O-Ring	
	Nitrile (NBR)	T14063T0012
	Fluoroelastomer (FKM)	T14063T0022
	Silicone (VMQ)	T14063T0032
15 <sup>(1,2)</sup>	Soft Seat	
	Nitrile (NBR)	T14055T0012
	Fluoroelastomer (FKM)	T14055T0022
16 <sup>(1)</sup>	Diaphragm Assembly	
	67CF (without relief)	
	Nitrile (NBR)	T14119T0022
	Fluoroelastomer (FKM)	T14119T0042
	Type 67CFR (with relief)	
	Nitrile (NBR)	T14119T0012
	Fluoroelastomer (FKM)	T14119T0032
	Silicone (VMQ)	T14119T0052
17	Spring	
	Types 67CF and 67CFR, Plated steel (standard)	
	0 to 20 psig (0 to 1,4 bar), Green stripe	T14130T0012
	0 to 35 psig (0 to 2,4 bar), Silver	T14059T0012
	0 to 60 psig (0 to 4,1 bar), Blue stripe	T14058T0012
	0 to 125 psig (0 to 8,6 bar), Red stripe	T14060T0012
	Type 67CFR (NACE), Inconel (NACE)	
	0 to 35 psig (0 to 2,4 bar), Silver stripe	T14113T0012
	0 to 60 psig (0 to 4,1 bar), Blue	T14114T0012
	0 to 125 psig (0 to 8,6 bar), Red	T14115T0012
18	Adjusting Screw	
	For standard spring case	
	Square head (standard)	T14061T0012
	Handwheel	T14102T0012
	Wire seal (not shown)	T14104T0012
	For spring case with 1/4-inch NPT vent	
	Square head for closing cap	T14101T0012
	Handwheel	T14103T0012
19	Locknut	1A946324122
20	Upper Spring Seat	1B798525062
22	Pressure Gauge	
	Brass	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B8579X022
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B8579X032
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B8579X042
	Stainless Steel	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B9639X012
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B9639X022
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B9639X032
23	1/4-Inch Pipe Plug	
	Socket head, steel	1C333528992
	Hex head, stainless steel	1A767535072
24	Tire Valve	1H447099022
26 <sup>(1)</sup>	Filter Gasket	
	Nitrile (NBR)	T14081T0012
	Fluoroelastomer (FKM)	T14081T0022
31	Panel Mounting Nut	10B2657X012
32	Wire Seal (not shown)	1U7581000A2
33	Closing Cap	23B9152X012
34	Spacer	T14123T0012
35	Mounting adaptor plate for Fisher 2500 Series Controller	T21043T0012

1. Recommended Spare Part

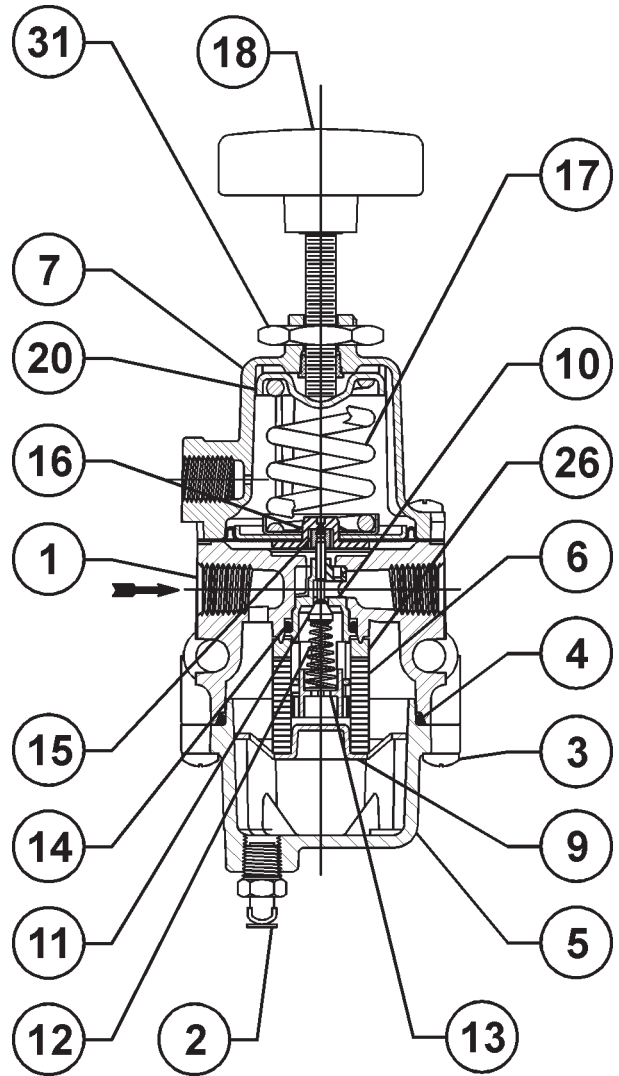
2. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, and 15.

# 67CF Series



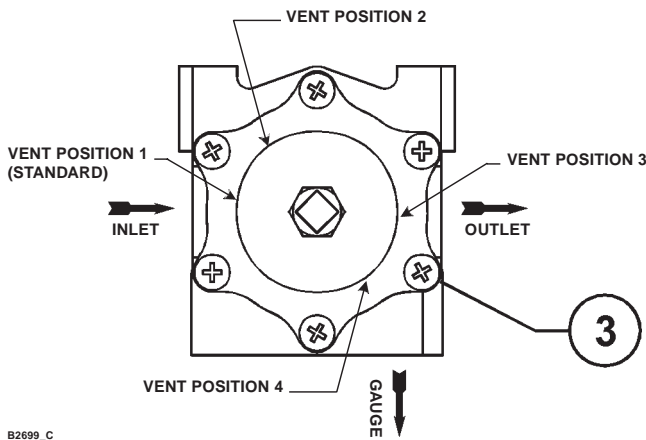
B2693

**STANDARD CONSTRUCTION**



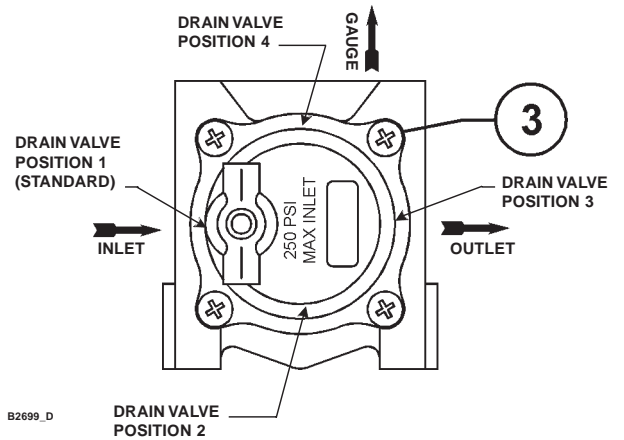
B2696

**PANEL MOUNT OPTION  
(INCLUDES HANDWHEEL, MOUNTING NUT,  
AND 1/4-INCH NPT SPRING CASE VENT)**



B2699\_C

**SPRING CASE VENT POSITIONS**



B2699\_D

**DRAIN VALVE POSITIONS**

Figure 2. 67CF Series Assembly Drawings

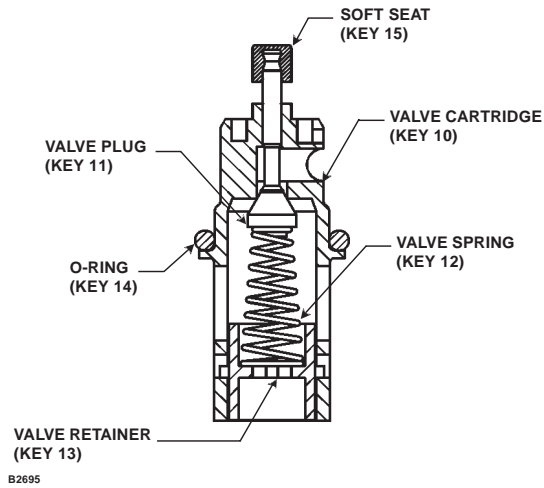


Figure 3. Valve Cartridge Assembly

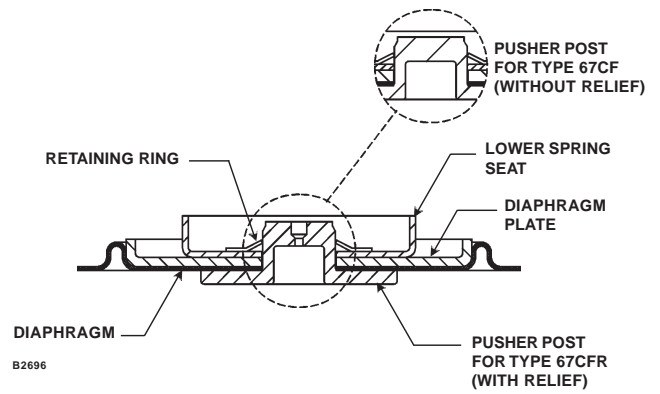


Figure 4. Diaphragm Assembly (Key 16)

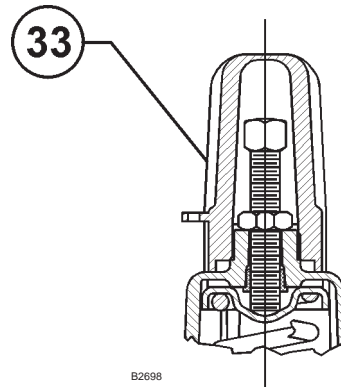


Figure 5. Optional Closing Cap (Only Available with the 1/4-inch Spring Case Vent)

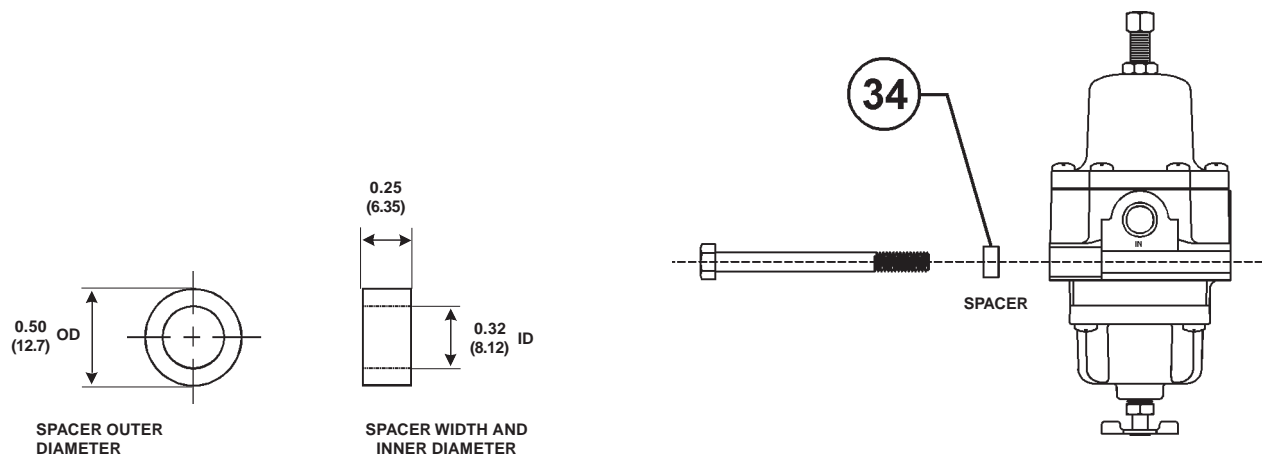


Figure 6. Spacer Diameter and Assembly  
(For Installing 67CF Series Regulator in an Existing Installation if the Mounting Bolts are too Long)

# 67CF Series

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**FISHER-ROSEMOUNT™ Managing The Process Better.™**

Fisher Controls

Instruction Manual

**Y690 Series Pressure Reducing Regulators****FISHER®**

October 1993

Form 5337

**Introduction****Scope of Manual**

This manual provides instructions for installation, start-up, maintenance, and parts information for the Y690 Series pressure regulators. Instructions and parts lists for other equipment used with these regulators are found in separate manuals.

**Product Description**

The Y690 Series regulator design (figure 1) is ideally suited to control gas supply to in-plant processing equipment. The rugged casings and sliding pusher post design withstands the full 150 psig (10.3 bar) inlet pressure at both the inlet and outlet connections. Because the regulators can withstand the full inlet pressure, a downstream relief valve is not required to protect the

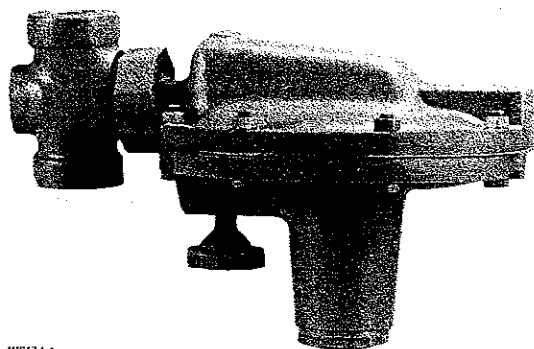
downstream side of the regulator unless full capacity relief is required.

The pressure reducing regulators (figure 1) may be applied in a variety of commercial and industrial applications. Available type numbers are described as follows:

**Type Y690**—Very low-pressure, 1 to 7 inches wc (2 to 16 mbar), direct-operated regulator with internal registration requiring no downstream control line.

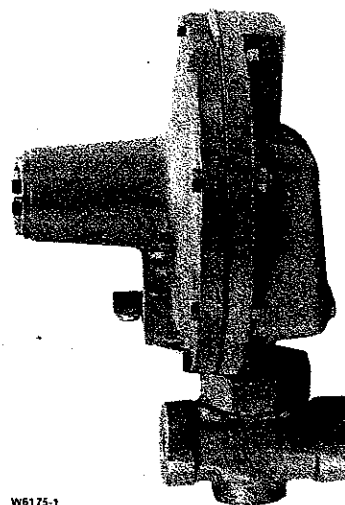
**Type Y690H**—Higher-pressure, 5 inches wc to 7 psig (12 to 480 mbar), direct-operated regulator with internal registration requiring no downstream control line.

**Type Y690M**—Direct-operated regulator with the same pressure rating as the Type Y690H. The Type Y690M has a blocked throat and O-ring stem seal to prevent leakage around the stem. Lower diaphragm casing assembly is tapped for 1/2-inch NPT for control line connection.



W6174-1

TYPE Y690



W6175-1

TYPE Y690H

Figure 1. Y690 Series Pressure Reducing Regulators

Table 1. Specifications

<p><b>Body Sizes and End Connection Styles<sup>(1)</sup></b>            NPT screwed: ■ 3/4 x 3/4, ■ 1 x 1, ■ 1-1/4 x 1-1/4 inch            CI 150 &amp; 300 RF Flanges: ■ 3/4 x 3/4, ■ 1 x 1 inch</p> <p><b>Maximum Allowable Inlet Pressure<sup>(2)</sup></b>            150 psig (10.4 bar)</p> <p><b>Maximum Outlet Pressure (Casing)<sup>(2)</sup></b>            150 Psig (10.3 bar)</p> <p><b>Outlet Pressure Ranges<sup>(2)</sup></b>            See table 2</p>	<p><b>Maximum Emergency Outlet Pressure to Avoid Internal Part Damage (emergency only)<sup>(2)</sup></b>            150 Psig (10.3 bar)</p> <p><b>Material Temperature Capabilities<sup>(2)</sup></b>  <b>Standard Elastomers:</b> - 20 to 150°F (- 29 to 66°C)  <b>High-Temperature Elastomers:</b> + 40 to 300°F (+ 5 to 149°C)</p> <p><b>Spring Case Connection</b>            1/4 inch NPT</p> <p><b>Diaphragm Case Connection</b>            1/2 inch NPT (Type Y690M only)</p> <p><b>Approximate Weight</b>            17 lbs (7.7 kg)</p>
<p>1. Flanged end connections and end connections for other than U.S. standard can usually be provided; consult the Fisher sales office or sales representative.</p>	<p>2. The pressure/temperature limits in this manual, and any applicable standard limitation, should not be exceeded.</p>

## Specifications

Table 1 gives some general regulator ratings and other specifications. Individual regulator data is stamped on the nameplate as it comes from the factory.

## Installation

### WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is over-pressured or is installed where service conditions could exceed the limits given in table 1, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe and well ventilated location

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from

external sources. A regulator should be inspected for damage periodically and after any overpressure condition beyond the emergency outlet pressure limit specified in table 1. Key numbers referenced in this section are shown in figures 3 through 5.

### Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.

1. Only personnel qualified through training and experience should install, operate, and maintain a regulator. For a regulator that is shipped separately, make sure that there is no damage to, or foreign material in, the regulator. Also ensure that all tubing and piping have been blown free.

2. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body. Normal installation is with the spring case barrel vertical above or below the diaphragm case. However, when using a Type Y690 regulator, for proper operation to achieve the published capacities, the spring case barrel should be installed pointed down as shown in figure 1. For complete actuator casing drainage of the Types Y690H & Y690M, the regulators should be installed as shown in figure 2. If continuous operation of the system is required during inspection or maintenance, install a three-valve bypass around the regulator.

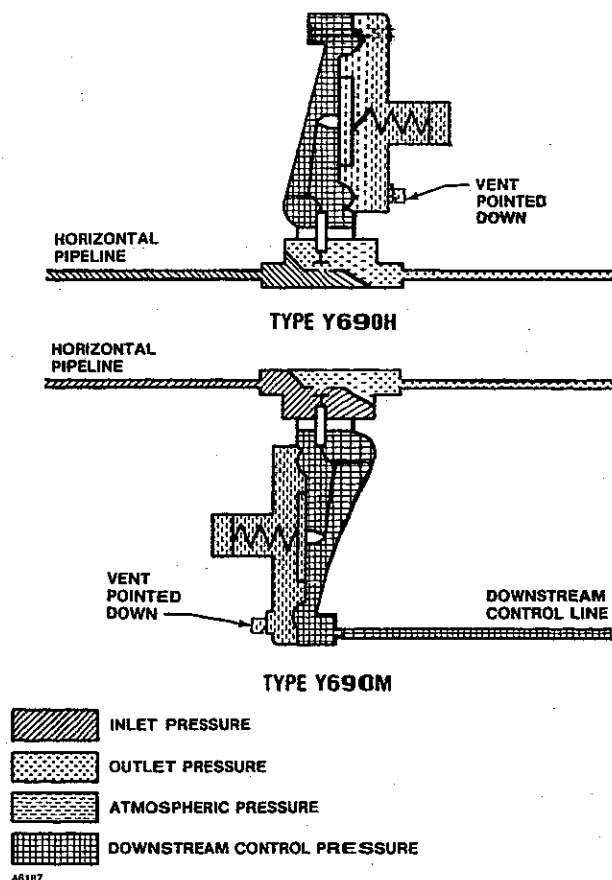


Figure 2. Self Draining Installation Schematics

### WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

3. To keep the spring case vent from being plugged or the spring case from collecting moisture, corrosive chemicals, or other foreign material, point the vent down or otherwise protect it. The diaphragm case assembly (key 20) may be rotated in order to obtain desired positioning.

4. To remotely vent the regulator, remove the vent (key 65) and install obstruction-free tubing or piping into the 1/4-inch NPT vent tapping. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

5. The Type Y690M regulator requires a downstream control line. Be sure to install this control line before putting the regulator into operation. The downstream control line pipe should be at least 1/2-inch in diameter and connected to a straight section of outlet piping 5 to 10 pipe diameters downstream of the regulator. A hand valve should be installed in a straight section of the control line. This hand valve can be throttled down to dampen out pulsations which may cause instability or cycling of the regulator.

## Startup and Adjustment

### WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm and spring case area section of the maintenance procedure.

Y690 Series regulators can be placed in operation by slowly introducing inlet pressure. The regulator takes control when downstream pressure is established.

The regulator has been adjusted at the factory to provide approximately the reduced pressure requested on the order. With a spring-loaded regulator, the pressure setting may be adjusted to a value within the spring range shown in table 2. To adjust the pressure setting, perform the following steps (key numbers are referenced in figures 3 through 5):

1. Remove the closing cap (key 3).
2. Use a 1-inch (25.4 mm) hex rod to turn the adjusting screw (key 2) either clockwise to increase outlet pressure or counterclockwise to decrease outlet pressure.

## Shutdown

First close the nearest upstream shutoff valve and then close the nearest downstream shutoff valve to vent the regulator properly. Next, open the vent valve between the regulator and the downstream shutoff valve nearest to it. All pressure between these shutoff valves is released through the open vent valve, since a Y690 Series regulator remains open in response to the decreasing downstream pressure.



Table 2. Outlet (Control) Pressure Ranges

Type Number	Control Spring Color	Control Spring Part Number	Outlet Pressure Range
Y690	Orange	1B558527052	1-2.5 inches wc (2-6 mbar) <sup>(1)</sup>
	Red	1B653827052	2.5-7 inches wc (6-16 mbar) <sup>(1)</sup>
Y690H & Y690M	Red	1B653827052	5-10 inches wc (12-25 mbar) <sup>(2)</sup>
	Olive Drab	1B653927022	7-15 inches wc (17-37 mbar) <sup>(2)</sup>
	Yellow	1B537027052	0.5-1.2 psig (34-83 mbar) <sup>(2)</sup>
	Lt. Green	1B537127022	1.2-2.5 psig (83-172 mbar) <sup>(2)</sup>
	Lt. Blue	1B537227022	2.5-4.5 psig (.17-.31 bar) <sup>(2)</sup>
	Black	1B537327052	4.5-7 psig (.31-.48 bar) <sup>(2)</sup>

1. To achieve the published outlet pressure rating the spring case barrel must be installed below the diaphragm as shown in figure 1.  
2. With spring case barrel above the diaphragm. With the spring case barrel below the diaphragm, the spring range is 2-inches wc (4 mbar) lower and with the spring barrel horizontal, the range is 1-inch wc (2.5 mbar) lower.

## Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends upon the severity of service conditions or the requirements of local, state, and federal regulations. Due to the care Fisher takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher.

### WARNING

**To avoid personal injury, property damage, or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.**

Key numbers are referenced in figures 3 through 5.

### Body Area

This procedure is for gaining access to the disk assembly, orifice, body gasket, split ring, and pitot tube if used. All pressure must be released from the diaphragm case assembly, and the disk assembly must be open, before these steps can be performed.

1. Unscrew the union nut (key 19) from the body (key 28) and remove the diaphragm case assembly (key 20) and split ring (key 17). With a Type Y690 or Y690H (figures 3, 4 & 5) regulator, the diaphragm case assembly (key 20) must be tipped toward the body outlet to allow removal clearance for the pitot tube (key 76).

2. Inspect and replace the orifice (key 27) if necessary. Protect the orifice seating surface during disassembly

and assembly. Lubricate the threads of the replacement orifice with a good grade of pipe thread sealant and install with 29 to 37 foot-pounds (39 to 50 N·m) of torque.

3. Remove the cotter pin (key 14) if it is necessary to replace the disk assembly (key 25).

4. To replace or reposition the pitot tube (key 76, figures 3, 4 or 5), remove the pitot tube screws (key 77), install the pitot tube so that it points into the outlet of the body (key 28) after the diaphragm case assembly (key 20) is installed, and secure with the pitot tube screw (key 77).

5. Install the disk assembly (key 25) and secure it with the cotter pin (key 14).

6. If necessary, install the replacement body gasket (key 16) into the body (key 28).

7. Slide the union nut (key 19) as far as it will go onto the diaphragm case assembly (key 20). Install both halves of the split ring (key 17) into the slots of the diaphragm case assembly (key 20) and secure them by sliding the union nut down on the split ring.

8. Install the diaphragm case assembly (key 20) with the attached split ring (key 17) and union nut (key 19) so that the pitot tube (key 76, if used) fits into the outlet of the body (key 28).

9. Tighten the union nut (key 19) until the diaphragm case assembly (key 20) is secure on the body (key 28).

### Diaphragm and Spring Case Area

This procedure is for gaining access to the spring, diaphragm, and lever assembly stem. All pressure must be released from the diaphragm case assembly before these steps can be performed.

**To Change the Control Spring:****Note**

Any remote control drive unit used with a Y690 Series regulator must be removed from the spring case (key 23) before these steps can be performed.

1. Remove the closing cap (key 3), and turn the adjusting screw (key 2) counterclockwise until all compression is removed from the control spring (key 1).
2. Change the control spring to match the desired spring range.
3. Replace the adjusting screw (key 2).
4. Install a replacement closing cap gasket (key 37), if necessary, and reinstall the closing cap (key 3).
5. If the spring range was changed, be sure to change the stamped spring range on the nameplate.

**To Disassemble and Reassemble Diaphragm Parts:**

Key numbers are referenced in figures 3 through 5.

1. Remove the closing cap (key 3), and turn the adjusting screw (key 2) counterclockwise to remove the adjusting screw (key 2) and the control spring (key 1).
2. Remove the spring case hex nuts (key 22), cap screws (key 21), and spring case (key 23).
3. Remove the diaphragm (key 5) plus attached parts by tilting them so that the pusher post (key 8, figures 3, 4 and 5) slips off the lever assembly (key 9). To separate the diaphragm or diaphragm assembly (key 5) from the attached parts, unscrew the spring holder screw (key 36) from the pusher post (key 8, figures 3, 4 and 5).
4. Inspect the pusher post and the O-ring (key 10), replace if required.
5. Remove hex nut (key 34) to separate the diaphragm and attached parts.
6. To replace the lever assembly (key 9), remove the machine screws (key 11). To replace the stem (key 13) also perform body area maintenance procedure steps 1 and 3, and pull the stem (key 13) out of the lower casing assembly (key 20).
7. Install the stem (key 13) into the lower casing assembly (key 20) and perform body area maintenance procedure steps 5 through 9 as necessary.

8. Install the lever assembly (key 9) into the stem (key 13) and secure the lever assembly (key 9) with machine screws (key 11).

9. Install the parts on the pusher post in the order listed below:

- Pusher post connection (key 33)
- Diaphragm plate, Type Y690 only (key 24)
- Diaphragm (key 5) pattern side up
- Diaphragm plate (key 24)
- Belleville washer, Types Y690H & Y690M only (key 86)
- Control spring seat (key 4)
- Hex nut (key 34) — Torque the hex nut 9 to 12 foot-pounds (12 to 15 N·m) to secure parts to the pusher post connector (key 33)
- Relief valve spring (key 32)

10. Insert and tighten the spring holder screw (key 36) with a torque of 1 to 3 foot-pounds (1 to 4 N·m) to secure the diaphragm parts to the pusher post (key 8).

11. Install the assembled parts in the lower casing (key 20). Make sure that the lever (key 9) fits in the pusher post (key 8) and that the holes in the diaphragm align with the holes in the lower casing.

12. Install the spring case (key 23) on the lower casing assembly (key 20) so that the vent assembly (key 65) is correctly oriented, and secure with the cap screws (key 21) and hex nuts (key 22, not shown) fingertight or snug.

13. Insert the control spring (key 1) into the spring case (key 23), followed by the adjusting screw (key 2).

14. Turn the adjusting screw (key 2) clockwise until there is enough control spring (key 1) force to provide proper slack to the diaphragm (key 5). Using a crisscross pattern, finish tightening the cap screws (key 21) and hex nuts (key 22, not shown) to 18 to 21 foot-pounds (24 to 28 N·m) of torque. To adjust the output pressure to the desired setting, refer to the Startup and Adjustment section.

15. Install a replacement closing cap gasket (key 37) if necessary, and then install the closing cap (key 3).

**Parts Ordering**

When corresponding with the Fisher sales office or sales representative about this regulator, include the type number and all other pertinent information stamped on the nameplate. Specify the eleven-character part number when ordering new parts from the following parts list.



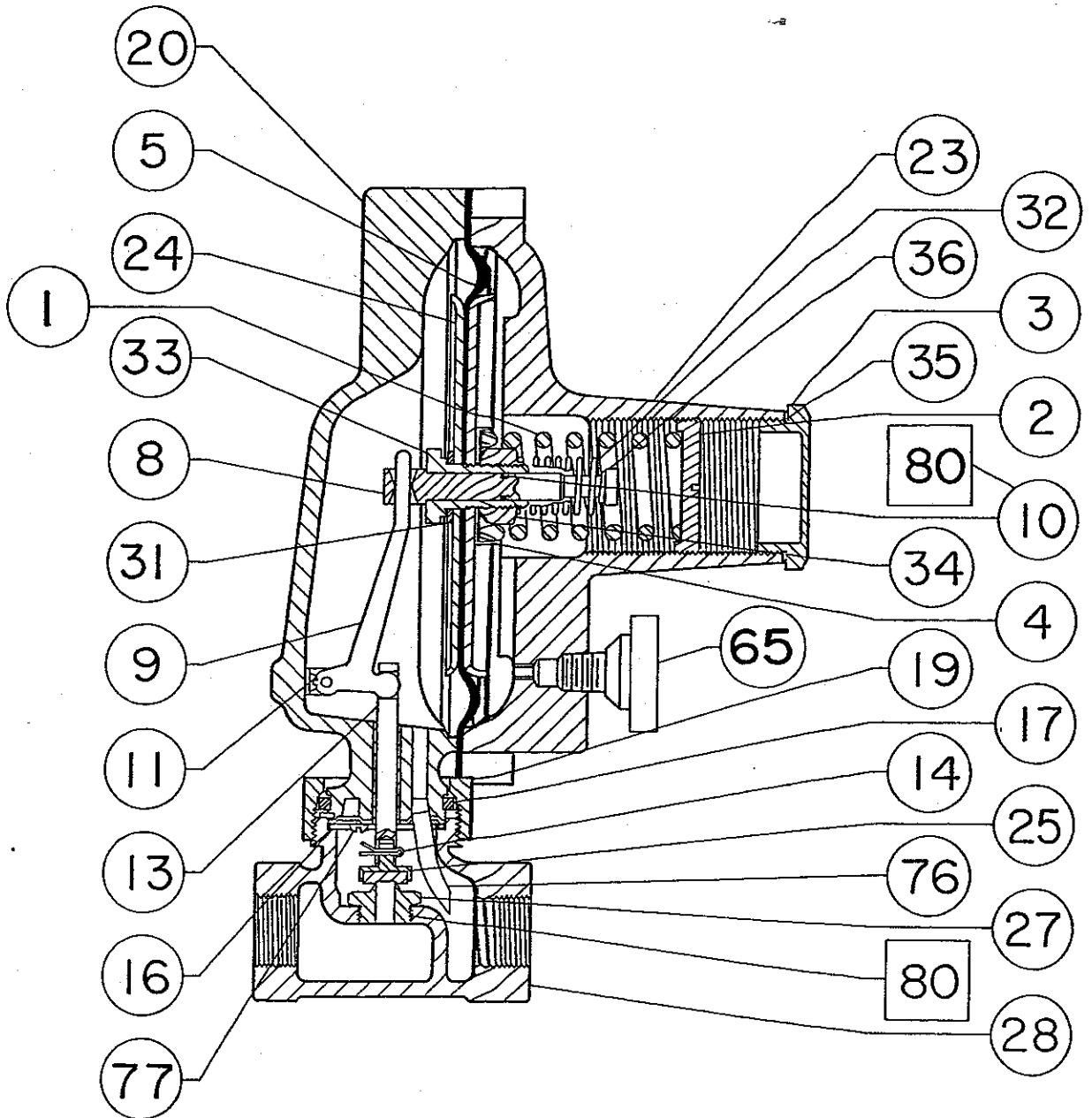
# Y690 Series

## Parts List

### Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the National Association of Corrosion Engineers (NACE) standard MR0175.

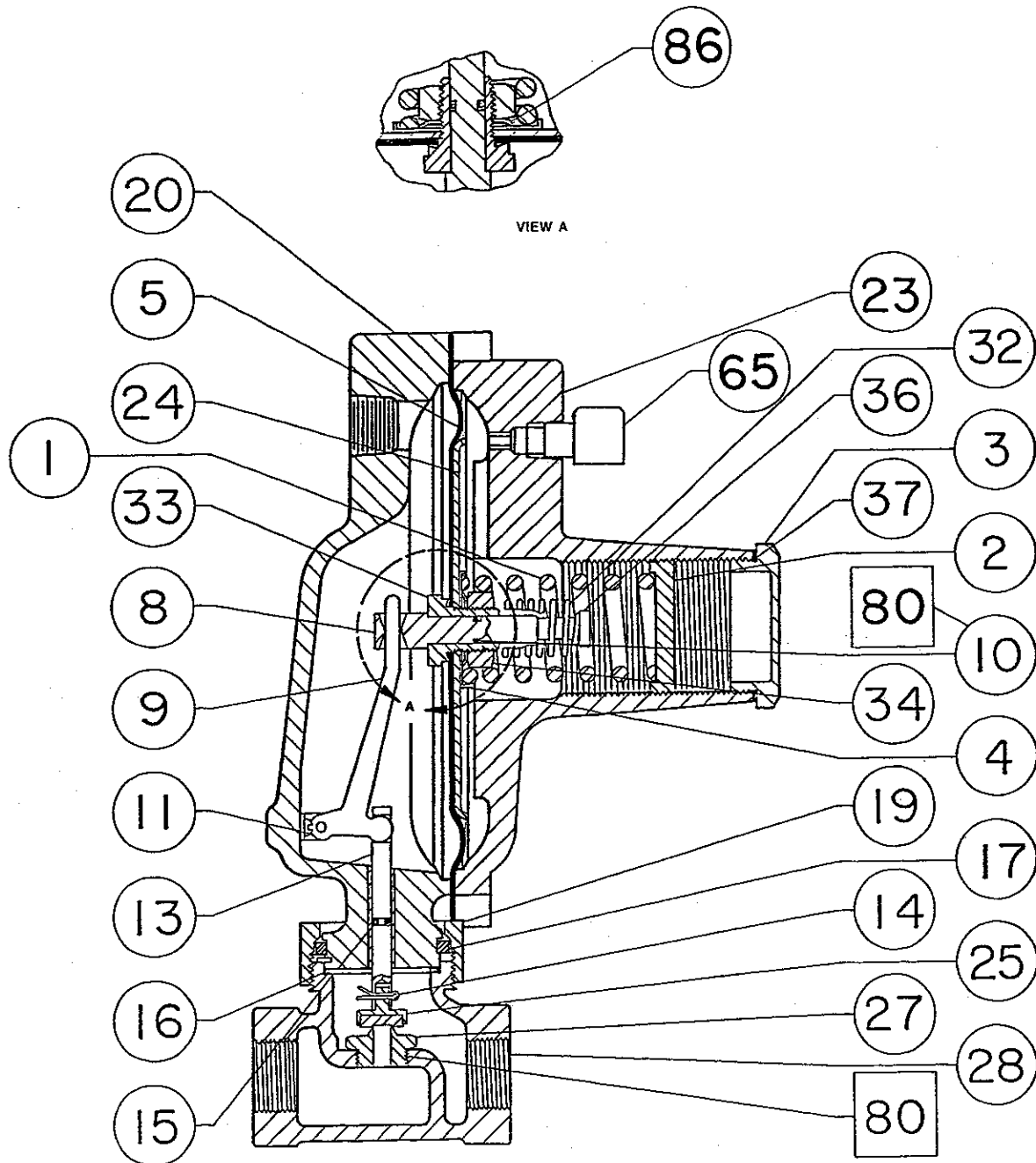
Key	Description	Part Number	Key	Description	Part Number
	Parts Kit for Y690 Series (included are keys 5, 10, 14, 15, 16, 25, and 37)	RY690X00012	14*	Cotter Pin, stainless steel (also NACE)	1A866537022
1	Control Spring, pl steel	See table 2	15*	O-Ring, (Type Y690M only), Stainless steel disk holder	1D289906992
2	Adjusting Screw, pl steel	1B537944012		Nitrile disk (also NACE)	1D2899X0022
	Stainless steel (when used w/Type 661)	14A7998X012		Fluoroelastomer disk (also NACE)	1H2926X0012
3	Closing Cap			EPR disk (also NACE)	1D2899X0022
	For ductile iron spring case assembly			PTFE disk	
	Plastic for spring-loaded regulator	T11069X0012		Aluminum disk holder	
	Steel for pressure-loaded regulator	1E422724092		Nitrile disk	1D289906992
	For stainless steel spring case assembly, stainless steel	1E422735072		Fluoroelastomer disk	1D2899X0022
4	Control Spring Seat, pl steel	13B0104X012		EPR disk	1H2926X0012
5*	Diaphragm		16*	Body Gasket, composition	1A832504032
	Nitrile	23B0101X012	17	Split Ring, plated steel	1A832648722
	Fluoroelastomer	23B0101X022	19	Union Nut	
8	Pusher Post			For steel or stainless steel diaphragm case assy, stainless steel	1N687835072
	For Types Y690H and Y690M			For steel diaphragm case assy, stainless steel	1N6878X0032
	Stainless steel, standard	13B0105X012		For ductile iron diaphragm case assy, malleable iron	1E471119062
	NACE, stainless steel	13B0105X022	20	Lower Casing Assembly	
	For Type Y690, stainless steel	13B0108X012		Ductile iron	33B0110X042
	NACE, stainless steel	13B0108X022		Stainless steel	33B0110X032
9	Lever Assembly		21	Diaphragm Case Cap Screw, (not shown) plated steel (8 req'd)	1B116224052
	Stainless steel, standard	1B5375000B2	22	Hex Nut (not shown), plated steel (8 req'd)	1A309324122
	Brass	1B5375X0082	23	Spring Case Assembly	
	For NACE, stainless steel	1B5375X0032		Ductile iron	13B0109X042
10*	Pusher Post O-Ring			Stainless steel	13B0109X032
	Nitrile	1D687506992	24	Diaphragm Plate	
	Fluoroelastomer	1N430406382		pl steel, (2 req'd for Type Y690)	13B0102X012
	EPR	1D6875X0032	25*	Disk Assembly	
11	Machine Screw (2 req'd)			Stainless steel disk holder with	
	Stainless steel (also NACE)	1A866435042		Nitrile disk (for Type Y690H only)	1C4248X0202
	Brass	1A331928982		Nitrile disk (for Type Y690M only)	1C4248X0252
13	Stem			Fluoroelastomer disk	1C4248X0052
	For Types Y690 or Y690H			PTFE disk	1C4248000D2
	Stainless steel	1A832735172		EPR disk	1C4248X0302
	Stainless steel (NACE)	1A8327X00A2		Aluminum disk holder with	
	For Type Y690M only			Nitrile disk (for Type Y690H only)	1C4248X0212
	Stainless steel	1E375535172		Nitrile disk (for Type Y690M only)	1C4248X0252
	Stainless steel (NACE)	1E3755X0022		Fluoroelastomer disk	1C4248X0182
				For NACE, Stainless steel disk holder with	
				Nitrile disk	1C4248X0252
				Fluoroelastomer disk	1C4248X0192
				EPR disk	1C4248X0152



□ APPLY LUB  
PARTS NOT SHOWN: 22

43B0115-C

Figure 3. Type Y690 Regulator



L1 APPLY LUB  
 PARTS NOT SHOWN: 22  
 4380659-C

Figure 5. Type Y690M Regulator

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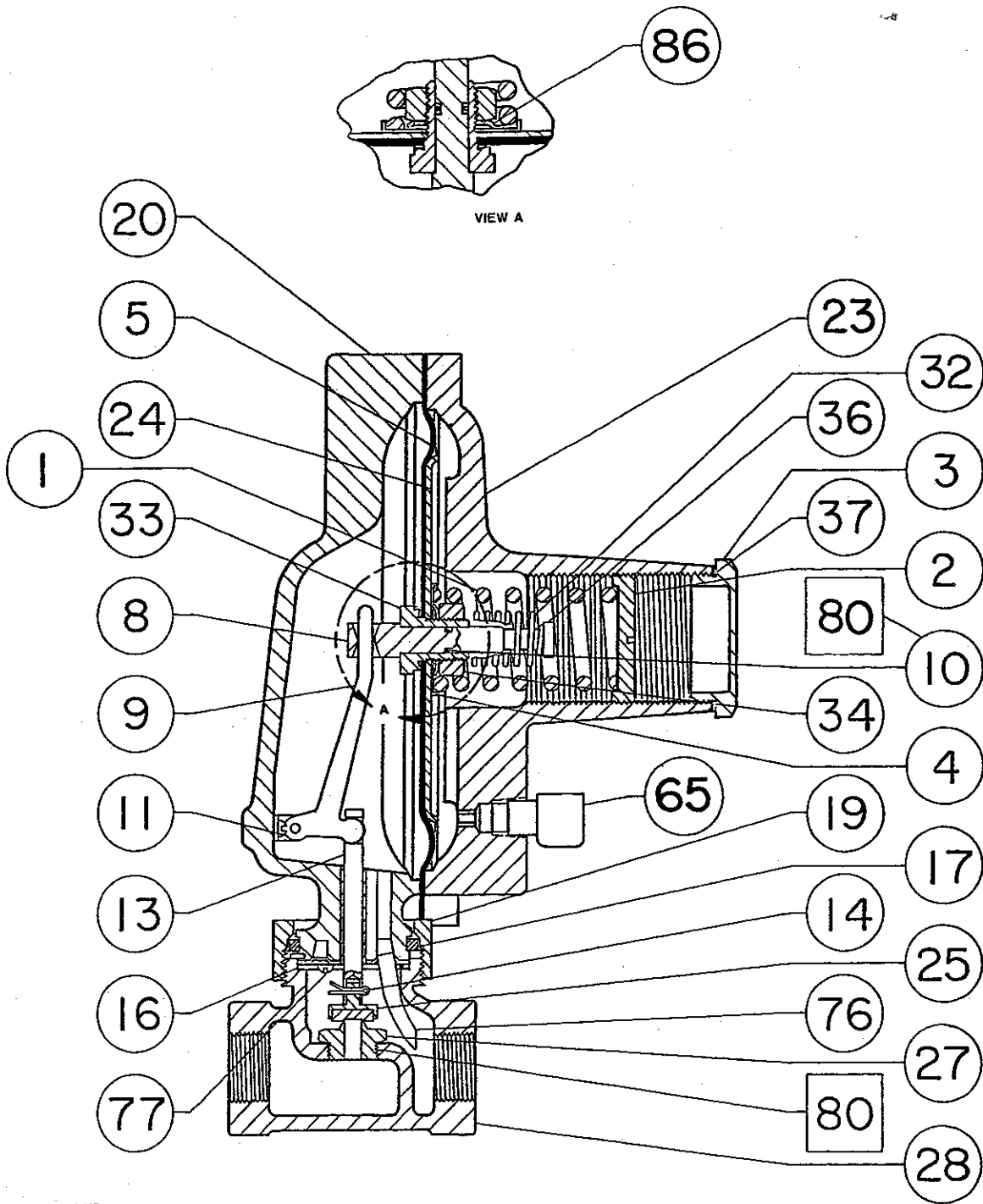
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 4380117-C

Figure 4. Type Y690H Regulator

Key	Description	Part Number	Key	Description	Part Number
27	Orifice		28	Body (Cont'd.)	
	Stainless Steel			Stainless steel	
	3/32-inch (2.4 mm)	0R044135032		3/4 x 3/4-inch size	1E162733092
	1/8-inch (3.2 mm)	1A936735032		1 x 1-inch size	1J691133092
	3/16-inch (4.8 mm)	00991235032		1-1/4 x 1-1/4-inch size	1J691233092
	1/4-inch (6.4 mm)	0B042035032		Class 150 Raised Face Flanged	
	5/16-inch (7.9 mm)	0B042135032		3/4 x 3/4-inch size	22B4317X012
	3/8-inch (9.5 mm)	0B042235032		1 x 1-inch size	14B3116X022
	7/16-inch (11.1 mm)	1A834635032		Class 300 Raised Face Flanged	
	1/2-inch (12.7 mm)	1A928835032		3/4 x 3/4-inch size	14B3116X042
	9/16-inch (14.3 mm)	1C425235032		1 x 1-inch size	23A2389X032
	Aluminum			DIN 16/25/40	
	3/32-inch (2.4 mm)	0R044109022		3/4 x 3/4-inch size	24B0635X022
	1/8-inch (3.2 mm)	1A936709012		1 x 1-inch size	24B0028X022
	3/16-inch (4.8 mm)	00991209012	32	Overpressure spring, steel	1B541327022
	1/4-inch (6.4 mm)	0B042009012	33	Pusher Post Connector	
	5/16-inch (7.9 mm)	0B042109012		Stainless steel	23B0106X012
	3/8-inch (9.5 mm)	0B042209012		Stainless steel (NACE)	23B0106X022
	7/16-inch (11.1 mm)	1A8346X0012	34	Hex Nut (for Types Y690, Y690H or Y690M)	1A354024122
	1/2-inch (12.7 mm)	1A928809012	36	Spring Holder Screw, pl steel	1C323114012
	9/16-inch 14.3 mm)	1C4252X0012	37	Closing Cap Gasket, composition	1P753306992
	Stainless steel (NACE)		65	Vent Assembly, plastic	
	3/32-inch (2.4 mm)	0R0441X0012		Type Y602-1	17A6570X012
	1/8-inch (3.2 mm)	1A9367X0022		Type Y602-11 (for Types Y690H or Y690M)	17A5515X012
	3/16-inch (4.8 mm)	009912X0012		Type Y602-12 (for Types Y690H or Y690M)	27A5516X012
	1/4-inch (6.4 mm)	0B0420X0012	76	Pitot Tube (for Types Y690 or Y690H only)	
	5/16-inch (7.9 mm)	0B0421X0012		For stainless steel disk assy,	
	3/8-inch (9.5 mm)	0B0422X0012		Stainless steel	1D2916000A2
	7/16-inch (11.1 mm)	1A8346X0022		For aluminum disk assy, pl steel	
	1/2-inch (12.7 mm)	1A9288X0012		Type Y690	1D2916000A2
	9/16-inch 14.3 mm)	1C4252X0022		Type Y690H	2D837144012
28	Body		77	Pitot Tube Screw (for Types Y690 or Y690H only) (4 req'd)	
	Ductile iron			For stainless steel disk assy,	
	3/4 x 3/4-inch size	1E4501X0012		Stainless steel	1D968438992
	1 x 1-inch size	1E4503X0012		For aluminum disk assy, plated steel	
	Steel			Type Y690	1D968438992
	NPT			Type Y690H	1D884324052
	3/4 x 3/4-inch size	1E162722012	80	Lubricant, Dow Corning 33, 10 oz. tube	T13078T0012
	1 x 1-inch size	1J691122012	86	Belleville Washer (for Types Y690H or Y690M only)	13B6920X012
	Class 150 Raised Face Flanged				
	3/4 x 3/4-inch size	22B4317X022			
	1 x 1-inch size	14B3116X012			
	Class 300 Raised Face Flanged				
	3/4 x 3/4-inch size	14B3116X032			
	1 x 1-inch size	23A2389X012			
	DIN 16/25/40				
	3/4 x 3/4-inch size	2AB0635X012			
	1 x 1-inch size	24B0028X012			

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3		PRESSURE INSTRUMENTS				SHEET 2 OF 2
						SPEC NO _____ FILE 14.11.P
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE SWITCHES		NO	BY	DATE	REVISION	JOB # 054468
		0	RDD	03/11/05	ISSUED FOR PURCHASE	DATE 03/11/2005
						REQ.
		BY	CHK'D			APPR.
1	TAG NO.	PSHH-633 DEETHANIZER REBOILER FUEL GAS				
2	FUNCTIONS	RECORD _____	INDICATE _____	CONTROL _____	BLIND _____	SWITCH <u>X</u> _____
3	CASE	MFR STD <u>X</u> _____	NOM SIZE _____	COLOR : MFR STD <u>X</u> _____	OTHER _____	
4	MOUNTING	FLUSH _____	SURFACE _____	YOKE _____	OTHER _____	
5	ENCLOSURE CLASS	GENERAL PURPOSE _____	WEATHER PROOF _____	EXPLOSION PROOF <u>X</u> _____	CLASS I DIV I _____	
6	POWER SUPPLY	117 V 60Hz _____	OTHER AC _____	DC <u>X</u> _____	VOLTS _____	
7	CHART	STRIP _____	ROLL _____	FOLD _____	CIRCULAR _____	TIME MARKS _____
8	CHART DRIVE	SPEED _____				POWER _____
9	SCALES	TYPE _____				
10	TRANSMITTER OUTPUT	RANGE 1 _____	2 _____	3 _____	4 _____	
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____				
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____		DECREASES _____		
13	AUTO - MAN SWITCH	NONE _____		MFR STD _____	OTHER _____	
14	SET POINT ADJ.	MANUAL _____		EXTERNAL _____	REMOTE _____	OTHER _____
15	MANUAL REG.	NONE _____		MFR STD _____	OTHER _____	
16	OUTPUT	4 - 20 mA _____	10 - 50 mA _____	21 - 103 kPa(ga) _____	42 - 206 kPa (ga) _____	OTHER _____
17	SERVICE	GAGE PRESS. <u>X</u> _____	VACUUM _____	ABSOLUTE _____	COMPOUND _____	
18	ELEMENT TYPE	DIAPHRAGM <u>X</u> _____	HELIX _____	BOURDON _____	BELLOWS _____	OTHER _____
19	MATERIAL	316 SS <u>X</u> _____	BER. COPPER _____	OTHER _____		
20	RANGE	FIXED <u>X</u> _____	ADJ. RANGE _____	SET AT 210 kPag _____		
21	PROCESS DATA	OVERRANGE PROTECTION TO _____				
22	PROCESS CONN.	PRESSURE : NORMAL <u>82</u> KPAG _____	MAX. <u>861</u> KPAG _____	ELEMENT RANGE <u>62 - 517</u> KPAG _____		
		14 mm NPT _____	21 mm NPT <u>X</u> _____	OTHER _____		
		LOCATION : BOTTOM _____	BACK <u>X</u> _____	OTHER _____		
23	ALARM SWITCHES	QUANTITY <u>1</u> _____	FORM _____	RATING _____		
24	FUNCTION	PRESSURE _____	DEVIATION _____	CONTACTS TO <u>CLOSE</u> _____ ON INC. PRESS		
25	OPTIONS	FILT - REG. _____	SUP. GAGE _____	OUTPUT GAGE _____	CHARTS _____	
		DIAPH SEAL _____	TYPE _____	DISPH _____	BOT BOWL _____	
		CONN. _____	CAPILLARY : LENGTH _____	MATERIAL _____		
		OTHER _____				
26	MFR. & MODEL NO.	<u>CCS DUAL SNAP</u> _____				
27	MODEL NO.	<u>6900GZE14</u> _____				
28	P. O. NUMBER	_____				

NOTES:

AREA. UNIT # :



PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3		PRESSURE INSTRUMENTS				SHEET 1 OF 2
						SPEC NO _____ FILE 14.11.P
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE SWITCHES		NO	BY	DATE	REVISION	JOB # 054468
		0	RDD	03/11/05	ISSUED FOR PURCHASE	DATE 03/11/2005
						BY _____ CHK'D _____ APPR. _____
1	TAG NO.	PSLL-633 DEETHANIZER REBOILER FUEL GAS				
2	FUNCTIONS	RECORD _____	INDICATE _____	CONTROL _____	BLIND _____	SWITCH <u>X</u> _____
3	CASE	MFR STD <u>X</u> _____	NOM SIZE _____	COLOR : MFR STD <u>X</u> _____	OTHER _____	
4	MOUNTING	FLUSH _____	SURFACE _____	YOKE _____	OTHER _____	
5	ENCLOSURE CLASS	GENERAL PURPOSE _____	WEATHER PROOF _____	EXPLOSION PROOF <u>X</u> _____	CLASS I DIV I _____	
6	POWER SUPPLY	117 V 60Hz _____	OTHER AC _____	DC <u>X</u> _____	VOLTS _____	
7	CHART	STRIP _____	ROLL _____	FOLD _____	CIRCULAR _____	TIME MARKS _____
8	CHART DRIVE	SPEED _____			POWER _____	
9	SCALES	TYPE _____				
10	TRANSMITTER OUTPUT	4 - 20 mA _____	10 - 50 mA _____	21 - 103 kPa(g) _____	42 - 206 kPa (g) _____	OTHER _____
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____				
12	ACTION	ON MEAS. INCREASE OUTPUT :		INCREASES _____	DECREASES _____	
13	AUTO - MAN SWITCH	NONE _____	MFR STD _____	OTHER _____		
14	SET POINT ADJ.	MANUAL _____	EXTERNAL _____	REMOTE _____	OTHER _____	
15	MANUAL REG.	NONE _____	MFR STD _____	OTHER _____		
16	OUTPUT	4 - 20 mA _____	10 - 50 mA _____	21 - 103 kPa(ga) _____	42 - 206 kPa (ga) _____	OTHER _____
17	SERVICE	GAGE PRESS. <u>X</u> _____	VACUUM _____	ABSOLUTE _____	COMPOUND _____	
18	ELEMENT TYPE	DIAPHRAGM <u>X</u> _____	HELIX _____	BOURDON _____	BELLOWS _____	OTHER _____
19	MATERIAL	316 SS <u>X</u> _____	BER. COPPER _____	OTHER _____		
20	RANGE	FIXED <u>X</u> _____	ADJ. RANGE _____	SET AT <u>35</u> kPag _____		
21	PROCESS DATA	OVERRANGE PROTECTION TO _____				
22	PROCESS CONN.	PRESSURE : NORMAL <u>82</u> KPAG _____	MAX. <u>861</u> KPAG _____	ELEMENT RANGE <u>7 - 124</u> KPAG _____		
		14 mm NPT _____	21 mm NPT <u>X</u> _____	OTHER _____		
		LOCATION : BOTTOM _____	BACK <u>X</u> _____	OTHER _____		
23	ALARM SWITCHES	QUANTITY <u>1</u> _____	FORM _____	RATING _____		
24	FUNCTION	PRESSURE _____	DEVIATION _____	CONTACTS TO <u>CLOSE</u> _____	ON INC. PRESS _____	
25	OPTIONS	FILT - REG. _____	SUP. GAGE _____	OUTPUT GAGE _____	CHARTS _____	
		DIAPH SEAL _____	TYPE _____	DISPH _____	BOT BOWL _____	
		CONN. _____	CAPILLARY : LENGTH _____	MATERIAL _____		
		OTHER _____				
26	MFR. & MODEL NO.	<u>CCS DUAL SNAP</u> _____				
27	MODEL NO.	<u>6900GZE12</u> _____				
28	P. O. NUMBER	_____				

NOTES:

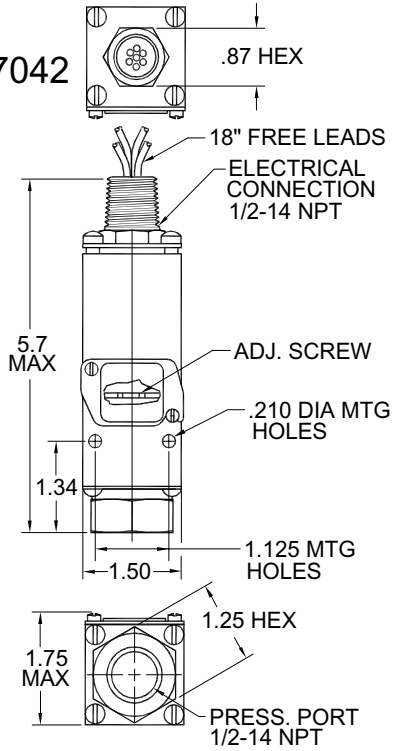
AREA. UNIT # :

**PSHH-633, PSL-633**

**Pressure 1 to 2500 psi**

**INSTALLATION DRAWING**

6900GZE  
6900GZE-7042



**Standard Features:**

- U.L./CSA Explosion Proof: Div. 1, 2 Div. 1 explosion-proof and hermetically sealed electrical assembly P/N 46-1058 (46-1061 for "M" model option), listed by both Underwriter's Laboratories, Inc. (File No. E32961) and CSA Testing Laboratories (File No. 22921) for hazardous locations, Class 1, Groups A, B, C, and D; Class 2 Groups E, F, and G.



- NEMA 4, 7, 9, 13.

**Ambient Temp. Range:**

-30°F to +160°F or  
-34°C to +71°C.

**How to Order:**

1. Specify model number.

**OPERATING AND ORDERING DATA:**

PRESSURE SWITCHES		1/2" in. STAINLESS STEEL			Model No. and Wetted Parts		
MODEL 6900GZE		• PRESSURE PORT AND DIAPHRAGM.			MODEL SPDT	MODEL DPDT	Wetted Parts
Max. Sys. Press. psi	Proof (Test) Press. psi	Adj. Set-Point Range		Approx Dead-band psi			
		On Incr. Press. psi	On Decr. Press. psi				
500	750	3-20	1-18	2	6900GZE12	6900GZEM12	316 SS Viton
500	750	9-75	3-69	6	6900GZE14	6900GZEM14	
1500	2000	18-150	6-138	12	6900GZE16	6900GZEM16	
1500	2000	45-375	15-345	30	6900GZE18	6900GZEM18	
2000	3000	300-1000	225-925	75	6900GZE20	6900GZEM20	
3000	4500	700-2500	520-2320	180	6900GZE22	6900GZEM22	

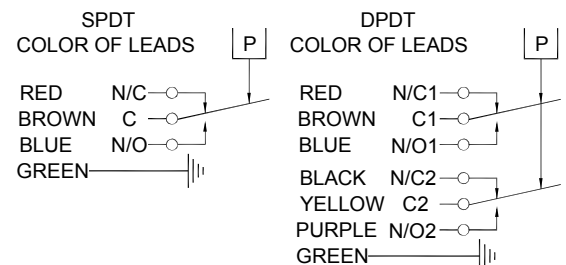
PRESSURE SWITCHES		1/2" in. STAINLESS STEEL			EXTERNAL PARTS STAINLESS STEEL CONSTRUCTION		
MODEL 6900GZE-7042		• PRESSURE PORT AND DIAPHRAGM			MODEL SPDT	MODEL DPDT	Wetted Parts
Max. Sys. Press. psi	Proof (Test) Press. psi	Adj. Set-Point Range		Approx. Dead band psi			
		On Incr. Press. psi	On Decr. Press. psi				
500	750	3-20	1-18	2	6900GZE12-7042	6900GZEM12-7042	316 SS Viton
500	750	9-75	3-69	6	6900GZE14-7042	6900GZEM14-7042	
1500	2000	18-150	6-138	12	6900GZE16-7042	6900GZEM16-7042	
1500	2000	45-375	15-345	30	6900GZE18-7042	6900GZEM18-7042	
2000	3000	300-1000	225-925	75	6900GZE20-7042	6900GZEM20-7042	
3000	4500	700-2500	520-2320	180	6900GZE22-7042	6900GZEM22-7042	

ELECTRICAL CHARACTERISTICS:			
Rating of Switch Element			
VOLTS	AMPERES		Res.
	SPDT	DPDT "M"	
	Res.	Res.	
125 AC — 50/60 Hz	11.0	11.0	
250 AC — 50/60 Hz	11.0	11.0	
30 DC	5.0	5.0	
125 DC	0.5	0.5	

**SHIPPING WEIGHTS:**

Models:	Oz	Grams
6900GZE*	19	539
6900GZE*-7042	16	794

**SCHEMATIC AND WIRING CODE**





PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE RELIEF VALVES				SHEET 1 OF 3 SPEC NO FILE 14.11.P			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE SAFETY VALVES				NO	BY	DATE	REVISION	JOB # 054468		DATE 03/11/2005	
				0	RDD	03/11/05	ISSUE FOR PURCHASE	REQ.			
								BY	CHK'D	APPR.	
G	1	TAG NO.	PSV-600	PSV-610				PSV-670		PSV-681	
E	2	SERVICE	INLET GAS	CHILLER				C3 COMP		C3 ACCUMULATOR	
N	3	LINE NO. / VESSEL NO.	E-600	V-610				K-670		V-680	
E	4	FULL NOZZLE / SEMI NOZZLE	FULL	FULL				FULL		FULL	
R	5	SAFETY OR RELIEF	SAFETY	SAFETY				SAFETY		SAFETY	
A	6	CONV. BELLOW, PILOT OP	CONVENTIONAL	CONVENTIONAL				CONVENTIONAL		CONVENTIONAL	
L	7	BONNET TYPE	BOLTED	BOLTED				SCREWED		SCREWED	
C	8	SIZE : INLET	48 mm	73 mm	89 mm	114 mm	48 mm	60 mm	60 mm	73 mm	
O	9	FLANGE RATING OR SCREWED	600#	150#	150#	150#	SCREWED	SCREWED	SCREWED	SCREWED	
N	10	TYPE OF FACING	RF	RF	RF	RF	FNPT	FNPT	FNPT	FNPT	
M	11	BODY AND BONNET	WCC	WCC				WCC		WCC	
A	12	SEAT AND DISC	316SS	316SS				316SS		316SS	
T	13	RESILIENT SEAT SEAL	316SS	316SS				316SS		316SS	
E	14	GUIDES AND RINGS	316SS	316SS				316SS		316SS	
R	15	SPRING	CS	CS				CS		CS	
I	16	BELLOWS									
L	17										
O	18	CAP : SCREWED / BOLTED	SCREWED	SCREWED				SCREWED		SCREWED	
P	19	LEVER : PLAIN / PACKED	NO	NO				NO		NO	
T	20	TEST GAG	NO	NO				NO		NO	
I	21										
O	22										
N	23										
B	24	CODE	ASME	ASME				ASME		ASME	
A	25	FIRE								YES	
S	26	BASIS	FULL FLOW	TUBE RUPTURE				FULL FLOW		AREA=69.1FT^2 WETTED	
	27										
F	28	FLUID	NATURAL GAS	HYDROCARBON GAS				PROPANE		PROPANE	
L	29	FLUID STATE	VAPOUR	VAPOUR				VAPOUR		VAPOUR	
U	30	REQUIRED CAPACITY	14,750 KG/HR	14,750 KG/HR				3120 KG/HR		4255 KG/HR	
I	31	MOL. WEIGHT	19.4	19.4				44.1		44.1	
D	32	OPER. PRESS.	6850 kPa(g)	8963 kPa(g)	100 kPa(g)	1724 kPa(g)	1379 kPa(g)	1724 kPa(g)	1379 kPa(g)	1724 kPa(g)	
A	33	OPER. TEMP.	43 °C	43 °C	-5.5 °C	43 °C	66 °C	66 °C	43 °C	52.8 °C	
D	34	BACK PRESS.: CONSTANT		kPa(g)				kPa(g)		kPa(g)	
A	35	VARIABLE		kPa(g)				kPa(g)		kPa(g)	
T	36	TOTAL		kPa(g)				kPa(g)		kPa(g)	
A	37	% ALLOWABLE OVERPRESSURE	10	10				10		21	
	38	OVERPRESSURE FACTOR									
	39	COMPRESSIBILITY FACTOR	1.0	1.0				1.0		1.0	
	40	LATENT HEAT OF VAPORIZE								118.9 BTU/HR-FT2	
	41	RATIO OF SPECIFIC HEATS	1.27	1.28				1.13		1.13	
	42	OPERATING VISCOSITY (cP)									
	43	BAROMETER PRESSURE kPa									
	44										
	45	CALCULATED AREA	0.414 in2	1.893 in2				0.305 in2		0.372 in2	
	46	SELECTED AREA	0.5849 in2	3.3170 in2				0.357 in2		0.567 in2	
	47	ORIFICE DESIGNATION	g	L							
	48	MANUFACTURER	CONSOLIDATED	CONSOLIDATED				CONSOLIDATED		CONSOLIDATED	
	49	MODEL NO.	1.5" X 2.5" 1912Gc	3" X 4" - 1905Lc				1.5-19357Lc		2-19567Lc	
	50	P. O. NUMBER									

NOTES:

AREA. UNIT # :

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE RELIEF VALVES				SHEET 2 OF 3 SPEC NO FILE 14.11.P			
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE SAFETY VALVES				NO	BY	DATE	REVISION	JOB # 054468		DATE 03/11/2005	
				0	RDD	03/11/05	ISSUE FOR PURCHASE	REQ.			
								BY	CHK'D	APPR.	
G	1	TAG NO.		PSV-630		PSV-690		PSV-655A/655B		PSV-601/602	
E	2	SERVICE		DEETHANIZER		FUEL GAS SCRUBBER		GLYCOL INJ PUMP		GLYCOL/CARBON FILTERS	
N	3	LINE NO. / VESSEL NO.		T-630		V-690		P-655A/B		F-601/602	
E	4	FULL NOZZLE / SEMI NOZZLE		FULL		FULL		FULL		FULL	
R	5	SAFETY OR RELIEF		SAFETY		SAFETY		SAFETY		SAFETY	
A	6	CONV. BELLOW, PILOT OP		CONVENTIONAL		CONVENTIONAL		CONVENTIONAL		CONVENTIONAL	
L	7	BONNET TYPE		SCREWED		SCREWED		SCREWED		SCREWED	
C	8	SIZE : INLET	OUTLET	60 mm	73 mm	48 mm	60 mm	27 mm	33 mm	27 mm	33 mm
O	9	FLANGE RATING OR SCREWED		SCREWED		SCREWED		SCREWED		SCREWED	
N	10	TYPE OF FACING		FNPT		FNPT		MNPT		FNPT	
M	11	BODY AND BONNET		WCC		WCC		WCC		WCC	
A	12	SEAT AND DISC		316SS		316SS		316SS		316SS	
T	13	RESILIENT SEAT SEAL		316SS		316SS		316SS		316SS	
E	14	GUIDES AND RINGS		316SS		316SS		316SS		316SS	
R	15	SPRING		CS		CS		CS		CS	
I	16	BELLOWS									
L	17										
O	18	CAP : SCREWED / BOLTED		SCREWED		SCREWED		SCREWED		SCREWED	
P	19	LEVER : PLAIN / PACKED		NO		NO		NO		NO	
T	20	TEST GAG		NO		NO		NO		NO	
I	21										
O	22										
N	23										
B	24	CODE		ASME		ASME		ASME		ASME	
A	25	FIRE								YES	
S	26	BASIS		FAILURE OF LCV-620A		FAILURE OF PRV-690		FULL FLOW		AREA=10.3FT^2 WETTED	
	27										
	28	FLUID		H.C. VAPOUR		NATURAL GAS		E. GLYCOL		E.GLYCOL/WATER MIX	
F		FLUID STATE		VAPOUR		VAPOUR		LIQUID		STEAM	
L	29	REQUIRED CAPACITY		6990 KG/HR		942 KG/HR		5.7 L/MIN		123.6 KG/HR	
U	30	MOL. WEIGHT	OPER. SP. GR.	19.4		19.4		1.044			
I	31	OPER. PRESS.	SET PRESS.	1930 kPa(g)	3792 kPa(g)	700 kPa(g)	1724 kPa(g)	7240 kPa(g)	8963 kPa(g)	345 kPa(g)	1000 kPa(g)
D	32	OPER. TEMP.	REL. TEMP.	-13 °C	-23 °C	38 °C	38 °C	66 °C	66 °C	35 °C	184 °C
	33	BACK PRESS.: CONSTANT		kPa(g)		kPa(g)		kPa(g)		kPa(g)	
D	34	VARIABLE		kPa(g)		kPa(g)		kPa(g)		kPa(g)	
A	35	TOTAL		kPa(g)		kPa(g)		kPa(g)		kPa(g)	
T	36	% ALLOWABLE OVERPRESSURE		10		10		10		21	
A	37	OVERPRESSURE FACTOR									
	38	COMPRESSIBILITY FACTOR		1.0		1.0		1.0			
	39	LATENT HEAT OF VAPORIZE								860 BTU/LB	
	40	RATIO OF SPECIFIC HEATS		1.27		1.27					
	41	OPERATING VISCOSITY (cP)						1.35			
	42	BAROMETER PRESSURE kPa									
	43										
	44										
	45	CALCULATED AREA		0.396 in2		0.127 in2		0.0028 in2		0.0316 in2	
	46	SELECTED AREA		0.567 in2		0.357 in2		0.096 in2		0.096 in2	
	47	ORIFICE DESIGNATION									
	48	MANUFACTURER		CONSOLIDATED		CONSOLIDATED		CONSOLIDATED		CONSOLIDATED	
	49	MODEL NO.		2-19567Mc		1.5-19357Lc		3/4-19096Mc		3/4-19096Lc	
	50	P. O. NUMBER									

NOTES:

AREA. UNIT # :

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE RELIEF VALVES				SHEET 3 OF 3 SPEC NO FILE 14.11.P				
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : PRESSURE SAFETY VALVES				NO	BY	DATE	REVISION	JOB # 054468		DATE 03/11/2005		
				0	RDD	03/11/05	ISSUE FOR PURCHASE	REQ.				
								BY	CHK'D	APPR.		
G	1	TAG NO.	PSV-640	PSV-615								
E	2	SERVICE	GLYCOL FLSH TANK	REF. SUBCOOLER								
N	3	LINE NO. / VESSEL NO.	V-640	E-615								
E	4	FULL NOZZLE / SEMI NOZZLE	FULL	FULL								
A	5	SAFETY OR RELIEF	SAFETY	SAFETY								
R	6	CONV. BELLOW, PILOT OP	CONVENTIONAL	CONVENTIONAL								
L	7	BONNET TYPE	SCREWED	BOLTED								
C	8	SIZE : INLET	33 mm	48 mm	89 mm	114 mm						
O	9	FLANGE RATING OR SCREWED	SCREWED	SCREWED	150#	140#						
N	10	TYPE OF FACING	MNPT	FNPT	RF	RF						
M	11	BODY AND BONNET	WCC	WCC								
A	12	SEAT AND DISC	316SS	316SS								
T	13	RESILIENT SEAT SEAL	316SS	316SS								
E	14	GUIDES AND RINGS	316SS	316SS								
R	15	SPRING	CS	CS								
I	16	BELLOWS										
L	17											
O	18	CAP : SCREWED / BOLTED	SCREWED	SCREWED								
P	19	LEVER : PLAIN / PACKED	NO	NO								
T	20	TEST GAG	NO	NO								
I	21											
O	22											
N	23											
B	24	CODE	ASME	ASME								
A	25	FIRE										
S	26	BASIS	FAILURE OF LCV-620B	TUBE RUPTURE								
	27		0.25" MICROFLUTE									
F	28	FLUID	HYDROCARBON VAPOUR	HYDROCARBON VAPOUR								
L	29	FLUID STATE	VAPOUR	VAPOUR								
U	30	REQUIRED CAPACITY	399 KG/HR	14,750 KG/HR								
I	31	MOL. WEIGHT	19.4	19.4								
D	32	OPER. PRESS.	100 kPa(g)	1724 kPa(g)	1380 kPa(g)	1724 kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	
	33	OPER. TEMP.	93 °C	-23 °C	30 °C	-23 °C	°C	°C	°C	°C	°C	
D	34	BACK PRESS.: CONSTANT		kPa(g)		kPa(g)		kPa(g)		kPa(g)		
A	35	VARIABLE		kPa(g)		kPa(g)		kPa(g)		kPa(g)		
T	36	TOTAL		kPa(g)		kPa(g)		kPa(g)		kPa(g)		
A	37	% ALLOWABLE OVERPRESSURE	10	10								
	38	OVERPRESSURE FACTOR	1.0	1.0								
	39	COMPRESSIBILITY FACTOR	1.0	1.0								
	40	LATENT HEAT OF VAPORIZE										
	41	RATIO OF SPECIFIC HEATS	1.27	1.27								
	42	OPERATING VISCOSITY (cP)										
	43	BAROMETER PRESSURE kPa										
	44											
	45	CALCULATED AREA	0.048 in2	1.828 in2				mm 2		mm 2		
	46	SELECTED AREA	0.226 in2	3.3170 in2				mm 2		mm 2		
	47	ORIFICE DESIGNATION		L								
	48	MANUFACTURER	CONSOLIDATED	CONSOLIDATED								
	49	MODEL NO.	1-19226Lc	3" X 4" 1905 LC								
	50	P. O. NUMBER										
NOTES:												
AREA. UNIT # :												

# Consolidated®

## INSTALLATION, OPERATION AND MAINTENANCE MANUAL

### Consolidated® Safety Relief Valve Type 1900



Industrial Valves

DRESSER

#### Industrial Valve Operation

Dresser Valve and Controls Division  
Alexandria, Louisiana 71309-1430 (USA)

Design Options  
Include:

Bellows  
(-30),

O-Ring Seat  
(DA),

Liquid Trim  
(LA)

and

Thermodisc®  
(TD)

CON-2  
Revised 7/97

## Product Safety Sign and Label System

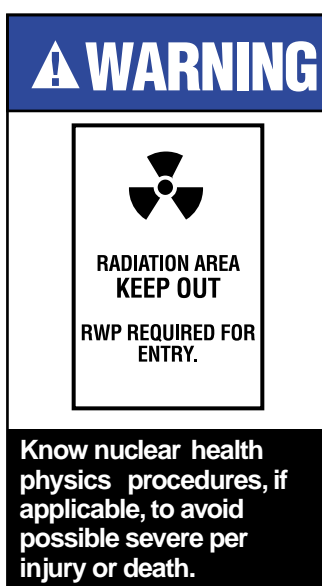
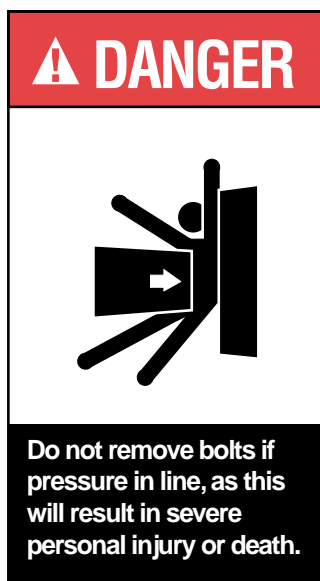
If and when required, appropriate safety labels have been included in the rectangular margin blocks throughout this manual. Safety labels are vertically oriented rectangles as shown in the **representative examples** (below), consisting of three panels encircled by a narrow border. The panels can contain four messages which communicate:

- The level of hazard seriousness.
- The nature of the hazard.
- The consequence of human, or product, interaction with the hazard.
- The instructions, if necessary, on how to avoid the hazard.

The top panel of the format contains a signal word (DANGER, WARNING, or CAUTION) which communicates the level of hazard seriousness.

The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of human or product interaction with the hazard. In some instances of human hazards the pictorial may, instead, depict what preventive measures to take, such as wearing protective equipment.

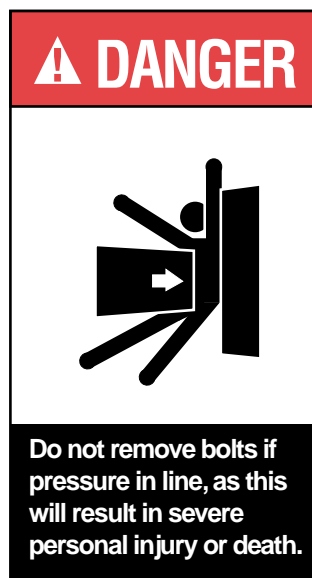
The bottom panel may contain an instruction message on how to avoid the hazard. In the case of human hazard, this message may also contain a more precise definition of the hazard, and the consequences of human interaction with the hazard, than can be communicated solely by the pictorial.



### SAFETY ALERTS!

#### READ – UNDERSTAND – PRACTICE

1. DANGER: High temperature/pressure can cause injury. Be sure all system pressure is absent before repairing or removing valves.
2. DANGER: Don't stand in front of valve outlet when discharging. STAND CLEAR OF VALVE to prevent exposure to trapped, corrosive media.
3. DANGER: When inspecting a pressure relief valve for leakage, BE VERY CAREFUL!





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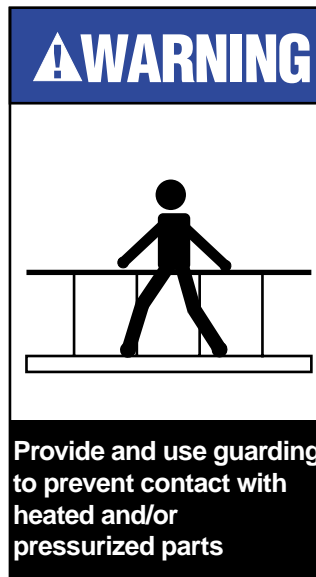
## Subject

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**SAFETY ALERTS!**  
**READ – UNDERSTAND – PRACTICE**

1. **WARNING:** Allow the system to cool to room temperature before cleaning, servicing or repairing the system. Hot components or fluids can cause severe personal injury or death.
2. **WARNING:** Always read and comply with safety labels on all containers. Do not remove or deface the container labels. Improper handling or misuse could result in severe personal injury or death.
3. **WARNING:** Never use pressurized fluids/gas/air to clean clothing or body parts. Never use body parts to check for leaks or flow rates or areas. Pressurized fluids/gas/air injected into or near the body can cause severe personal injury or death.
4. **WARNING:** It is the responsibility of the owner to specify and provide guarding to protect persons from pressurized or heated parts. Contact with pressurized or heated parts can result in severe personal injury or death.
5. **WARNING:** Do not allow anyone under the influence of intoxicants or narcotics to work on or around pressurized systems. Workers under the influence of intoxicants or narcotics are a hazard both to themselves and other employees and can cause severe personal injury or death to themselves or others.
6. **WARNING:** Incorrect service and repair could result in product or property damage or severe personal injury or death.



7. **WARNING:** These **WARNINGS** are as complete as possible but not all-inclusive. Dresser cannot know all conceivable service methods nor evaluate all potential hazards.
8. **WARNING:** Use of improper tools or improper use of right tools could result in personal injury or product or property damage.
9. **WARNING:** Some valve products manufactured by DVCD may be used in radioactive environments. Consequently, prior to starting any operation in a radioactive environment, the proper "health physics" procedures should be followed, if applicable.

1. CAUTION: Heed all service manual warnings. Read installation instructions before installing valve(s).
2. CAUTION: Wear hearing protection when testing or operating valves.
3. CAUTION: Wear appropriate eye and clothing protection.
4. CAUTION: Wear protective breathing apparatus to protect against toxic media.

**NOTE:**

Any service questions not covered in this manual should be referred to Dresser's Service Department, Phone (318) 640-6055.

**⚠ WARNING**




**RADIATION AREA  
KEEP OUT**

**RWP REQUIRED FOR  
ENTRY.**

**Know nuclear health physics procedures, if applicable, to avoid possible severe per injury or death.**

**⚠ CAUTION**



**Heed all service manual warnings. Read installation instructions before installing valve(s).**

**⚠ CAUTION**



**Wear necessary protective equipment to prevent possible injury.**

## II. Terminology for Safety Relief Valves

- **Accumulation**  
Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percentage of that pressure, or actual pressure units.
- **Back Pressure**  
Back pressure is the pressure on the discharge side of a safety relief valve:
  1. **Superimposed Back Pressure**  
Superimposed back pressure is the pressure in the discharge header before the safety relief valve opens.
    - a) Constant - Specify single constant back pressure (e.g., 20 psig/1.38 bar).
    - b) Variable - Specify variable back pressure range using min. and max. limits (e.g., 0 to 20 psig/1.38 bar).
  2. **Built-up Back Pressure**  
Built-up back pressure is pressure which develops at the valve outlet as a result of flow, after the safety relief valve has been opened.
- **Blowdown**  
Blowdown is the difference between set pressure and reseating pressure of a pressure relief valve, expressed as a percentage of the set pressure, or actual pressure units.
- **Cold Differential Set Pressure**  
Cold differential set pressure is the pressure at which the valve is adjusted to open on the test stand. This pressure includes the corrections for back pressure and/or temperature service conditions.
- **Differential Between Operating and Set Pressures**  
Valves in process service will generally give best results if the operating pressure does not exceed 90% of the set pressure. However, on pump and compressor discharge lines, the differential required between the operating and set pressures may be greater because of pressure pulsations coming from a reciprocating piston. It is recommended that the valve be set as high above the operating pressure as possible.
- **Lift**  
Lift is the actual travel of the disc away from the closed position when a valve is relieving.
- **Maximum Allowable Working Pressure**  
Maximum allowable working pressure is the maximum gauge pressure permissible in a vessel at a designated temperature. A vessel may not be operated above this pressure, or its equivalent, at any metal temperature other than that used in its design. Consequently, for that metal temperature, it is the highest pressure at which the primary pressure safety relief valve is set to open.
- **Operating Pressure**  
The operating pressure is the gauge pressure to which the vessel is normally subjected in service. A suitable margin is provided between operating pressure and maximum allowable working pressure. For assured safe operation, the operating pressure should be at least 10% under the maximum allowable working pressure or 5 psi (.34 bar), whichever is greater.
- **Overpressure**  
Overpressure is a pressure increase over the set pressure of the primary relieving device. Overpressure is similar to accumulation when the relieving device is set at the maximum allowable working pressure of the vessel. Normally, overpressure is expressed as a percentage of set pressure.
- **Rated Capacity**  
Rated capacity is the percentage of measured flow at an authorized percent overpressure permitted by the applicable code. Rated capacity is generally expressed in pounds per hour (lb/hr) for vapors; standard cubic feet per minute (SCFM) or m<sup>3</sup>/min for gases; and in gallons per minute (GPM) for liquids.
- **Relief Valve**  
A relief valve is an automatic pressure-relieving device, actuated by static pressure upstream from the valve, a relief valve is used primarily for liquid service.
- **Safety Relief Valve**  
A safety relief valve is an automatic pressure-relieving device which may be used as either a safety or relief valve, depending upon application. A safety relief valve is used to protect personnel and equipment by preventing excessive overpressure.

## II. (Continued)

- **Safety Valve**  
A safety valve is an automatic pressure-relieving device actuated by the static pressure upstream of the valve, and characterized by rapid opening or pop action. It is used for steam, gas or vapor service.
- **Set Pressure**  
Set pressure is the gauge pressure at the valve inlet, for which the relief valve has been adjusted to open under service conditions. In liquid service, set pressure is determined by the inlet pressure at which the valve starts to discharge. In gas or vapor service, the set pressure is determined by the inlet pressure at which the valve pops.
- **Simmer**  
Simmer is characterized by the audible passage of a gas or vapor across the seating surfaces just prior to "pop". The difference between this "start to open pressure" and the set pressure is simmer, and is generally expressed as a percentage of set pressure.
- **Valve Trim**  
Valve trim includes the nozzle and disc.

## III. Introduction

A safety relief valve is an automatic pressure actuated relieving device suitable for use either as a safety valve or relief valve, depending on application.

Safety relief valves are used on hundreds of different applications, including liquids and hydrocarbons; therefore, the valve is designed to meet many requirements. The 1900 series valves included in this manual can **only** be used to meet Section VIII requirements. It cannot be used on ASME Code Section I steam boilers or superheaters, but may be used on process steam.

## IV. Design Features and Nomenclature

- **Cap and Lever Interchangeability**  
Many times it is necessary to change the type of cap or lever in the field after a valve has been installed. All flanged Consolidated® Safety Relief Valves are designed so they can be converted to any type of lever or cap desired. It is not necessary to remove the valve from the installation, nor will the set pressure be affected when making such a change.
- **Design Simplicity**  
Consolidated Safety Relief Valves have a minimum number of component parts. This results in a savings by minimizing spare parts inventory and simplifies valve maintenance.
- **Nomenclature Related to Design Features**  
Applicable nomenclature of the components of Type 1900 valves, including those with design options for bellows O-Ring seat, and liquid trim and Thermodisc, is identified in Figures 1 thru 6 on pages 6 and 7.
- **Simple Blowdown Adjustment**  
The Consolidated single blowdown ring design makes it possible to set and test a valve that has been in service when it cannot be set on line and must be taken to the customer's shop. The ring can be positioned so that the set point can be observed although the volume of the testing media is very low. After the set pressure has been established, proper blowdown can be attained by merely positioning the ring in accordance with the adjusting ring position shown in Tables 12-14 (as appropriate), on page 34 of this manual.
- **Valve Interchangeability**  
A Standard Consolidated Safety Relief Valve may be converted to the bellows type, the O-Ring seat seal type, etc. and vice versa. This requires a minimum number of new parts, and results in lower costs should conversion be required.

## CONSOLIDATED SAFETY RELIEF VALVE TYPE 1900 - CONVENTIONAL

Part No.	Nomenclature
1	Base
2	Nozzle
3	Adjusting Ring
4	Adjusting Ring Pin
5	Adj. Ring Pin Gasket
6	Disc
7	Disc Retainer
8	Disc Holder
9	Guide
10	Guide Gasket
11	Bonnet
12	Bonnet Gasket
13	Base Stud
14	Stud Nut
15	Spindle
16	Spindle Retainer
17	Spring Washer
18	Spring
19	Adjusting Screw
20	Adjusting Screw Nut
21	Screwed Cap
*22	Bolted Cap
*23	Packed Cap
*24	Plain Cap
*25	Cap Bolt
*26	Cap Set Screw
27	Cap Gasket
*28	Release Nut
*29	Release Locknut
*30	Lever
*31	Lifting Fork
*32	Lever Shaft
*33	Packing
*34	Packing Nut
*35	Top Lever
*36	Drop Lever
40	Eductor Tube
41	Bonnet Vent Plug

\* Shown in Figures 38-42 on page 39 of this manual.

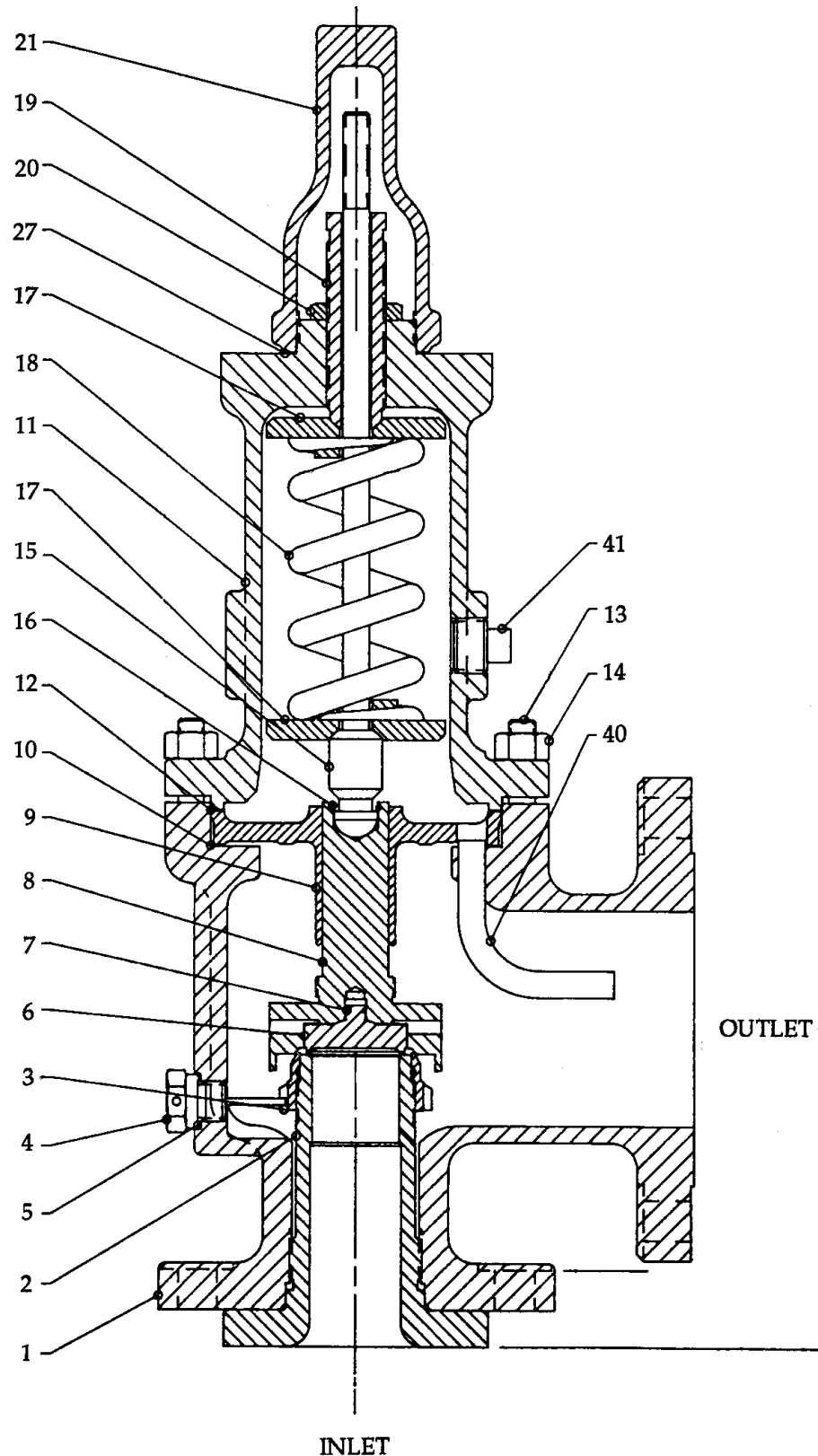
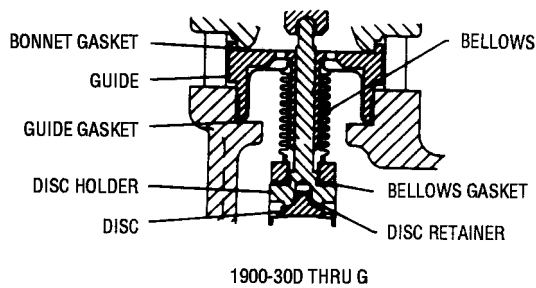
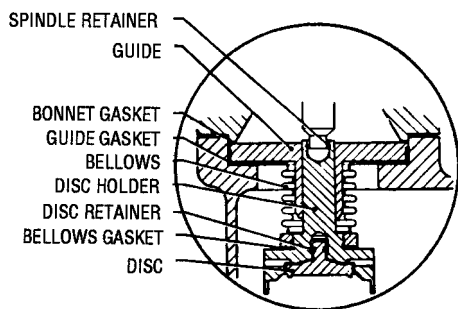


FIGURE 1

## DESIGN OPTIONS

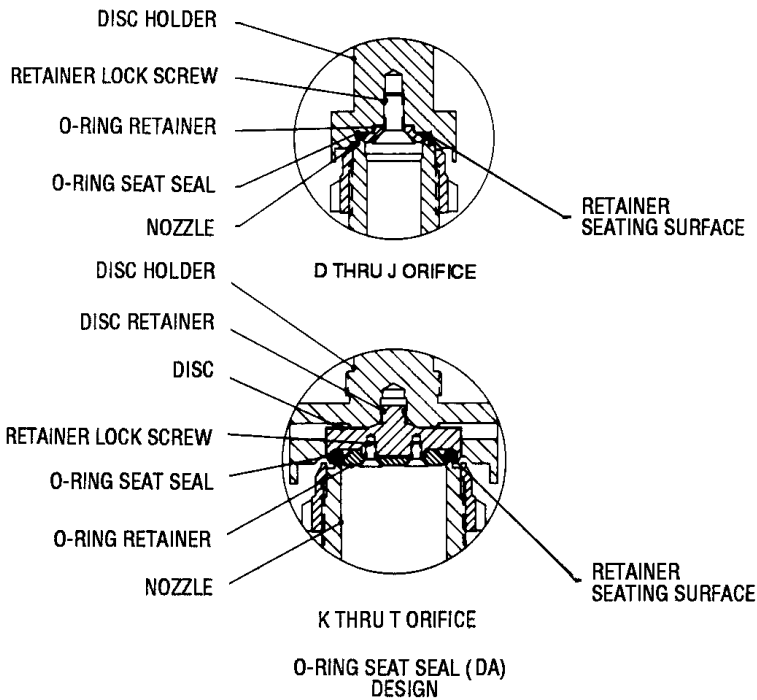


1900-30D THRU G



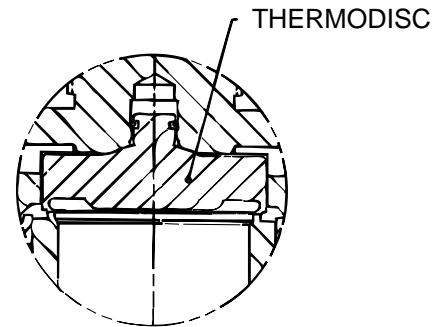
1900-30H THRU T BELLOWS DESIGN

FIGURE 2



O-RING SEAT SEAL (DA) DESIGN

FIGURE 4



THERMODISC (TD) DESIGN

FIGURE 3

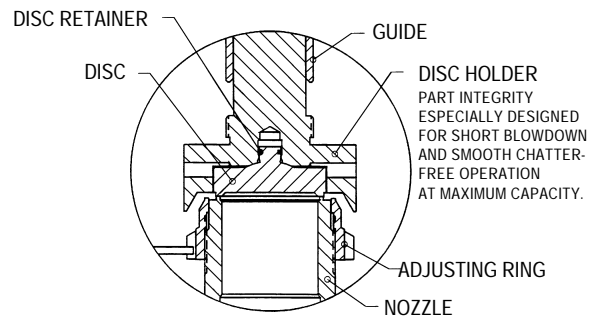


FIGURE 5  
LA Liquid Trim Design  
(See Fig. 20)

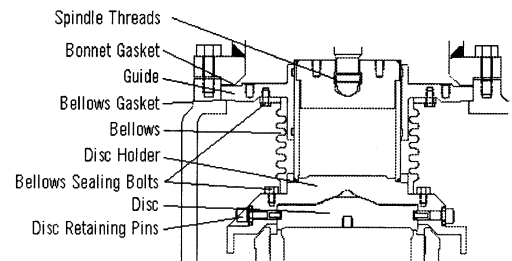


FIGURE 6  
V & W Orifice Only

**NOTE:**

A combination of the O-Ring seat seal and liquid trim design options is designated as DA-LA.

## V. Handling, Storage and Pre-Installation

- Handling**

A flanged valve, either crated or uncrated, should always be kept with the inlet flange down (i.e., in order to prevent possible misalignment and damage to internals).

Uncrated valves should be moved or hoisted by wrapping a chain or sling around discharge neck, then around upper bonnet structure in such manner as will ensure the valve is in a vertical position during lift, i.e. not lifted in horizontal position.

**NOTE:**

**Never lift the full weight of the valve by the lifting lever.**

**Crated valves should always be lifted with the inlet flange down, i.e., same as installation position.**

Safety relief valves, either crated or uncrated, should never be subjected to sharp impact. This would be most likely to occur by bumping or dropping during loading or unloading from a truck. While hoisting to the installation, care should be taken to prevent bumping the valve against steel structures and other objects.



- Storage**

Safety relief valves should be stored in a dry environment to protect them from the weather. They should not be removed from the skids or crates until immediately prior to installation.

Flange protectors and seating plugs should not be removed until the valve is ready to be bolted into the installation, i.e., both inlet and outlet.

- Pre-installation**

When safety relief valves are uncrated, and the flange protectors or sealing plugs removed immediately prior to installation, meticulous care should be exercised to prevent dirt and other foreign materials from entering the inlet and outlet ports while bolting in place.





## VI. Recommended Installation Practices

### A. Mounting Position

Safety relief valves should be mounted in a vertical upright position (per API RP520). Installing a safety relief valve in other than a vertical position ( $\pm 1$  degree) will adversely affect its operation in varying degrees, as a result of induced misalignment of moving parts.

A stop valve may be placed between the pressure vessel and its relief valve only as permitted by code regulations. If a stop valve is located between the pressure vessel and safety relief valve, the stop valve port area should equal or exceed the nominal internal area associated with the pipe size of the safety relief valve inlet. The pressure drop from the vessel to the safety relief valve shall not exceed 3% of the valve's set pressure, when flowing at full capacity.

The flanges and sealing faces of the valve and all connecting piping must be free from dirt, sediment and scale.



### B. Inlet Piping

The inlet piping (see Figure 7, below) to the valve should be short and direct from the vessel, or equipment, being protected. The connection to the vessel should be provided with a radius to permit smooth flow to the valve. Sharp corners should be avoided. If this is not practical then the inlet should be bored at least one additional pipe diameter. In any event, the pressure drop from the vessel to the valve should not exceed 3% of valve set pressure when the valve is flowing full capacity. In no event should the inlet piping be smaller in diameter than the inlet connection of the valve. Excessive pressure drop at the inlet of a pressure relief valve in gas, vapor, or flashing-liquid service will cause extremely rapid opening and closing of the valve, which is known as "chattering". Chattering will result in lowered capacity and damage to the seating surfaces. The most desirable installation is that in which the nominal size of the inlet piping is the same as, or greater than, the nominal size of the valve inlet flange, and in which the length does not exceed the face-to-face dimensions of a standard tee of the required pressure class.

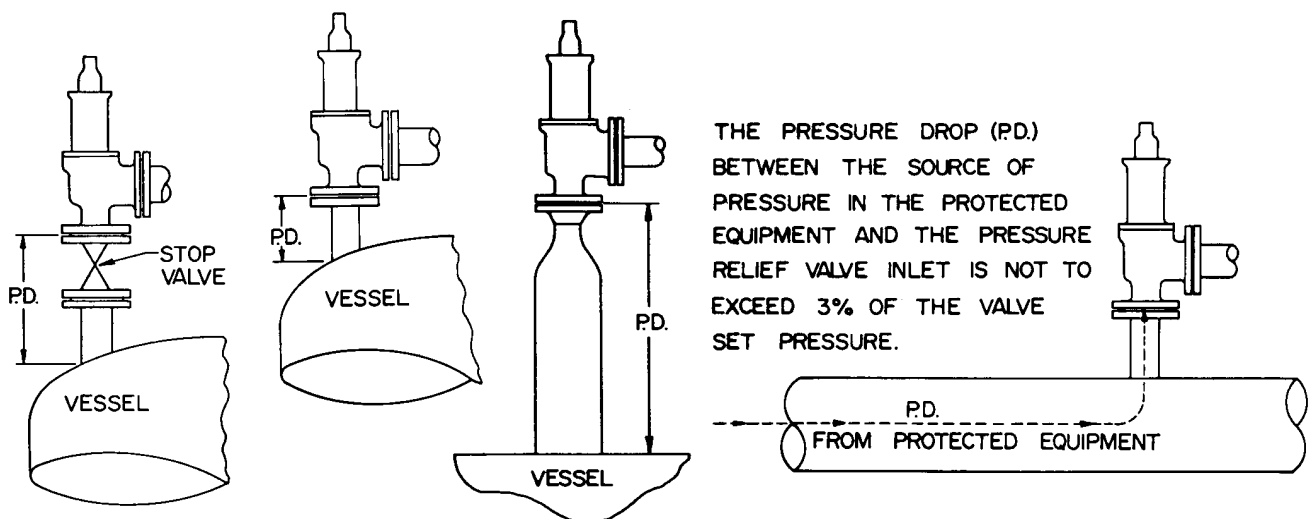


FIGURE 7

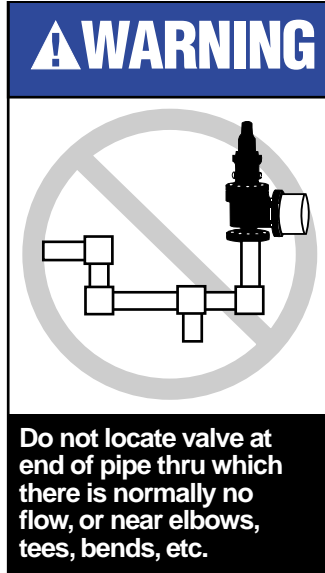
## VI.B. (Continued)

Safety relief valve inlets should not be located at the end of a long, horizontal inlet pipe through which there is normally no flow. Foreign matter may accumulate, or liquid may be trapped, and may interfere with the operation of the valve or be the cause of more frequent valve maintenance.

Safety relief valve inlets should not be located where excessive turbulence is present such as near elbows, tees, bends, or throttling valves.

Section VIII of the ASME Boiler and Pressure Vessel Code requires that the design of the inlet connection consider stress conditions induced by reaction forces during valve operation, by external loading, by vibration and by loads due to thermal expansion of discharge piping.

1. The determination of reaction forces during valve discharge is the responsibility of the vessel and/or piping designer. DVCD publishes certain technical information about reaction forces under various fluid flow conditions, but assumes no liability for the calculations and design of the inlet piping.
2. External loading by poorly designed discharge piping and support systems can be the cause of excessive stresses and distortions in the valve as well as the inlet piping. The stresses set up in the valve may cause malfunctioning or leakage of the valve. Forced alignment of the discharge piping will also induce such stresses. Discharge piping should be independently supported and carefully aligned.



3. Vibrations in the inlet piping systems may cause valve seat leakage and/or fatigue failure of the piping. These vibrations may cause the disc seat to slide back and forth across the nozzle seat and result in damage to the seating surfaces. Vibration may also cause separation of the seating surfaces and premature wear to certain valve parts. High-frequency vibrations are more detrimental to pressure relief valve tightness than low-frequency movements. This effect can be minimized by providing a larger difference between the operating pressure of the system and the set pressure of the valve, particularly under high-frequency conditions.
4. Temperature changes in the discharge piping may be caused by fluid flowing from the discharge of the valve, prolonged exposure to the sun, or heat radiated from nearby equipment. Any change in temperature of the discharge piping will cause a change in the length of the piping. The resulting change in length may cause stresses which will be transmitted to the pressure relief valve and its inlet piping. Stresses caused by thermal changes in the discharge piping can be avoided by proper support, anchoring, or provision for flexibility of the discharge piping. **Fixed supports should not be used.**

## VI. (Continued)

### C. Outlet Piping

Alignment of the internal parts of a safety relief valve is important to ensure proper operation (see Figure 8, below). Although the valve body will withstand a considerable mechanical load, unsupported discharge piping consisting of more than a companion flange, long radius elbow and a short vertical pipe is not recommended. Care should be taken to ensure thermal expansion of piping and support system does not produce strains in a valve. Spring supports are recommended where this may be the case. The discharge piping should be designed to allow for vessel expansion as well as expansion of the discharge pipe itself. This is particularly important on long distance lines.

Consideration should be given to discharge pipe movement resulting from wind loads. A continual oscillation of the discharge piping introduces stress distortion in the valve body and the resultant movement of the internal parts may cause leakage.

Where possible, drains should be piped away to prevent the collection of water or corrosive liquid in the valve body. Attention should be given to the support of the drainage piping.

When two or more valves are piped to discharge into a common header, the built-up back pressure resulting from the opening of one (or more) valve(s) may cause a superimposed back pressure in the remaining valves, unless the bonnet is vented. Under these conditions, use of bellows valves is recommended. Bellows valves may also permit use of a smaller size manifold.

In every case, the nominal discharge pipe size should be as large as, or larger than, the nominal size of the pressure relief valve outlet flange. In the case of long discharge piping, it sometimes must be **much** larger.

#### NOTE:

**Bonnet vent is to be plugged for all non-bellows valves. Bellows valves must have open bonnet vent.**

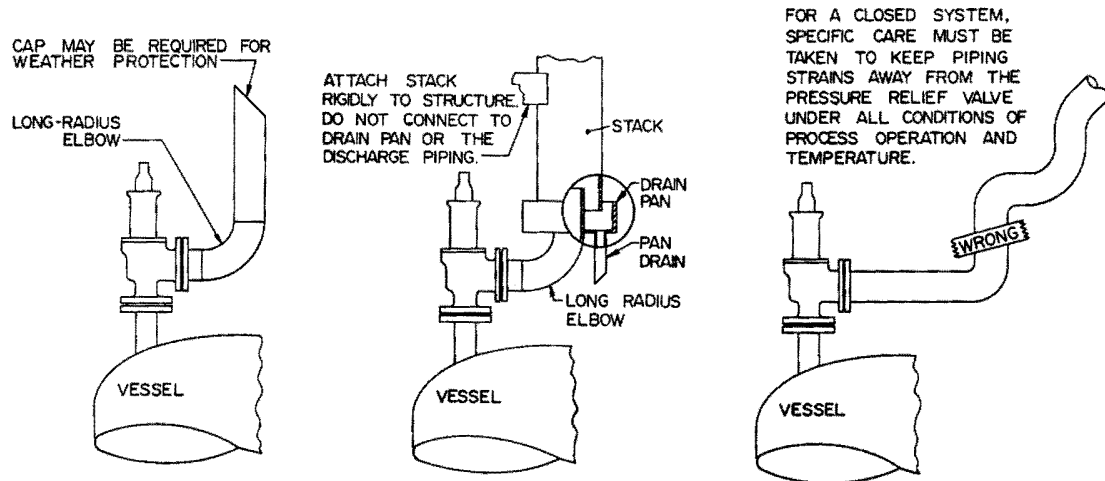


FIGURE 8

## VII. Disassembly Instructions

**NOTE:**

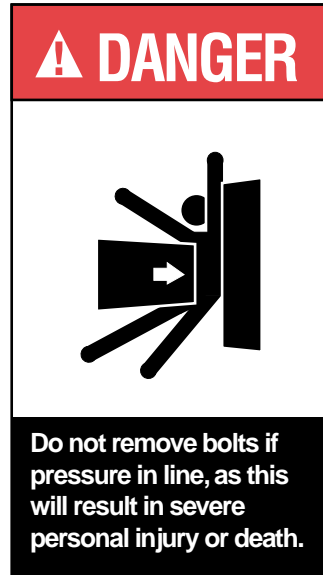
Many pressure vessels that are protected by Consolidated® Safety Relief Valves contain dangerous materials. Decontaminate and clean the valve inlet and outlet and all external surfaces in accordance with the cleaning and decontaminating recommendations in the appropriate Material Safety Data Sheet.



Decontaminate or clean if necessary before pretesting or disassembly. Safety and environmental precautions must be taken for the decontamination or cleaning method used.

### A. General Information

Consolidated® Safety Relief Valves can be easily disassembled for inspection, reconditioning seats, or replacing internal parts. Appropriate set pressure can be established after reassembly. (Again, refer to Figures 1-6, on pages 6 and 7, for parts nomenclature.)



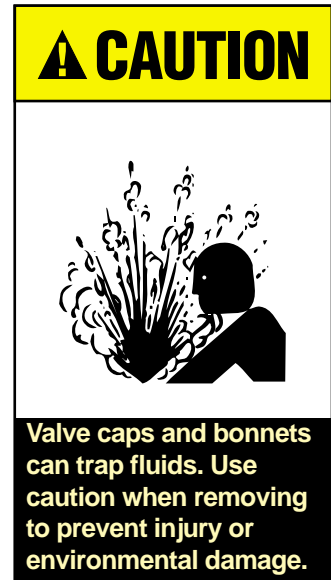
Do not remove bolts if pressure in line, as this will result in severe personal injury or death.

**NOTES:**

- Before starting to disassemble the valve, be sure that there is no media pressure in the vessel.
- Parts from one valve should not be interchanged with parts from another valve.

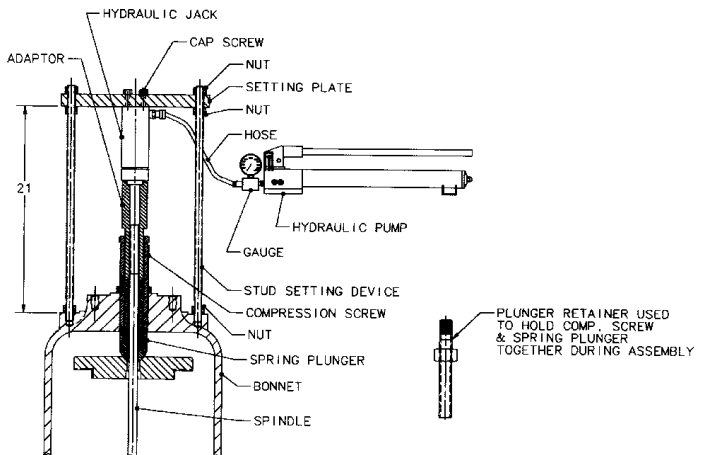
### B. Specific Steps

1. Remove the cap (including lifting gear); then, remove the cap gasket, if applicable.
2. Remove the adjusting ring pin and gasket. If the existing blowdown is to be restored upon reassembly, the position of the adjusting ring, with respect to the disc holder, should be determined. To do this, turn the adjusting ring counterclockwise (i.e., move notches on the adjusting ring from left to right). Record the number of notches passing the ring pin hole, which are required for the ring to contact the disc holder. This information will be used in setting the ring upon reassembly of the valves.



Valve caps and bonnets can trap fluids. Use caution when removing to prevent injury or environmental damage.

3. a. For D-T Orifice Valves: Loosen the adjusting screw nut. Using a Depth Micrometer or a Dial Caliper, measure the distance from the top of the spindle to the top of the Adjusting Screw. This allows the adjusting screw to be re-adjusted close to the proper spring compression without excessive testing. Record the measurement for reference when re-assembling the valve. **Note: This procedure does not substitute for actual**



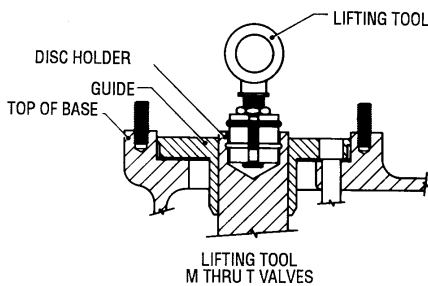
**Ram In Use**  
**FIGURE 9**

**VII.B. (Continued)**

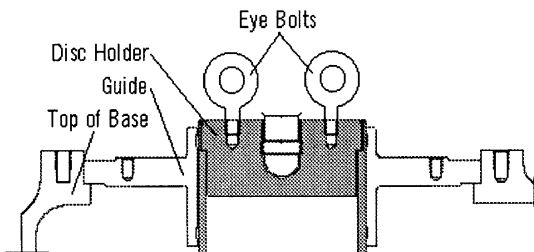
**pressure testing.** Remove the Compression Screw from the Bonnet. Use pliers to prevent the Spindle from turning when removing the Compression Screw.

b. For V and W Orifice Valves: Attach the setting device. Apply enough pressure to the plunger using the ram to free the compression screw. Unscrew the compression screw completely out of the bonnet. The valve should be set using the setting procedure after reassembly.

4. Remove the stud nuts and lift off the bonnet. Next, remove the bonnet gasket.
5. Remove the spring and spring washers. **The spring and spring washers should be kept together, as a unit, at all times.**
6. For D thru M orifice valves, remove the upper internal parts by carefully pulling "straight up" on the spindle. For bellows valves, care should be taken to avoid damaging the bellows or its flange. If parts are fouled, use a suitable solvent for loosening the components. For the P thru T orifice valves, special lifting tools are available for ease of upper, internal-parts removal. First, remove the spindle by using a screwdriver to compress the spindle retainer. Then insert the lifting tool (see Figure 10, below) into the disc holder spindle pocket and tighten the eyebolt. Remove the disc holder and disc by lifting up on the lifting tool. For V and W orifice valves, use the lifting lugs to lift the disc holder top and remove all internals.

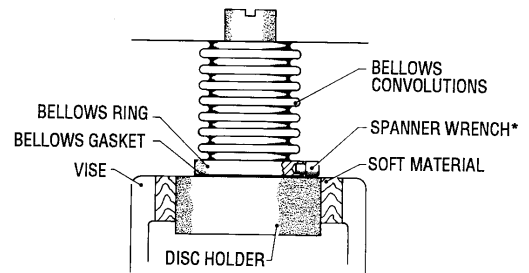


**FIGURE 10**



**FIGURE 10 b**

7. To remove the spindle from the disc holder for D thru M orifice valves, clamp the skirt portion of the disc holder snugly between two wooden V-blocks in a suitable vise (see Figure 11, below). Then compress the spindle retainer with a screwdriver or similar tool through the slots provided, and remove the spindle.
8. Remove guide from the disc holder. (For restricted lift valves, refer to Paragraph X.L., on page 28 of this manual.) For V and W orifice, unbolt bellows from guide before guide removal.
9. For D-T orifice bellows valves, the bellows is attached to the disc holder by right-hand threads. Apply a special spanner wrench\* to the bellows ring, and remove by turning counterclockwise (again, see Figure 11, below). The bellows convolutions are very thin, and fragile, and care should be taken to protect them from damage at all times. Next, remove the bellows gasket. For V and W orifice bellows valves, the bellows is bolted to the guide and disc holder. These bolts should be removed before removal of the guide.

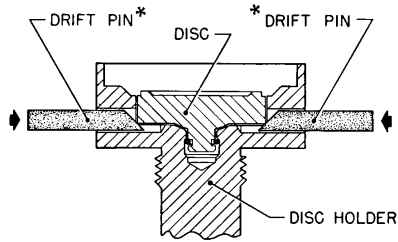


**FIGURE 11**

10. a. For D-T Orifice Valves: Remove the disc from the disc holder in the following manner. Clamp the stem portion of the disc holder, disc end up, firmly between two wooden V-blocks in a vise. Then start special drift pins\* into the holes in the disc holder (see Figure 12) with the tapered portion of the pins working against the top of the disc as indicated. Tap each pin alternately, with a light machinist's hammer, until the disc snaps out of the recess in the disc holder.
- b. For V and W Orifice Valves: Turn the disc holder on its side. Remove the retaining bolts. Attach the lifting lug to the disc and lift out.

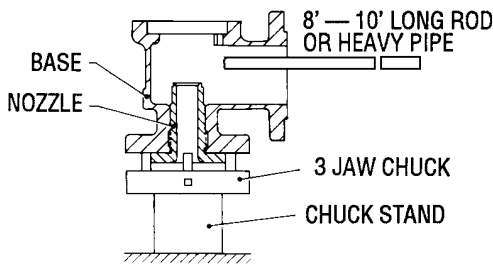
\* Drift Pins, See Section XVII, page 43 for details.

**VII.B. (Continued)**



**FIGURE 12**

11. For O-Ring seat seal valves only, remove the retainer lock screw(s), retainer and O-Ring.
12. Remove the adjusting ring by turning it counterclockwise (left-handed).
13. The nozzle should be removed from the base. (Reference nozzle removal methods in paragraph 14.)
14. The nozzle is normally removed for routine maintenance and service. The nozzle is assembled to the base with threads and may be removed by turning it counterclockwise. To facilitate removal of the nozzle from the base, it may be found beneficial to first soak the threaded joint with a suitable penetrating liquid or solvent. In instances where the nozzle is frozen into the base, its removal may be helped by sufficiently heating the base from the outside with a blowtorch in the area of the nozzle threads, while dry ice or other cooling medium is applied to the inside of the nozzle.



**FIGURE 13**

**NOTE:**

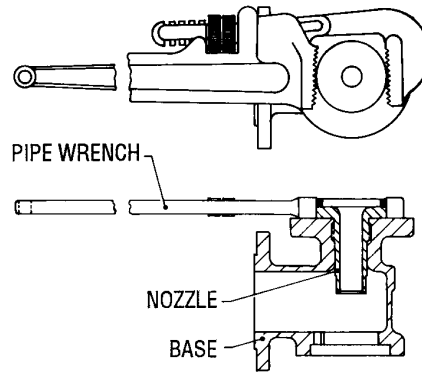
Should heat be applied, use care to prevent cracking of cast parts.

15. Utilize a 3 or 4 jaw chuck welded vertically to a stand bolted to a concrete floor. Chuck on nozzle flange and break the body loose from the nozzle with a heavy rod or pipe (see Figure 13).

**NOTE:**

Exercise care when inserting a rod or pipe in the outlet, in order to ensure that the valve nozzle is not damaged during this operation.

16. Use a large pipe wrench on nozzle flange to remove the nozzle from the base (see Figure 14).



**FIGURE 14**

**VIII. Cleaning**

1900 Series Safety Relief Valve internal parts may be cleaned with industrial solvents, cleaning solutions and wire brushes. If you are using cleaning solvents, take precautions to protect yourself from potential danger from breathing fumes, chemical burns, or explosion. See the solvent's Material Safety Data Sheet for safe handling recommendations and equipment.

**⚠ DANGER**

Follow recommendations for safe handling in the solvent's Material Safety Data Sheet and observe safe practices for any cleaning method.

It is not recommended to "sand blast" internal parts as it can reduce the dimensions of the parts. The base, bonnet and cap castings may be sand blasted with care not to erode internal surfaces, or damage machined surfaces.

**IX. Parts Inspection**

**A. Nozzle Inspection Criteria**

Nozzle should be replaced if:

1. Dim. from seat to first thread after remachining and lapping is less than D min. on Table 1.
2. Both thread sections are damaged from pitting and/or corrosion.

## VIII. (Continued)

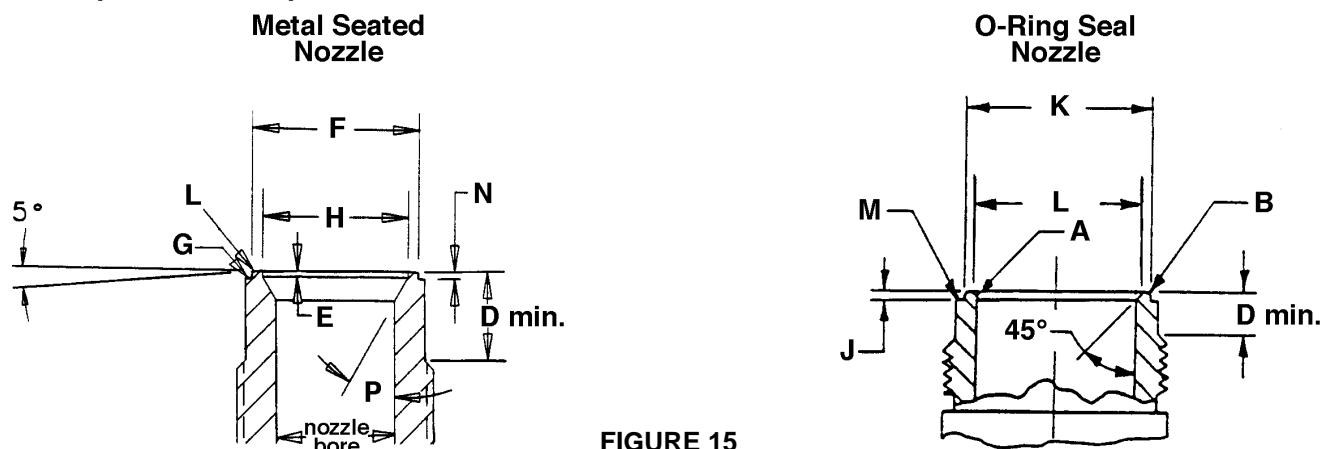


FIGURE 15

TABLE 1

ENGLISH UNITS, INCH											
Nozzle		Metal-To-Metal						O-Ring Seat Seal			
Orifice	D Min.	E $\pm$ . <sup>.005</sup> / <sub>.000</sub>	F $\pm$ . <sup>.000</sup> / <sub>.002</sub>	H $\pm$ . <sup>.002</sup> / <sub>.000</sub>	N $\pm$ . <sup>.005</sup> / <sub>.000</sub>	P $\pm$ 1/2°	Radius B $\pm$ . <sup>.002</sup> / <sub>.000</sub>	J $\pm$ . <sup>.005</sup>	K	L Max.	
D-1	13/32	.015	—	.518	—	30°	.015	.062	.573 <sup>+.000</sup> / <sub>-.002</sub>	.537	
E-1	15/32	.020	.788	.686	.025	30°	.015	.060	.733 <sup>+.000</sup> / <sub>-.002</sub>	.688	
D-2,E-2,F	5/16	.030	.955	.832	.035	30°	.015	.079	.868 <sup>+.000</sup> / <sub>-.003</sub>	.814	
G	5/16	.035	1.094	.954	.035	30°	.021	.090	1.060 <sup>+.000</sup> / <sub>-.003</sub>	.999	
H	1/4	.035	1.225	1.124	.035	45°	.021	.060	1.216 <sup>+.000</sup> / <sub>-.003</sub>	1.167	
J	3/8	.035	1.546	1.436	.035	45°	.021	.074	1.534 <sup>+.000</sup> / <sub>-.003</sub>	1.481	
K	7/16	.063	1.836	1.711	.063	45°	.021	.126	1.838 <sup>+.000</sup> / <sub>-.004</sub>	1.781	
L	7/16	.063	2.257	2.132	.063	45°	.016	.126	2.208 <sup>+.000</sup> / <sub>-.004</sub>	2.158	
M	7/16	.063	2.525	2.400	.063	45°	.021	.126	2.536 <sup>+.000</sup> / <sub>-.004</sub>	2.480	
N	1/2	.063	2.777	2.627	.063	45°	.021	.101	2.708 <sup>+.000</sup> / <sub>-.004</sub>	2.652	
P	5/8	.093	3.332	3.182	.093	45°	.021	.150	3.334 <sup>+.000</sup> / <sub>-.004</sub>	3.279	
Q	7/8	.093	4.335	4.185	.093	45°	.021	.188	4.338 <sup>+.000</sup> / <sub>-.006</sub>	4.234	
R	1	.093	5.110	4.960	.093	45°	.021	.215	5.095 <sup>+.000</sup> / <sub>-.006</sub>	5.036	
T	3/4	—	6.234	6.040	.093	—	.021	.142	6.237 <sup>+.000</sup> / <sub>-.007</sub>	6.174	
W	1 3/4"	.350	11.058	10.485	.348	30°	—	—	—	—	

TABLE 1A

METRIC UNITS, MM											
Nozzle		Metal-To-Metal						O-Ring Seat Seal			
Orifice	D Min.	E $\pm$ . <sup>.13</sup> / <sub>.0</sub>	F $\pm$ . <sup>.0</sup> / <sub>.05</sub>	H $\pm$ . <sup>.05</sup> / <sub>.0</sub>	N $\pm$ . <sup>.13</sup> / <sub>.0</sub>	P $\pm$ 1/2°	Radius B $\pm$ . <sup>.05</sup> / <sub>.0</sub>	J $\pm$ . <sup>.13</sup>	K	L Max.	
D-1	10.3	.38	—	13.16	—	30°	.38	1.57	14.55 <sup>+.00</sup> / <sub>-.05</sub>	13.64	
E-1	11.9	.51	20.01	17.43	.64	30°	.38	1.52	18.62 <sup>+.00</sup> / <sub>-.05</sub>	17.47	
D-2,E-2,F	7.9	.76	24.26	21.13	.89	30°	.38	2.01	22.05 <sup>+.00</sup> / <sub>-.08</sub>	20.68	
G	7.9	.89	27.79	24.24	.89	30°	.53	2.29	26.92 <sup>+.00</sup> / <sub>-.08</sub>	25.37	
H	6.3	.89	31.12	28.55	.89	45°	.53	1.52	30.89 <sup>+.00</sup> / <sub>-.08</sub>	29.64	
J	9.5	.89	39.27	36.47	.89	45°	.53	1.88	38.96 <sup>+.00</sup> / <sub>-.08</sub>	37.62	
K	11.1	1.60	46.63	43.46	1.60	45°	.53	3.20	46.69 <sup>+.00</sup> / <sub>-.10</sub>	45.24	
L	11.1	1.60	57.33	54.15	1.60	45°	.41	3.20	56.08 <sup>+.00</sup> / <sub>-.10</sub>	54.81	
M	11.1	1.60	64.14	60.96	1.60	45°	.53	3.20	64.41 <sup>+.00</sup> / <sub>-.10</sub>	62.99	
N	12.7	1.60	70.54	66.73	1.60	45°	.53	2.57	68.78 <sup>+.00</sup> / <sub>-.10</sub>	65.07	
P	15.9	2.36	84.63	80.82	2.36	45°	.53	3.81	84.68 <sup>+.00</sup> / <sub>-.10</sub>	83.28	
Q	22.2	2.36	110.11	106.30	2.36	45°	.53	4.78	110.19 <sup>+.00</sup> / <sub>-.15</sub>	107.54	
R	25.4	2.36	129.79	125.98	2.36	45°	.53	5.46	129.41 <sup>+.00</sup> / <sub>-.15</sub>	127.92	
T	19.0	—	158.34	153.42	2.36	—	.53	3.61	158.42 <sup>+.00</sup> / <sub>-.18</sub>	156.82	
W	44.5	8.89	280.90	266.30	8.84	30°	—	—	—	—	

**IX.A. (Continued)**

3. Top of flange and intersecting surface are damaged from galling and/or tearing.
4. Seat Width - see Table 7 on page 23 for proper seat width.

**B. Nozzle Seat Width**

Using a measuring magnifying glass, (See Maintenance Section "C" page 22), determine if the finish lapped seat surface must be machined prior to lapping. If the seat can be lapped flat without exceeding the required seat width, as indicated in table 7, it does not require machining. In order to reduce the seat width, the 5° angle surface must be machined. The Nozzle must be replaced, if the "D" dimension, is reduced below the minimum as indicated in table 1, or 1a.

**NOTE:** Flange thickness changes the center-to-face dimension. The minimum dimension for orifices D through P is 43/64 and orifices Q through T is 51/64.

**C. Nozzle Bore Inspection Criteria**

All Type 1900 Valve nozzles, **manufactured after August 1978**, have increased bore diameters. Physically, the nozzles (original versus new) are interchangeable, but their rated capacities are different. The following Table shows how each orifice was affected.

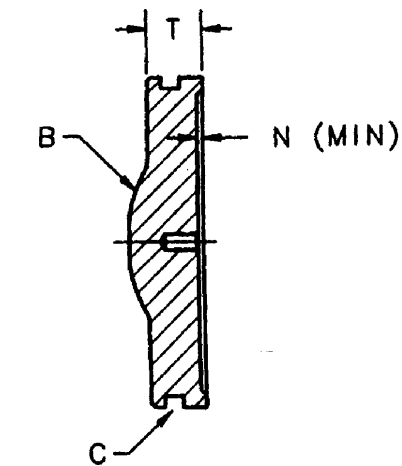
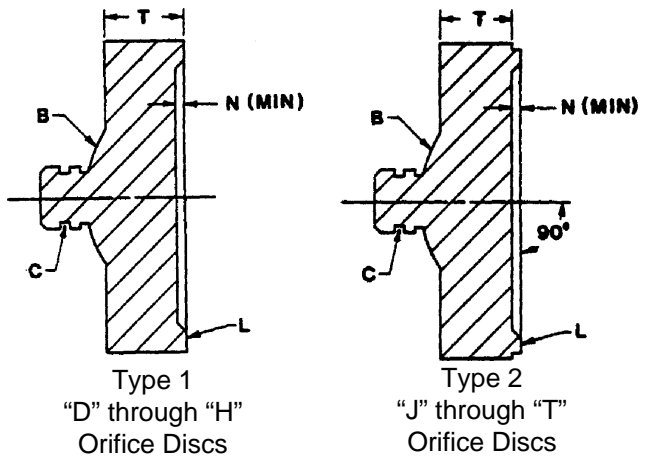
**TABLE 2**

Orifice	Pre-1978 Bore Diameter in Inches	Current Bore Diameter in Inches	Pre-1978 Bore Diameter in Millimeters	Current Bore Diameter in Millimeters
D-1	.393-.398	.404-.409	9.98-10.11	10.26-10.39
E-1	.524-.529	.539-.544	13.31-13.44	13.69-13.82
D-2	.650-.655	.674-.679	16.51-16.64	17.12-17.25
E-2	.650-.655	.674-.679	16.51-16.64	17.12-17.25
F	.650-.655	.674-.679	16.51-16.64	17.12-17.25
G	.835-.840	.863-.868	21.21-21.34	21.92-22.05
H	1.045-1.050	1.078-1.083	26.54-26.67	27.38-27.51
J	1.335-1.340	1.380-1.385	33.91-34.04	35.05-35.18
K	1.595-1.600	1.650-1.655	40.51-40.64	41.91-42.04
L	1.985-1.990	2.055-2.060	50.42-50.55	52.20-52.32
M	2.234-2.239	2.309-2.314	56.74-56.87	58.65-58.78
N	2.445-2.450	2.535-2.540	62.10-62.23	64.39-64.51
P	2.965-2.970	3.073-3.078	75.31-75.44	78.05-78.18
Q	3.900-3.905	4.045-4.050	99.06-99.19	102.74-102.87
R	4.623-4.628	4.867-4.872	117.42-117.55	123.62-123.75
T	6.000-6.006	6.037-6.043	152.40-152.55	153.34-153.49
W		10.029-10.034		254.74-254.86

**D. 1900, 1900-30 Standard Disc**

**Inspection Areas**

The standard 1900 disc as pictured in Figure 16 can be machined until the "N" dimension is reduced to the minimum, as listed in Table 3. The "T" dimension is provided to ensure the disc has not been machined beyond its limits. If the thickness of the disc ("T" min.), is reduced by remachining, the entire disc holder assembly would drop lower with respect to the seating plane of the nozzle. This would create a significant change in the huddle chamber configuration and result in significantly more "simmer" prior to opening.



(For 1900 V and W Only)  
Type 3

Disc Inspection Areas  
**FIGURE 16**



IX. (Continued)

TABLE 3

DISC TYPE	ORIFICE SIZE	INCHES		MILLIMETERS	
		"T" Minimum	"N" Minimum	"T" Minimum in millimeters	"N" Minimum in millimeters
TYPE 1	D-1	.155	.005	3.94	.127
	E-1	.158	.005	4.01	.127
	F, D-2, E-2,	.174	.010	4.42	.254
	G	.174	.010	4.42	.254
	H	.335	.010	9.02	.254
TYPE 2	J	.359	.010	9.12	.254
	K	.422	.015	10.72	.381
	L	.457	.015	11.61	.381
	M	.457	.015	11.61	.381
	N	.495	.015	12.57	.381
	P	.610	.015	15.49	.381
	Q	.610	.015	15.49	.381
	R	.610	.015	15.49	.381
TYPE 3	V	—	.015	—	.381
	W	1.692	.015	42.98	.381

Minimum Allowable Dimensions after Machining of the Disc Seat

**E. 1900 Series  
Thermodisc®  
Replacement Criteria**

If seat defects and damage can not be lapped out without reducing the "A" dimension below that shown on **NOTE 4**, the Thermodisc must be replaced.

**NOTE 4:** The dimension through the orifices is difficult to measure. If you cannot measure the .006 minimum thickness of the thermal lip, replace the Thermodisc.

TABLE 4

ORIFICE SIZE	"A" MIN. DIMENSION (IN)	"A" MIN. DIMENSION (MM)
D, E, F, G & H	.006	.153
J	.013	.331
K, L, M & N	.014	.356
P	.017	.432
Q & R	.015	.381
T	.025	.635
V & W	—	—

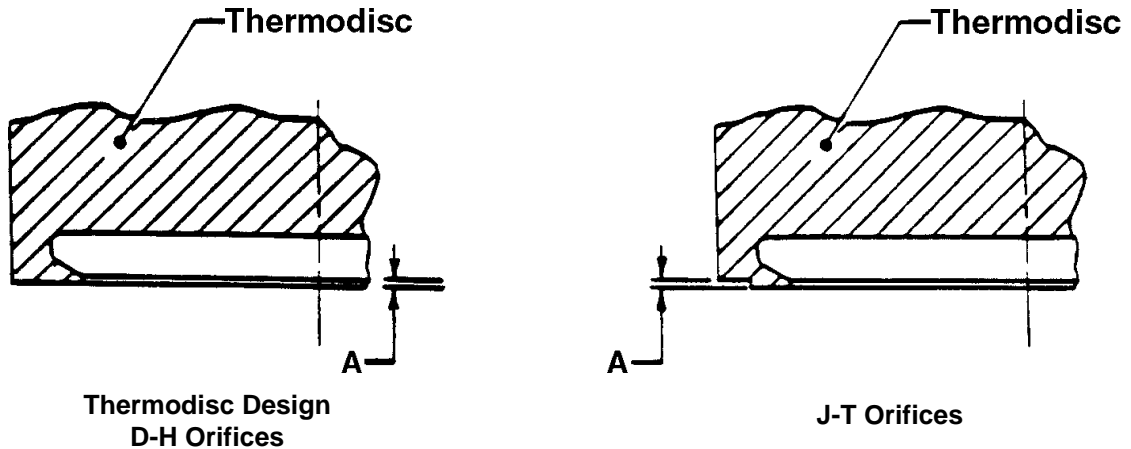
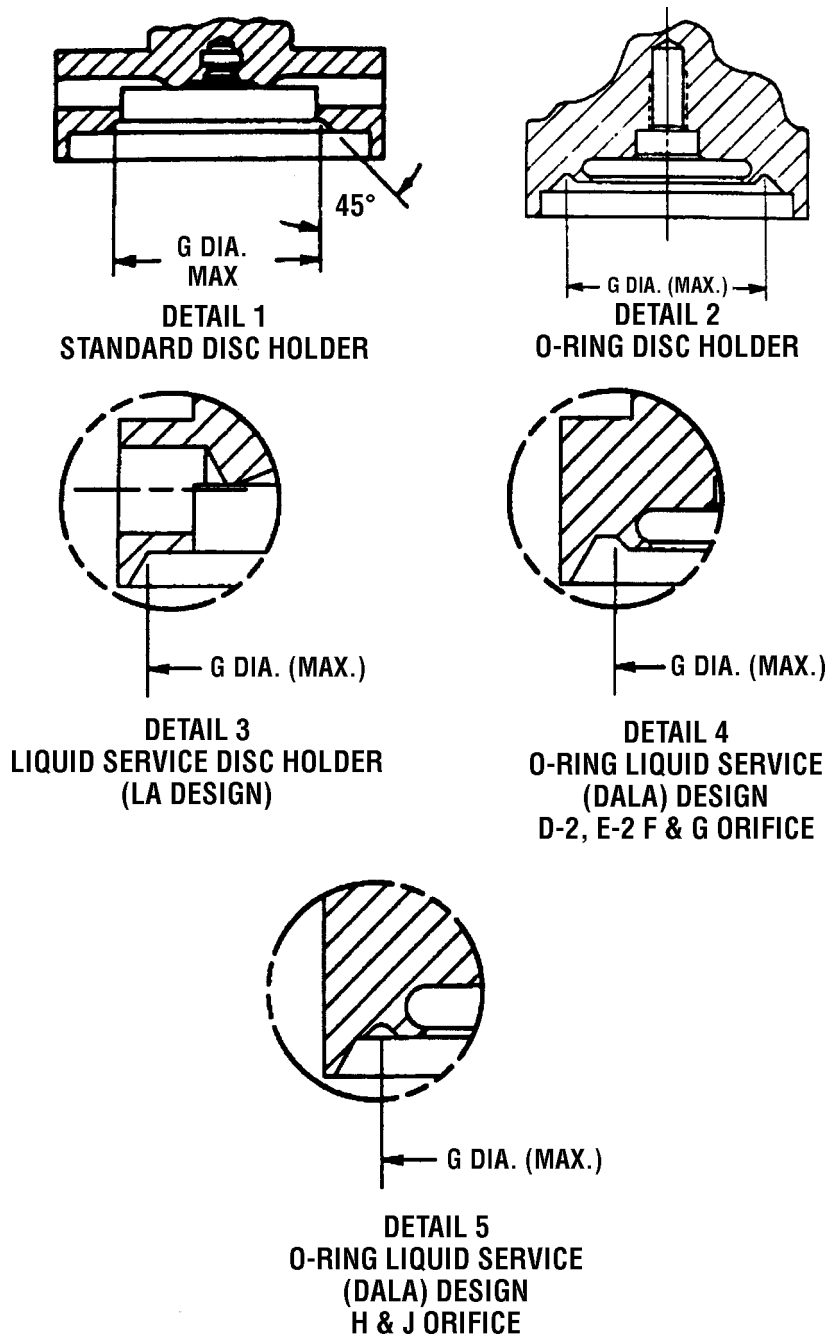


FIGURE 17

**IX. (Continued)**

**F. Disc Holder Inspection Criteria**

There are several designs of disc holders. Depending on the service and the type of valve. The particular type may be found in the details of Figure 16. for identification purposes the "G" dimension is provided. Please note that there are low pressure and high pressure disc holders.



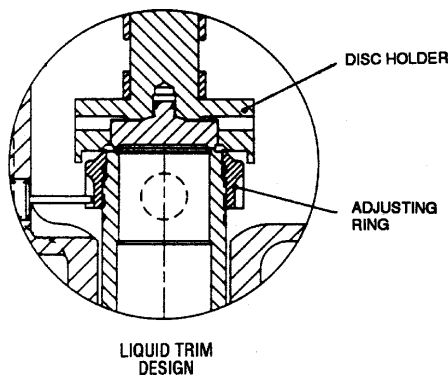
**FIGURE 18**

**IX. (Continued)**

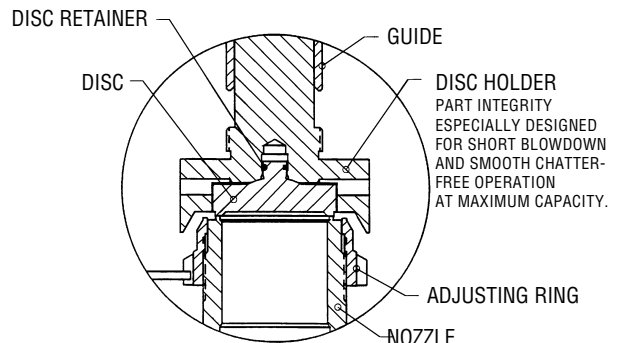
**TABLE 5**

G Diameter in inches for Disc Holder Identification. See Figure 18, for design details. (Detail 1, is standard unless noted).								
Orifice Size	Standard Disc Holder				O-Ring Disc Holder			
	Low Pressure	High Pressure	Liquid Trim		Liquid Trim		Low Pressure	High Pressure
			LS Design	LA Design	DL Design	DALA Design		
D-1	0.715	0.715	0.811	0.765 Detail 3	0.811	n/a	0.811	0.811
E-1	1.012	0.922	0.971	1.061 Detail 3	0.971	n/a	0.940 Detail 2	0.971
D-2	1.167	1.032	1.167	1.265 Detail 3	1.100 Detail 2	1.092 Detail 4	1.100 Detail 2	1.032
E-2	1.167	1.032	1.167	1.265 Detail 3	1.100 Detail 2	1.092 Detail 4	1.100 Detail 2	1.032
F	1.167	1.032	1.167	1.265 Detail 3	1.167 Detail 2	1.092 Detail 4	1.100 Detail 2	1.032
G	1.272	1.183	1.272	1.374 Detail 3	1.272	1.262 Detail 4	1.270 Detail 2	1.183
H	1.491	1.394	1.491	1.655 Detail 3	1.491	1.494 Detail 5	1.489 Detail 2	1.394
J	1.929	1.780	1.929	2.155 Detail 3	1.929	1.865 Detail 5	1.851 Detail 2	1.780
K	2.126	2.126	2.264	2.468 Detail 3	2.264	2.468 Detail 3	2.264	2.264
L	2.527	2.527	2.762	3.062 Detail 3	2.762	3.062 Detail 3	2.527	2.527
M	2.126	2.126	3.054	3.358 Detail 3	3.054	3.358 Detail 3	2.264	2.980
N	3.088	3.088	3.480	3.827 Detail 3	3.480	3.827 Detail 3	2.527	2.527
P	3.950	3.950	4.361	4.811 Detail 3	4.361	4.811 Detail 3	2.980	2.980
Q	5.197	5.197	5.546	6.108 Detail 3	5.546	6.108 Detail 3	5.197	5.197
R	6.115	6.115	6.563	7.218 Detail 3	6.563	7.218 Detail 3	6.155	6.155
T	7.494	7.494	7.840	8.624 Detail 3	7.840	8.624 Detail 3	7.494	7.494
W	12-21/32	12-21/32	n/a	n/a	n/a	n/a	n/a	n/a

\*For valve manufactured prior to June 1987, use dimension 0.810 for D-1 orifice.



1900 LIQUID SERVICE (LS) INTERNALS  
**FIGURE 19**



1900 LIQUID SERVICE (LA) INTERNALS  
**FIGURE 20**

**IX. (Continued)**

**TABLE 5A**

G Diameter in millimeters for Disc Holder Identification. See Figure 18, for design details. (Detail 1, is standard unless noted).								
Orifice Size	Standard Disc Holder				O-Ring Disc Holder			
	Low Pressure	High Pressure	Liquid Trim		Liquid Trim		Low Pressure	High Pressure
			LS Design	LA Design	DL Design	DALA Design		
D-1	18.16	18.16	20.6	19.43 Detail 3	20.6	n/a	20.6	20.6
E-1	25.70	23.42	24.66	26.95 Detail 3	24.66	n/a	23.88 Detail 2	24.66
D-2	29.64	26.21	29.64	32.13 Detail 3	27.94 Detail 2	27.74 Detail 4	27.94 Detail 2	33.53
E-2	29.64	26.21	29.64	32.13 Detail 3	27.94 Detail 2	27.74 Detail 4	27.94 Detail 2	26.21
F	29.64	26.21	29.64	32.13 Detail 3	29.64 Detail 2	27.74 Detail 4	27.94 Detail 2	26.21
G	32.31	1.183	32.31	34.90 Detail 3	32.31	32.05 Detail 4	32.26 Detail 2	30.05
H	37.87	35.41	37.87	42.04 Detail 3	37.87	37.95 Detail 5	37.82 Detail 2	35.41
J	49.0	1.780	49.0	54.74 Detail 3	49.0	47.37 Detail 5	47.01 Detail 2	45.21
K	54.0	54.0	57.50	62.69 Detail 3	57.50	62.69 Detail 3	57.50	57.50
L	64.19	64.19	70.15	77.77 Detail 3	70.15	77.77 Detail 3	64.19	64.19
M	54.0	54.0	77.57	85.29 Detail 3	77.57	85.29 Detail 3	57.50	75.69
N	78.44	78.44	88.39	97.21 Detail 3	88.39	97.21 Detail 3	64.19	65.28
P	100.33	100.33	110.77	122.20 Detail 3	110.77	122.20 Detail 3	75.69	75.69
Q	132.00	132.00	140.87	155.14 Detail 3	140.87	155.14 Detail 3	132.00	132.00
R	155.32	155.32	166.70	183.34 Detail 3	166.70	183.34 Detail 3	156.34	156.34
T	190.35	190.35	199.14	219.05 Detail 3	199.14	219.05 Detail 3	190.35	190.35
W	321.47	321.47	n/a	n/a	n/a	n/a	n/a	n/a

\*For valve manufactured prior to June 1987, use dimension 20.57 mm for D-1 orifice.

**Set Pressure Change Note:** If it is necessary to change the valve set pressure, it may be also be necessary to change the disc holder. See Table 8 to determine if the disc holder must be changed to (from) low pressure from (to) high pressure when changing the set pressure.

**Media Change Note:** If the protected media is changed in form from a compressible fluid (air, gas or steam), to a non compressible fluid (liquid), change from a standard to a liquid trim disc holder.

**Bellows Conversion Note:** If a conventional 1900 valve has a D, E, F, G, H, or J orifice disc holder,

the disc holder must be exchanged for a bellows type holder.

**O-Ring Conversion Note:** If a standard metal seated 1900 valve is to be converted to an O-Ring valve, then the disc holder must be replaced with an O-Ring disc holder. If the valve has a "K" or larger orifice, the standard disc holder may be machined to receive the oversized O-Ring disc. Instructions for this procedure are provided with the kit. O-Ring disc holders may be obtained with the kit.

## IX. (Continued)

### G. Guide Inspection Criteria

Guide should be discarded if:

1. Visible galling is indicated in the inside guiding surface.
2. The gasket seating areas are pitted and cause the valve to leak between the bonnet and base.

Several different guides could be present in a particular valve depending if it is an O-Ring Valve or Bellows Valve or a Standard valve. On Table 6, find the line that contains the correct orifice size for the valve. Then measure the Barrel portion of the Disc Holder and compare the actual measurement to those indicated in Table 6, to determine the maximum allowable clearance between the disc holder and the guide.

Both the Guide and Disc Holder should be replaced if the clearance between the ID and the Guide and the OD of the Disc Holder is not within the clearance dimensions given in the table below.

### H. Spindle Inspection Criteria

Spindle should be replaced if:

1. The bearing point is pitted, galled or distorted.
2. Threads torn so lift nuts won't thread on or off.
3. Concentricity—if spindle cannot be straightened less than .007 total indicator runout (see section X.J and Figure 31).

### I. Spring Inspection Criteria

Spring should be discarded if:

1. Pitting and corrosion of the coils reduces coil diameter.
2. Inspect for end parallelism in the free height condition.
3. Check for any obvious unevenness in coil spacing or spring distortion.

4. Spring Washers are custom made for each end of a particular spring. The maximum clearance between the A and A<sub>1</sub> dimension, and B and B<sub>1</sub> dimension (see figure 21), should be 1/32 inch (.79mm) for springs with an inside diameter of less than four inches (100mm). The clearance for valves with a spring inside dimension that is four inches (101. plus) or larger should be 3/64 inch (1.19mm). If you find you must replace a spring, order a Spring Assembly as it will include custom fit Spring Washers not just a spring.

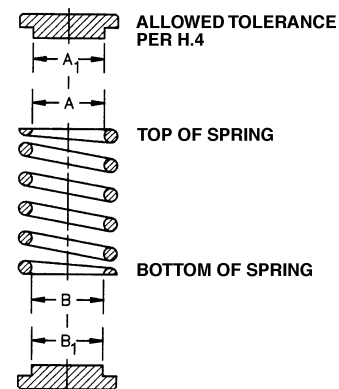


FIGURE 21

5. If constant back pressure is present in a conventional 1900 Series Safety Relief Valve (without balancing bellows), the correct spring should be chosen so that the **COLD DIFFERENTIAL SET PRESSURE** is within the spring range. Normally the spring is selected so that the Set Pressure of the valve is in the spring range. If only the relieving temperature causes the Cold Differential Set Pressure, then the spring is selected using the Set Pressure not the Cold Differential Set Pressure. See Section XII.E for further discussion of set pressure compensation.

TABLE 6

ALLOWABLE CLEARANCE FOR GUIDE AND DISC HOLDER

Orifice Size	Disc Holder Nominal Barrel Size in inches	Disc Holder Diametral Clearance in inches	Disc Holder Nominal Barrel Size in millimeters	Disc Holder Diametral Clearance in millimeters
D, E, F, G	.450, .496, .527 .995	.003-.007 .004-.008	11.43, 12.6, 13.38 25.27	.076-.177 .102-.203
H	.682 1.119	.004-.009 .005-.010	17.32 28.42	.102-.228 .127-.254
J, M	.994, 1.119, 1.744	.005-.010	25.24, 28.42, 44.3	.127-.254
K, L	1.242, 1.367	.007-.012	31.55, 34.72	.178-.305
N	1.870 2.242	.004-.009 .007-.012	47.50 56.95	.102-.228 .178-.305
P	2.304, 2.491	.008-.013	58.52, 63.27	.203-.330
Q,R	3.488, 3.988	.010-.017	88.6, 101.29	.254-.432
T	5.190	.012-.020	131.82	.304-.508
Q-2, R-2, T-3	2.304	.008-.014	58.52	.203-.355
W	8.425	.013-.026	214.0	.330-.660

## X. Maintenance Instructions

### A. General Information

After the valve has been disassembled, a close inspection should be made of the seating surfaces. In a majority of cases, a simple lapping of seats is all that is necessary to put the valve in first class working order. If an inspection of the parts shows the valve seating surfaces to be badly damaged, machining will be required before lapping. O-Ring seat seal valve nozzles can only be reconditioned by machining, not lapping. (For specific information concerning the machining of nozzle and disc seating surfaces, see Paragraphs X.H. and X.I. which follow.)

#### NOTE:

**In order to determine if the valve contains \*Glide-Aloy™ treated components (i.e., the disc holder and/or the guide), which will be identified for a particular valve by the coding found on the valve nameplate, please consult the Appendix to this manual for pertinent supplemental information.**

The seating surfaces of the metal seated Consolidated® Safety Relief Valve are flat. The nozzle seat is relieved by a 5° angle on the outside of the flat seat. The disc seat is wider than the nozzle seat; thus, the control of seat width is the nozzle seat (see Figure 22).

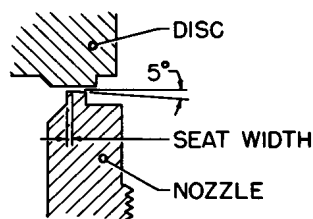


FIGURE 22

Reconditioning of the seating surfaces of the nozzle and disc is accomplished by lapping with a cast iron lap, coated with a lapping compound.

Anytime the V or W orifice valve is disassembled, be sure to inspect the guide rings for wear. If worn, replace before assembly.

#### NOTE:

**In order to establish leak free valve seats, the nozzle seating surface and the disc seating surface must be lapped flat.**

### B. Lapping Nozzle Seats (Non O-Ring Styles)

#### NOTE:

**Nozzle laps as illustrated below are available from DVCD (instructions and part numbers are located in the tooling section of this manual. It is not recommended to use these laps if the valve nozzle can be removed and machined to the seat dimensions described in Table 7 on page 23.**

The 5° angle of the nozzle should be lapped first (see Figure 23, below). Then, invert the nozzle lap and use the flat side as a “starter” lap to insure squareness of the seat (see Figure 24, below). Finish lapping should be done with a ring lap (see Figure 25, below). The ring lap is to be used in an eccentric or figure-eight motion (see Paragraph X.G. for further information). Keep the lap squarely on the flat surface and avoid any tendency to rock the lap which will cause rounding of the seat.

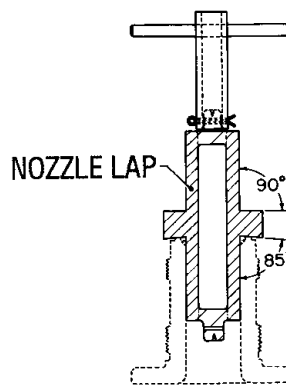


FIGURE 23

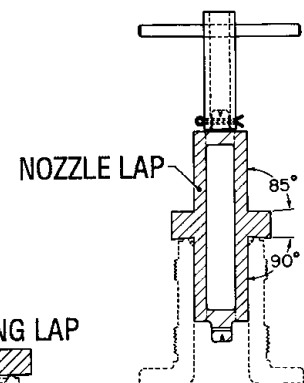


FIGURE 24

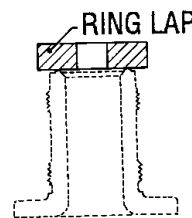


FIGURE 25

### C. Nozzle Seat Widths-Lapped

A wide nozzle seat will induce simmer, especially in the smaller orifice lower pressure valves. For this reason, the seat of non-O-Ring valves should be as narrow as practical. Since the seat must be wide enough to carry the bearing load imposed upon it by the spring force, the higher pressure valves must have wider seats than the lower pressure valves. The nozzle seat width should conform with those listed in Table 7, on page 23.

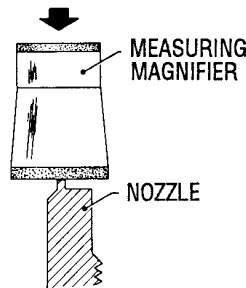
**X.C. (Continued)**

**TABLE 7**

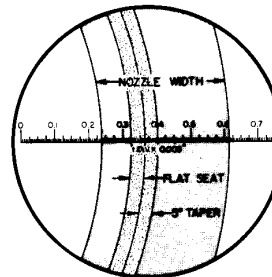
Orifice	Set Pressure psig (bar) for Metal Seated Valves except TD		Suggested Lapped Seat Width in Inches (mm)	
D thru J	15-50	(1.03-3.45)	.012-.020	(.30-.51 mm)
	51-100	(3.52-6.90)	.018-.028	(.46-.71 mm)
	101-250	(6.96-17.24)	.025-.035	(.64-.89 mm)
	251-400	(17.31-27.58)	.032-.042	(.81-1.07 mm)
	401-800	(27.65-55.16)	.038-.048	(.96-1.22 mm)
D thru F	801-1500	(55.23-103.42)	.042-.052	(1.07-1.32 mm)
	1501-3000	(103.49-206.84)	.045-.055	(1.14-1.40 mm)
	3001-6000	(206.91-413.69)	.050-.060	(1.27-1.52 mm)
G thru J	801-1000	(55.23-68.95)	.040-.050	(1.02-1.27 mm)
	1001-2800	(69.02-193.05)	.042-.055	(1.07-1.40 mm)
	2801-6000	(193.12-413.79)	.045-.060	(1.14-1.52 mm)
K thru N	15-50	(1.03-3.45)	.025-.040	(.64-1.02 mm)
	51-100	(3.52-6.90)	.030-.045	(.76-1.14 mm)
	101-250	(6.96-17.24)	.035-.050	(.89-1.27 mm)
	251-400	(17.31-27.58)	.040-.055	(1.02-1.40 mm)
	401-800	(27.65-55.16)	.045-.060	(1.14-1.52 mm)
P thru R	15-50	(1.03-3.45)	.030-.045	(.76-1.14 mm)
	51-100	(3.52-6.90)	.035-.050	(.89-1.27 mm)
	101-250	(6.96-17.24)	.045-.060	(1.14-1.52 mm)
	251-400	(17.31-27.58)	.050-.065	(1.27-1.65 mm)
	401-800	(27.65-55.17)	.060-.070	(1.52-1.78 mm)
	801-1000	(55.23-68.95)	.062-.070	(1.57-1.78 mm)
T	15-50	(1.03-3.45)	.040-.060	(1.02-1.52 mm)
	51-100	(3.52-6.90)	.045-.065	(1.14-1.65 mm)
	101-200	(6.96-13.79)	.050-.070	(1.27-1.78 mm)
	201-300	(13.86-20.68)	.060-.080	(1.52-2.03 mm)
W	15-50	(1.03-3.45)	.095-.105	(2.41-2.67 mm)
	51-100	(3.52-6.90)	.115-.125	(2.92-3.17 mm)
	101-250	(6.96-17.24)	.135-.145	(3.43-3.68 mm)
	251-300	(17.31-20.68)	.155-.165	(3.94-4.19 mm)

Orifice	Set Pressure psig (bar) for TD Option only		Suggested Seat Width in Inches (mm) for TD Option only	
D thru F	15-50	(1.03-3.45)	.020-.030	(.50-.76 mm)
	101-300	(6.96-20.68)	.035-.045	(.89-1.14 mm)
	301-800	(20.75-55.17)	.045-.055	(1.14-1.40 mm)
	801 plus	(55.24 plus)	Add .005 (.13 mm) for each additional 100 psig	
	G thru J	15-100	(1.03-6.89)	.025-.035
101-300		(6.96-20.68)	.035-.040	(.89-1.01 mm)
301-800		(20.75-55.17)	.045-.055	(1.14-1.4 mm)
801 plus		(55.24 plus)	Add .005 (.13 mm) for each additional 100 psig	
K thru N	15-100	(1.03-6.89)	.035-.040	(.89-1.01 mm)
	101-300	(6.96-20.68)	.045-.055	(1.14-1.4 mm)
	301-800	(20.75-55.17)	.055-.065	(1.4-1.65 mm)
	801 Plus	(55.24 plus)	Add .005 (.13 mm) for each additional 100 psig	
P thru R	15-100	(1.03-6.89)	.040-.050	(1.01-1.27 mm)
	101-300	(6.96-20.68)	.055-.065	(1.40-1.65 mm)
	301-800	(20.75-55.17)	.060-.070	(1.52-1.78 mm)
	801-1000	(55.24-68.95)	.065-.075	(1.65-1.90 mm)
T	15-100	(1.03-6.89)	.050-.065	(1.27-1.65 mm)
	101-300	(6.96-20.68)	.060-.075	(1.52-1.90 mm)
W	-	-	-	-

The seat width can be measured by the use of a "Measuring Magnifier" (see Figure 26 below). DVCD recommends the use of Model S1-34-35-37 (which is manufactured by Bausch and Lomb Optical Co., Rochester, N.Y.). This is a seven power glass, with a three quarter inch scale showing graduations of 0.005 inch. The use of this scale in measuring the nozzle seat width is shown in Figure 26 b (also below).



**FIGURE 26**



**FIGURE 26 b**

## **X.C. (Continued)**

If additional lighting is required for measuring the seat, DVCD suggests a goose-neck flashlight similar to the Type A Lamp Assembly Flashlight (which is manufactured by Standard Molding Corporation, Dayton, Ohio).

### **D. Lapping Disc Seats**

The disc seat may be lapped with a ring lap or a lapping plate. Lapping should be done in an eccentric or figure-eight motion in all directions, applying uniform pressure and rotating the disc or lap slowly. (See Paragraph X.G. for further information).

### **E. Precautions and Hints for Lapping Seats**

The following precautions and hints will enable maintenance personnel to do a "professional" job of lapping sets:

1. Keep work materials clean.
2. Always use a fresh lap. If signs of wearing (out of flatness) are evident, recondition the lap.
3. Apply a very thin layer of compound to the lap. This will prevent rounding off the edges of the seat.
4. Keep the lap squarely on the flat surface, and avoid any tendency to rock the lap which causes rounding of the seat.
5. When lapping, keep a firm grip on the part to prevent the possibility of dropping it and damaging the seat.
6. Lap, using eccentric or figure-eight motion in all directions, at the same time applying uniform pressure and rotating the lap slowly. (See Paragraph X.G. for further information.)
7. Replace the compound frequently after wiping off the old compound, and apply more pressure to speed the cutting action of the compound.

8. To check the seating surfaces, remove all compound from both the seat and the lap. Then, shine the seat with the same lap using the lapping motion described above. Low sections on the seating surface will show up as a shadow in contrast to the shiny portion. If shadows are present, further lapping is necessary and only laps known to be flat should now be used. Only a few minutes will be required to remove the shadows.
9. When the lapping is completed, any lines appearing as cross scratches can be removed by rotating the lap (which has been wiped clean of compound) on the seat about its own axis.
10. The seat should now be thoroughly cleaned using a lint-free cloth and a cleansing fluid.

### **F. Lapping O-Ring Seating Surfaces**

The contact surfaces of the nozzle and O-ring retainer are ground, prior to assembly, to provide metal to metal seat tightness in the event of O-ring failure.

Refer to Figure 4 (on page 7 of this manual) and assemble the retainer to the disc holder (D-J orifice), or disc (K-T orifice), using the retainer lock screw(s). Apply 3A compound to the retainer seating surface. Place the retainer on the nozzle seat and grind the retainer to the nozzle. Once uniform contact is established, clean the nozzle and retainer, and repeat the grinding procedure with 1000 grit compound.

Remove the retainer screw(s) and retainer, and thoroughly clean the retainer, retainer screws and disc holder or disc.



## X. (Continued)

### G. Reconditioning of Laps

1. Ring laps are reconditioned by lapping them on a flat lapping plate. The lapping should be done with a figure-eight motion as indicated in Figure 27, below. To assure the best results when lapping seats, the ring laps should be reconditioned after each usage and checked with an optical flat.

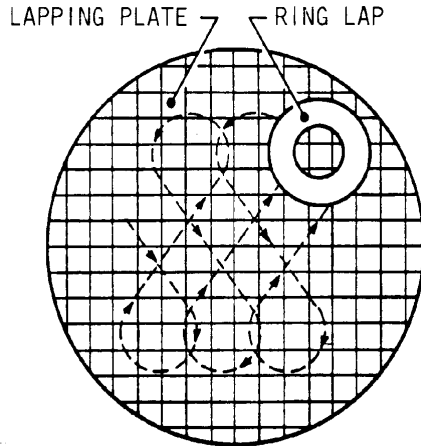


FIGURE 27

2. Nozzle laps must be remachined to recondition the lapping surfaces. Place the nozzle lap in a lathe between centers (see Figure 28, below). The surfaces marked A and B must be running concentric.

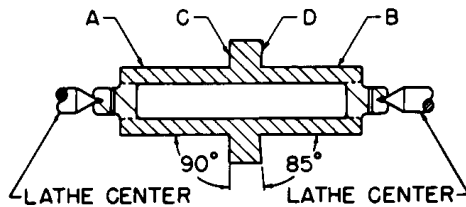


FIGURE 28

One lapping surface is 90° and the other is 85°. The angle of each surface is marked on the lap. Machine surfaces C and D, by taking light cuts at the proper angle, until the lapping surfaces are reconditioned.

### H. Remachining Nozzle Seats and Bores

The nozzle should be removed from the valve to be machined (see Figure 29). See Nozzle Removal Instructions in paragraph VII.B.14. If it can not be removed from the base, it should be machined inside the base.

#### 1. Lathe Set Up - Nozzle Removed

- a. Grip the nozzle in a four-jaw independent chuck, using a piece of soft material such as copper or fiber between the jaws and the nozzle as shown at A in Figure 29.
- b. True up the nozzle so that the surfaces marked B, C and D run true within .001" on indicator.

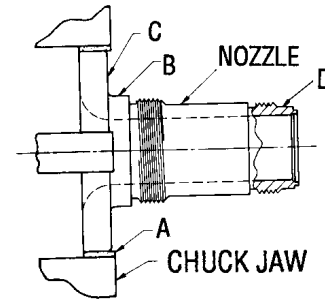


FIGURE 29

## X.H. (Continued)

### 2. Machining Procedure: Metal to Metal Seat

See Figure 15, page 15.

- a. Take light cuts across the surface L at 5°, until the damaged areas are removed. (See Figure 15) Turn to the smoothest possible finish.
- b. Cut back the outside surface at G, until dimension N is obtained. The surface at G is common to all nozzles **except the D-1. Omit this step on the D-1 orifice nozzles.**
- c. Machine bore diameter H, until dimension E is obtained. Re-establish angle P.
- d. The nozzle is now ready for lapping.
- e. When the minimum dimension D is reached, the nozzle should be discarded.

### 3. Machining Procedure: O-Ring Seat Seal

See Figure 15, page 15.

- a. Take light cuts across surface A (45°), until the damaged areas are removed. Turn to the smoothest possible finish.
- b. Cut back the outside surface at M, until dimension J is obtained.
- c. Machine radius B.
- d. The nozzle is now ready for grinding.
- e. When the minimum dimension D is reached, the nozzle should be discarded.

## I. Remachining the Disc Seat\*

The standard disc seating surface (see Figure 30) can easily be machined as follows:

1. Grip the disc in a four-jaw independent chuck (or collet, if appropriate), using a piece of soft material such as copper or fiber between the jaws and the disc as shown at A.
2. True up the disc so that the surface marked B and C run true within .001" (0.025 mm), TIR.
3. Take light cuts across the seating surface L until damaged areas are removed. Turn to smoothest possible finish.
4. The disc is now ready for lapping.
5. When the minimum dimension N or T (see Table 3) is reached the disc should be discarded. Do not re-establish surface C.

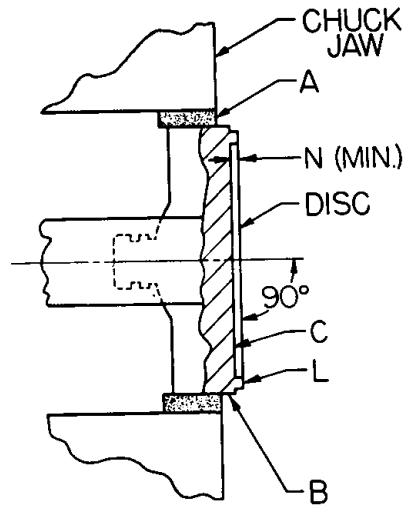


FIGURE 30

\*Thermodisc® and O-Ring discs are not to be machined.

**X. (Continued)**

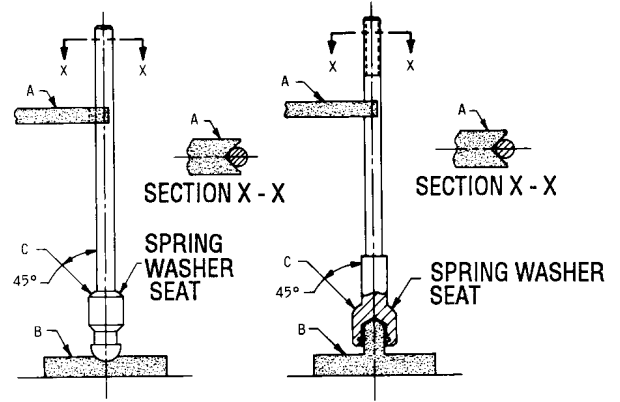
**J. Checking Spindle Concentricity**

It is important that the spindle of a safety relief valve be straight, in order to transmit the spring load to the disc without lateral binding. Over-gagging is one of the common causes of bent spindles. To check the essential working surfaces of the spindle, either of the following methods is recommended:

1. V-Block Support Set Up

- a. The ball pointed spindles should be placed in a piece of material, B, that has been recessed to permit free rotation of the spindle. For hollow spindles, a ball pointed support is required. (See Figure 31).
- b. Support the spindle with a V-block A, placed near the upper end of the spindle, but below the threads.

- c. Apply a machinist's indicator at approximately 45° to the outer edge of the spring washer seat at C. Rotate the spindle. The total indicator reading should not exceed .007" (.17 mm). Straighten the spindle, if necessary.



**FIGURE 31**

**TABLE 8**

Disc Holder Selection Criteria Pressures in psig, (kg/cm <sup>2</sup> ) units.								
Orifice Size	Air / Gas Non Liquid Service				Liquid Service			
	Metal Seat		"O" Ring DA		LS Design		LA Design	
	Use low pressure discholder	Use high pressure discholder	Use low pressure "O"ring discholder	Use high pressure "O"ring discholder	Metal Seats	"O" Ring Seat	Metal Seat	"O"Ring Seat
D-1 -30D-1	Not available	Use for all pressures	Use for all pressures same as DL disc holder	Not applicable	Use LS discholder for all pressures	Use DL or LS-DA discholders for all pressures	Use LA for all Pressures	LA-DA discholder is not applicable
E-1 -30E-1	5 - 100 (71-1435)	101 and greater (1436) and greater	5 - 35 (71-499)	36 (500) and greater same as DL discholder	Use LS discholder for all pressures	Use DL or LS-DA discholders for all pressures	Use LA discholder for all pressures	LA-DA discholder is not applicable
D-2 E-2 -30D-2 -30E-2 F-1 -30F-1	5 - 100 (71-1435)	101 and greater (1436) and greater	5 - 35 (71-499)	36 (500) and greater same as DL discholder	Use LS - Same as low pressure air / gas discholder	Use DL or LS-DA discholders for all pressures	Use LA discholder for all pressures	Use DA-LA disc-holders for all Pressures
G-1 -30G-1 H-1 -30H-1 J-2 30J-2	5 - 50 (71-711)	50 and greater (712) and greater	5 - 120 (71-1706)	121 (1720) and greater	Use LS discholder for all pressures	Use DL or LS-DA discholders for all pressures	Use LA discholder for all pressures	Use DA-LA disc-holders for all Pressures
K - T -30K-T	Not applicable	use standard discholder for all pressures	Not applicable	All Pressures	Use LS discholder for all pressures	Use DL or LS-DA discholders for all pressures	Use LA discholder for all pressures	Use DA-LA disc-holders for all Pressures

**X. (Continued)**

**K. Set Pressure Change-Disc Holder\***

The disc holder must be replaced if the set pressure must be changed and the change involves crossing the dividing line between high pressure and low pressure. See Table 8 to determine if the disc holder must be changed when changing the set pressure.

dimension of the D-1 or E-1, and the actual seat dimensions and bore diameter are identical to the F orifice nozzle.

Other 1900 series valves may be restricted in the same manner when necessary. These valves may be restricted to a minimum lift of 30% of the full rated capacity, or .080 inches or 2.03 mm. Please refer to National Board Code Case 1945-2.

**L. Checking Lift on Lift Restricted Valves**

General

Restricted lift valves have a limit washer which prevents the disc and disc holder from lifting beyond the required lift and resulting capacity. The D-1 and E-1 valves do not require limit washers. The D-2 and E-2 valves have a special nozzle with the overall height and flange

It is important to check lift on all restricted lift valves after servicing or replacing parts. This procedure is necessary to insure the reliability of the nameplate capacity.

**NOTE:**

The required lift for a "restricted lift" valve is indicated on the restricted lift nameplate, (see figure 33).

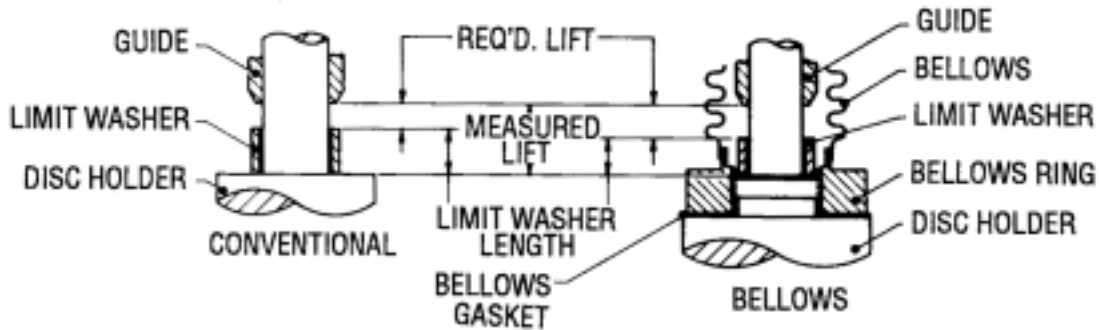


FIGURE 32

Restricted lift valves may be identified by the restricted lift nameplate (see Figure 33).

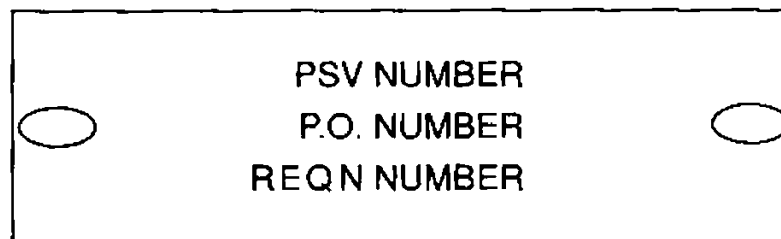
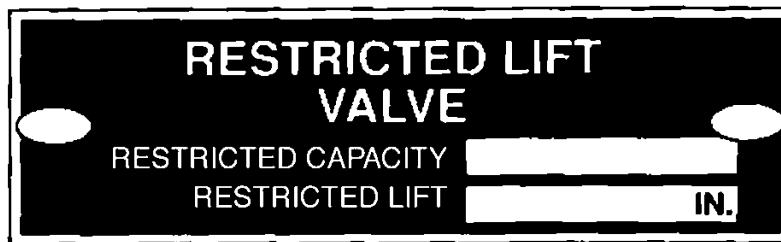


FIGURE 33

## X. (Continued)

### Specific Steps

Use the following procedure to determine the correct limit washer length.

1. Assemble the disc and holder (installing the bellows gasket and bellows, if applicable). Place the guide over the disc holder barrel; then connect the spindle to the disc holder. (Install the eductor tube in base, if applicable.) Then, install the adjusting ring below the seat.
2. Install the guide gasket and insert the assembly, from Step 1, above, into the base.
3. Install the bonnet gasket and bonnet (leaving out the spring assembly at this time).
4. Tighten the nuts to compress the gasket. **(Do not use an impact wrench on bellow valves.)**
5. Place a dial lift indicator on the bonnet and over the spindle, then zero the indicator.
6. Measure the total lift by pushing the disc upward.
7. Subtract the required lift of the valve from the measured lift, to find the required limit washer length.
8. Machine the limit washer to the required length. Next, machine the inside chamfer, then deburr and polish, as required.
9. Disassemble the valve, install the limit washer (with chamfer down), and prepare to reassemble the valve. Measure the actual lift of the valve, and compare it with the required lift for the valve, per the note above.
10. a. If the actual lift is less than required, machine the lift washer the additional amount necessary to obtain the required lift. (Machine, chamfer and deburr, before installation into the valve.)
  - b. If the actual lift is greater than the required amount, obtain a new limit washer, and begin again with Step 7, above. (Again, machine, chamfer and deburr, before installation into valve.)
11. Remove the bonnet and install the spring assembly; then, reinstall the bonnet and tighten the stud nuts.
12. The valve is now ready for setting and testing.

### NOTES:

- **The limit washer must be chamfered to fit over the radius on the disc holder. This**

**chamfered end must be located down, next to the backface of disc holder, when assembled.**

- **For bellows Type "D" and "E" valves, the limit washer must be chamfered on the lower end, to remove the knife edge of the cut off. For bellow valves, the outside diameter must also be checked, and emery clothed down to .680" or 17.3 mm maximum diameter, in order to avoid any interference with the bellows threads.**
- **Be sure of all dimension requirements for each valve. Do not interchange internal parts, or use a different base, after a set of parts has been custom-fit.**

## XI. Reassembly

### A. General Information

The Type 1900 Safety Relief Valve can be easily re-assembled after the required maintenance of internal parts has been performed. (Again, refer to Figures 1-6, on pages 6 and 7, for parts nomenclature.) All parts should be clean prior to assembly. Special attention should be given to guiding surfaces, bearing surfaces, flange faces, retainer recesses and grooves. See Section XVII for Recommended Compounds and Tools.

### NOTES:

- **Check all gaskets used during re-assembly. Undamaged solid metal gaskets (not pitted or creased) can be reused. All soft gaskets must be replaced. Before placing the (flat) gaskets, apply a light uniform coating of lubricant to the surface to be gasketed; then coat the top of the gasket with lubricant.**
- **If grinding in of bearing parts was necessary, be sure to remove all grinding compound; then, thoroughly clean both surfaces and rinse with alcohol or another suitable cleaner.**
- **With regard to restricted lift valves, be sure to measure the required lift before final assembly. (See Paragraph X.L. for instructions.)**
- **The last step before final assembly is lubrication. Apply lubricants sparingly, but be sure that each bearing surface is lightly (yet uniformly) covered.**

## XI.A. (Continued)

- If the involved valve has an O-Ring seat seal, refer to the tag plate mounted on the valve (see Figure 34) to determine O-Ring material and "as built" part number.



FIGURE 34

### B. Lubrication

Use a nickel based anti-seize lubricant on all threads, and bearing surfaces. Typical brands are TWIST™, NEVER-SEEZE™, OR FEL-PRO NICKEL EASE™.

### C. Specific Steps

1. If the valve nozzle was removed, apply thread lubricant to the nozzle threads before reinstalling in the valve base. Insert it in to the inlet flange of the base, and torque to the correct value listed in Table 9.

TABLE 9

Nozzle Torque Values +10% - 0%		
Orifice	Required Torque ft.lbs.	Required Torque nm
D-1	95	129
D-2	165	224
E-1		
E-2		
F-1	145	197
G		
H	165	224
J	335	455
K	430	584
L	550	746
M	550	746
N	640	868
P	1020	1383
Q	1400	1898
R	1070	1451
T	1920	2604
V	2000	2712
W	2000	2712

2. Reinstall the adjusting ring on the nozzle, below seat level, so that the disc will seat on the nozzle and not on the ring.

3. a. For restricted lift valves, if the nozzle did not require any machining, the same limit washer (tagged during disassembly) may possibly be reused. However, lift should be checked and verified as described in Paragraph X.L.  
 b. If a restricted lift valve nozzle was remachined, measure the required lift before final assembly. (Again, see Paragraph X.L. for instructions.)

4. Assemble the disc/disc holder as follows:
  - a. Prior to assembly of the disc into the disc holder, remove the spring clip from the back of the disc. Use 1000 grit grinding compound on the bearing surface to grind the disc into the disc holder to properly establish the bearing surface.
  - b. For all orifices, metal-to-metal discs, place the disc retainer into the groove in the disc. The retainer should “snap” into the disc holder pocket with moderate finger or hand force. **DO NOT USE EXCESSIVE FORCE TO ASSEMBLE THESE PARTS.** Be sure that the disc is free to “wobble” after it is in place.

For V and W orifice discs, place disc into disc holder and secure disc retaining bolts.

- c. For O-Ring disc sizes K thru T, reassemble the disc using a new O-Ring, O-Ring retainer, and new screws. Assemble the disc into the disc holder as described in Paragraph 4.a., above.
- d. For O-Ring disc sizes D thru J, reassemble the disc holder using a new O-Ring, O-Ring retainer, and new screw(s). These disc holders are ready for the next step.

5. For bellows valves through T, (see Figure 11 on page 13), place a new bellows gasket on the disc holder. Thread the bellows, finger-tight, down to the gasket on the disc holder. Use a pin spanner wrench, or special cable type wrench to turn the bellows ring down until a pressure tight joint is obtained.

For bellows valves V and W, place a new bellows gasket on the disc holder. Bolt down using proper torque as found in the assembly instructions.

6. On D and E restricted lift valves, install the limit washer with the chamfered side down.

## XI.C. (Continued)

7. Place the guide over the disc holder. **(DO NOT DROP.)** If bellows is present, the weight of the guide will slightly compress the bellows.
8. Set the disc holder (disc side down), on the work surface. Place a small amount of 1000 grit grinding compound onto the ball end of the spindle and place it in the spindle socket of the disc holder. Turn the spindle clockwise, and then counter clockwise, to seat the spindle/disc holder bearing point.
9. Place the spindle retainer over the end of the spindle head or disc holder, as applicable. Apply lubricant sparingly to the ball tip of the spindle. Place the spindle in the disc holder, and align the spindle retainer so that the gap is midway between the two slots. Using a screwdriver, compress the spindle retainer and guide it into the retaining groove. Be sure that the spindle turns freely.
10. With a small amount of 320 grit grinding compound spread on the spring washer bearing surface. Place the spring washer over the spindle/spring washer bearing surface and turn it clockwise and then counter-clockwise to seat in the bearing surface. In the same manner grind the compression screw into the bearing surface of the upper spring washer to establish a smooth bearing surface.

TABLE 10

Bonnet Nut Torque in ft.lbs. +10% - 0%													
	1905 1906	1910	1912	1914	1916	1918	1920	1921	1922	1923	1924	1926	1928
D-1	55	55	55	60	60	120	55	**	55	**	75	60	115
D-2	55	55	60	60	60	120	55	**	55	**	60	60	115
E-1	55	55	55	60	60	120	55	**	55	**	60	60	115
E-2	55	55	60	60	60	120	55	**	55	**	60	60	115
F	55	55	60	70	70	115	55	**	55	**	70	70	115
G	55	55	60	70	70	75	55	**	60	**	70	70	75
H	90	60	75	65	65	**	60	**	60	**	75	85	**
J	60	75	100	100	100	**	75	**	75	**	100	100	**
K	65	60	60	135	145	**	60	**	60	**	60	140	**
L	75	90	90	140	140	**	90	**	90	**	140	140	**
M	95	110	95	95	**	**	90	**	95	**	95	**	**
N	105	130	85	85	**	**	130	**	85	**	85	**	**
P	120	145	125	125	**	**	145	**	**	125	125	**	**
Q	105	125	150	**	**	**	105	**	**	**	**	**	**
R	115	115	135	**	**	**	115	**	150	**	**	**	**
T	95	**	**	**	**	**	**	**	135	**	**	**	**
-2T	**	125	**	**	**	**	**	125	**	**	**	**	**
V	130	130	**	**	**	**	**	**	**	**	**	**	**
W	130	130	**	**	**	**	**	**	**	**	**	**	**

\*\* Valves have not been built in this configuration.

**XI.C. (Continued)**

- 11. Place a new guide gasket in the base.
- 12. Install spindle/disc guide assembly. On M thru T sizes, use the same lifting tool (see Figure 10 on page 13) as was used during disassembly, then carefully lower it into the valve base. If conventional valve is involved, take care to align the hole(s) in the guide over the extended end of the eductor tube(s), to ensure proper fit. Then, install the spindle as described in Paragraph 8 above.

On V and W sizes, use the same lifting lugs as were used during disassembly.

- 13. Apply a small quantity of lubricant to the spring washer bearing surface of the spindle. Place the spring assembly on the spindle.
- 14. Place a new bonnet gasket in the base prior to installing the bonnet. Uniformly tighten the bonnet stud bolts using the correct pattern as displayed in Figure 35. Use table 10 or 10A, to determine the required torque for the subject valve. Then use Table 11, to determine the torque values for each round of the pattern. The last round insures that all the stud nuts are at the required torque.

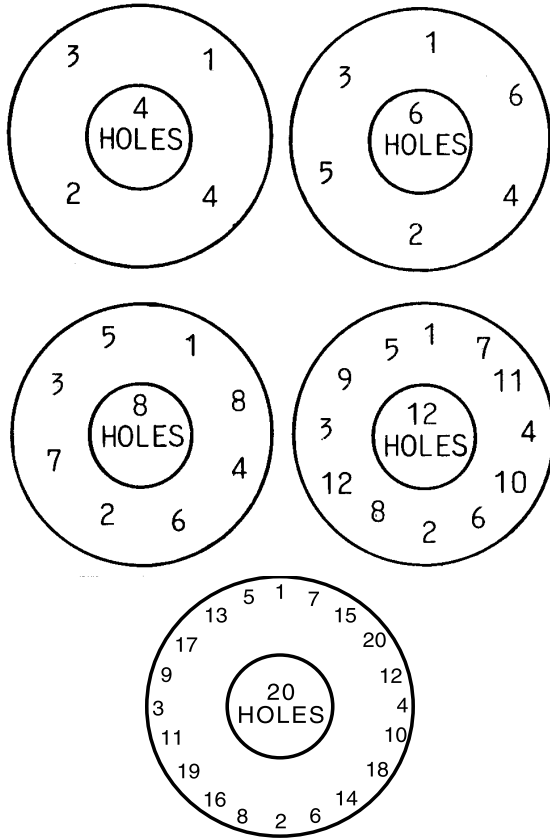
**TABLE 10A**

Bonnet Nut Torque in nm, +10% - 0%													
	1905 1906	1910	1912	1914	1916	1918	1920	1921	1922	1923	1924	1926	1928
D-1	75	75	75	82	82	163	75	**	75	**	102	82	156
D-2	75	75	82	82	82	163	75	**	75	**	82	82	156
E-1	75	75	75	82	82	163	75	**	75	**	82	82	156
E-2	75	75	82	82	82	163	75	**	75	**	82	82	156
F	75	75	82	95	95	156	75	**	75	**	95	95	156
G	75	75	82	95	95	102	75	**	82	**	95	95	102
H	123	82	102	89	89	**	82	**	82	**	102	116	**
J	82	102	136	136	136	**	102	**	102	**	136	136	**
K	89	82	82	184	197	**	82	**	82	**	82	189	**
L	102	123	123	189	189	**	123	**	123	**	189	189	**
M	129	150	129	129	**	**	123	**	129	**	129	**	**
N	143	177	116	116	**	**	177	**	116	**	116	**	**
P	163	197	170	170	**	**	197	**	**	125	170	**	**
Q	143	170	204	**	**	**	143	**	**	**	**	**	**
R	156	156	184	**	**	**	156	**	204	**	**	**	**
T	129	**	**	**	**	**	**	**	184	**	**	**	**
-2T	**	170	**	**	**	**	**	125	**	**	**	**	**
V	177	177	**	**	**	**	**	**	**	**	**	**	**
W	177	177	**	**	**	**	**	**	**	**	**	**	**

\*\* Valves have not been built in this configuration.



**XI.C. (Continued)**



**FIGURE 35**

15. With the adjusting screw lock nut assembled near the top of the adjusting screw, apply a small quantity of lubricant to the spherical end of the adjusting screw, and also lubricate the threads. Thread the adjusting screw into the bonnet, until it contacts the spring washer.

For V and W orifices, assemble the plunger and compression screw with the setting device. Set as if starting fresh.

16. When compressing the spring, hold the spindle with pliers to prevent the spindle from turning in the disc holder. Turn the adjusting screw clockwise, until the original distance between the end of the spindle and the top of the adjusting screw is obtained. This method of compressing the spring will "approximately" re-establish the original set pressure. **The valve must still be reset for the required pressure.**

17. Restore the adjusting ring to its original position, with reference to the disc holder, as recorded, and replace the adjusting ring pin using a new gasket. If the original position of the ring is not known, verify the number of notches on the adjusting ring, then refer to one of the three tables (i.e., Tables 12, 13 & 14), depending upon the number of notches on the ring, and set the ring position according to the applicable set pressure and orifice size.

18. The valve is now ready for Setting and Testing.

**TABLE 11**

Torque required for each round of pattern	
Round	Percentage of required torque
1	Wrench tight
2	25
3	60
4	100
5	100

**XI.C. (Continued)**

**TABLE 12**

<b>RING SETTINGS FOR VALVES WITH SERIAL NUMBERS BEFORE TK-68738*</b>			
<b>ORIFICE</b>	<b>NO. OF NOTCHES ON ADJ. RING</b>	<b>SET PRESSURE 100 PSIG (6.90 BAR) &amp; BELOW</b>	<b>SET PRESSURE ABOVE 100 PSIG (6.90 BAR)</b>
D-1	16	1 Notch	4 Notches
D-2	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
E-1	16	1 Notch	4 Notches
E-2	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
F	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
G	18	1 Notch	4 Notches
	30	2 Notches	6 Notches
H	24	1 Notch	5 Notches
	30	2 Notches	6 Notches
J	24	1 Notch	5 Notches
	30	2 Notches	8 Notches
K	24	6 Notches	14 Notches
	32	8 Notches	19 Notches
L	24	6 Notches	18 Notches
	40	10 Notches	31 Notches
M	24	7 Notches	20 Notches
	40	10 Notches	30 Notches
N	24	7 Notches	20 Notches
	40	10 Notches	30 Notches
P	24	8 Notches	24 Notches
	40	14 Notches	42 Notches
Q	28	10 Notches	28 Notches
	48	17 Notches	47 Notches
R	32	28 Notches	36 Notches
	48	42 Notches	64 Notches
T	24	30 Notches	38 Notches
W	-	-	-

**TABLE 13**

<b>RING SETTINGS FOR VALVES WITH SERIAL NUMBERS AFTER TK-68738*</b>			
<b>ORIFICE</b>	<b>NO. OF NOTCHES ON ADJ. RING</b>	<b>SET PRESSURE 100 PSIG (6.90 BAR) &amp; BELOW</b>	<b>SET PRESSURE ABOVE 100 PSIG (6.90 BAR)</b>
D-1	16	1 Notch	4 Notches
D-2	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
E-1	16	1 Notch	4 Notches
E-2	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
F	16	1 Notch	4 Notches
	24	2 Notches	6 Notches
G	18	1 Notch	4 Notches
	30	2 Notches	6 Notches
H	24	1 Notch	5 Notches
	30	2 Notches	6 Notches
J	24	1 Notch	5 Notches
	30	2 Notches	8 Notches
K	24	2 Notches	5 Notches
	32	2 Notches	7 Notches
L	24	2 Notches	6 Notches
	40	4 Notches	11 Notches
M	24	2 Notches	7 Notches
	40	4 Notches	12 Notches
N	24	3 Notches	8 Notches
	40	4 Notches	13 Notches
P	24	3 Notches	9 Notches
	40	5 Notches	16 Notches
Q	28	5 Notches	15 Notches
	48	8 Notches	25 Notches
R	32	7 Notches	20 Notches
	48	10 Notches	30 Notches
T	24	6 Notches	19 Notches
W	24	10 Notches	30 Notches

\* Valve Serial Numbers are alphabetically and numerically chronological.

**NOTES:**

- Be careful to choose the correct table.
- If the Valve has an "O" Ring Seat Seal, tighten and lock the adjusting screw prior to the final setting of the adjusting ring.
- Be sure the ring pin enters the notch in the ring, but does not bind the ring. The ring should move freely from side to side within the notch. If necessary, cut the pin to the needed length, or replace the pin.

**TABLE 14**

<b>LIQUID TRIM</b>			
<b>OLD - LS</b>		<b>NEW - LA</b>	
<b>ORIFICE</b>	<b>RING POSITION</b>	<b>ORIFICE</b>	<b>RING POSITION</b>
D	10	D	5
E	10	E	5
F	10	F	5
G	14	G	5
H	20	H	5
J	20	J	5
K	24	K	5
L	24	L	5
M	24	M	5
N	24	N	5
P	36	P	5
Q	42	Q	5
R	48	R	5
T	36	T	5

## XII. Setting and Testing

### A. General Information

Before putting the re-conditioned valve in service, it must be set to open at the required set pressure. Although the valve can be set on the service installation, it is more convenient to set the valve, and check seat tightness, on a test stand. Any spring replacement shall be in accordance with current DVCD guidelines.



### B. Test Equipment

Test stands for testing DVCD Safety Relief Valves normally consist of a pressure source, a supply line with a throttle valve, and a receiver having the following features:

1. Outlet for attaching valve to be tested.
2. Pressure gauge with a shut-off valve.
3. Drain line with a shut-off valve.
4. A volume in receiver adequate for the valve to be tested to achieve proper operation.

### C. Test Media

For best results, steam valves shall be tested on saturated steam; air or gas valves on air or gas, at ambient temperature; and liquid valves on water, at ambient temperature.

### D. Setting the Valve

The valve should be set to open at the set pressure as shown on the nameplate. If a cold differential set pressure is indicated on the nameplate, the valve should be set to open at that pressure. The cold differential set pressure is the set pressure corrected to compensate for back pressure and/or operating temperature.

If changes are to be made to the set pressure or back pressure or the service temperature changes, a new cold differential set pressure may need to be determined.



### E. Set Pressure Compensation

#### 1. Cold Differential Set Pressure For Temperature Compensation

During production testing of safety and safety relief valves, the valves are often tested at temperatures that are different from the temperature the valve will be

exposed to in service. Increasing the temperature from ambient causes the set pressure to decrease. This decrease in set pressure is due to thermal expansion of the seating area and spring relaxation.

Therefore, it is important to compensate for the difference between production test temperature and service temperature. The service temperature is the normal operating temperature of the valve. If the operating temperature is unavailable, no correction due to temperature will be made to valve set pressure.

Table 15, below, gives the set pressure multipliers that should be used when computing the cold differential set pressure for valves being set on an air or water test stand at ambient temperatures.

TABLE 15

OPERATING TEMP. F		MULTIPLIER	OPERATING TEMP. C		MULTIPLIER
250	120		1.003	900	
300	149	1.006	950	510	1.047
350	177	1.009	1000	538	1.050
400	204	1.013	1050	565	1.053
450	248	1.016	1100	593	1.056
500	260	1.019	1150	621	1.059
550	288	1.022	1200	649	1.063
600	316	1.025	1250	676	1.066
650	343	1.028	1300	704	1.069
700	371	1.031	1350	732	1.072
750	415	1.034	1400	760	1.075
800	427	1.038	1450	788	1.078
850	454	1.041	1500	815	1.081

Valves to be used in saturated steam service are tested on saturated steam and, therefore, no CDS is required. However, valves in superheated steam service are tested on saturated steam and, therefore, require a CDS.

Table 16, below, shows the multiplier that should be used based on temperature above the saturated temperature (degrees of superheat).

TABLE 16

Degrees of Superheat, Temp. above Sat.		Multiplier
Fahrenheit	Celsius	
100	38	1.006
200	93	1.013
300	149	1.019
400	187	1.025
500	260	1.031
600	315	1.038
700	371	1.044
800	427	1.050

**XII.E. (Continued)**

**2. Cold Differential Set Pressure For Back Pressure Compensation**

**NOTE:**

For valves with variable superimposed back pressure, install a bellows to allow the set pressure to remain constant.

When a conventional Type 1900 valve is to operate with a constant back pressure, the cold differential set pressure is the set pressure minus the constant back pressure.

When a Type 1900-30 D-1, or 1900-30 E-1, non-balanced bellows valve is used with constant back pressure, the set pressure must be compensated. This valve design cannot be used for variable back pressure. If the valve's set pressure, or back pressure, changes, contact DVCD Field Service at 318-640-6055 for the CDS of the valve.

When Consolidated® Type 1900-30 D-2, 1900-30 E-2 and 1900-30 F thru T balanced bellows valves are used with constant or variable back pressure, no compensation to the valve's set pressure is required due to back pressure.

**3. Sample Calculations For Type 1900 Consolidated Safety Relief Valve (Refer to preceding pages, Tables 15 & 16).**

Set pressure 2500 psig, temperature 500 F, back pressure atmospheric.

a. Set Pressure .....	2500	psig
Multiplier from <b>Table X</b> .....	<u>X1.019</u>	
Cold Differential Set Pressure .....	2547.5	psig

b. Set pressure 2500 psig, temperature 500 F, constant back pressure 150 psig		
Set Pressure .....	2500	psig
Minus Constant Back Pressure .....	<u>-150</u>	psig
Differential Pressure .....	2350	psig
Multiplier from <b>Table X</b> .....	<u>X1.019</u>	
Cold Differential Set Pressure .....	2395	psig

c. Set pressure 2500 psig, temperature 100 F, constant back pressure 150 psig		
Set Pressure .....	2500	psig
Minus Constant Back Pressure .....	<u>-150</u>	psig
Cold Differential Set Pressure .....	2350	psig

d. Set pressure 400 psig on superheated steam, temperature 650 F, back pressure atmospheric		
Operating Temperature .....	650	F
Minus Temperature of Sat. Steam at 400 psig .....	<u>-448</u>	F
Degrees of Superheat .....	202	F
Set Pressure .....	400	psig
Multiplier from <b>Table Xa</b> .....	<u>X1.013</u>	
Cold Differential Set Pressure .....	405	psig

**4. Setting Procedure**

**NOTE:**

Valves for steam service should be set using saturated steam. Valves for gaseous service should be set using air or nitrogen. Valves for liquid service should be set using water.

**NOTE:**

**The ASME Boiler and Pressure Vessel Code Section VIII set pressure tolerance is  $\pm 2$  psi (.14 bar) for set pressures less than 70 psig (4.8 bar) and  $\pm 3\%$  for pressures equal to or greater than 70 psig (4.8 bar).**

Before mounting the valve on the test stand, remove all dirt, sediment or scale from the test tank nozzle and the inlet port of the valve. Be sure that the test gauge is accurate and has recently been calibrated on a dead weight gauge tester.

Mount the valve on the test stand. If the adjusting screw of the reconditioned valve has been turned down to its original position, slowly bring the pressure up in the test tank to the cold differential set pressure. If the valve opens before the desired pressure is reached, additional compression is required on the spring. Hold the spindle to prevent rotation and turn the adjusting screw down (clockwise or right-handed). If the valve does not open at the desired pressure, maintain the required pressure in the test tank and slowly release the compression on the spring by turning the adjusting screw counterclockwise, until the valve opens. Continue adjustment until the valve opens at the desired pressure. Be sure to hold the spindle when turning the adjusting screw. The spindle should be centrally located within the adjusting screw. Hard rubbing of the spindle against the side of the adjusting screw can cause poor valve action.

**NOTE:**

**On compressible fluids, set pressure is defined as the pressure where the valve pops open, NOT where it begins to simmer.**

**NOTE:**

**On liquid valves, set pressure is indicated by the first continuous flow of water out of the outlet of the valve.**

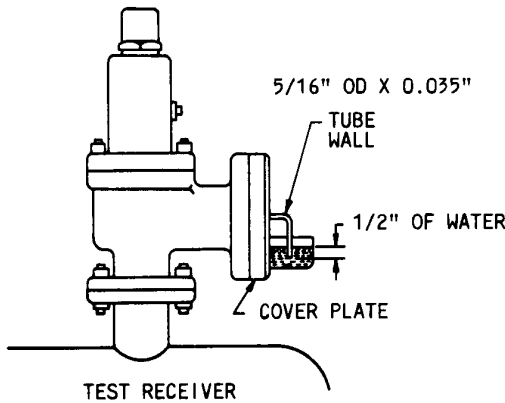
After the required set pressure is obtained, tighten the adjusting screw nut and repeat test. At least two repeat openings at the same pressure should be obtained to be sure that the valve is set accurately.

**XII. (Continued)**

**F. Seat Tightness Testing**

**1. General Information**

A typical test arrangement for determining seat tightness for safety relief valves on air or gas service (in accordance with ANSI B147.1/API RP 527) is shown in Figure 36.



**FIGURE 36**

Leakage measurement shall be made with the use of a piece of 5/16 in. OD tubing with 0.035 in. wall. The tube end shall be cut square and smooth. It shall also be perpendicular to, and 1/2 in. below, the surface of the water.

**2. Seat Tightness Testing: Metal to Metal Seats**

With the valve mounted vertically (as shown in Figure 39 above), the leakage rate, in bubbles per minute, shall be determined with pressure at the safety relief valve inlet, which must be held at 90 percent of the set pressure immediately after popping. For valves set at 50 psig or below, the pressure shall be held at 5 psi below set point. The test pressure shall be applied for a minimum of 1 min. for valves on inlet sizes through 2 inches; 2 min. for sizes 2-1/2, 3 and 4 inches; and 5 min. for sizes 6 and 8 inches.

For metal to metal valves, designated for gaseous service, the leakage rate (in bubbles per minute) shall not exceed that shown in Table 17.

**TABLE 17**

Type of Valve	Manufacturer's Orifice Size	Maximum (Bubbles per Minute)	Approximate Leakage Rate (Standard Cubic Feet per 24 hour) Maximum
Conventional	F and smaller	40	0.60
	G and larger	20	0.30
Balanced Bellows	F and smaller	50	0.60
	G and larger	30	0.45

There shall be **no** visible leakage for valves designated for steam service (and tested on steam) or for liquid service (and tested on water).

**3. Seat Tightness Testing for O-Ring Seat Seal Valve**

The "Tightness Standard" for O-Ring seat seal valves shall be no leakage at, or below, the test pressures shown in Table 18, below.

**TABLE 18**

Seat Tightness Testing for "O" Ring Seat Seals®		
Set Pressure		Test Pressure
(psig)	(bar)	(% of Set Pressure)
5 to 30	.35 to 2.07	90
31 to 50	2.14 to 3.45	92
51 to 100	3.52 to 6.9	94
100 and above	6.9 and above	95

**4. Recommended Back Pressure Testing for Joint Leakage**

After a given valve has been set for the correct opening pressure, and if the valve is to be used in a closed discharge system, it should be back pressure tested. Testing can be conducted by installing the cap, with gasket, and applying air, or nitrogen, to the base drain connection, or to the valve outlet. All other openings must be sealed.

Test pressure should be the greater of 30 psi (2 bar), or the actual valve back pressure. Air, or nitrogen, pressure should be held for 3 minutes, before applying leak detector solution to all connections (joints).

## XII.F. (Continued)

On bellows valves, also install a clean pipe plug in the bonnet vent connection, until it is finger tight. The purpose of this is to obtain the smallest possible leak path. **Remove this plug upon completion of test.**

Examine the following valve components for leakage during back pressure testing:

- The nozzle/base joint.
- The adjusting ring pin seal.
- The base/bonnet joint.
- The bonnet/cap joint.
- If conventional valve, the "tight" bonnet vent plug.
- The "loose" bonnet vent plug, if bellows valve.

Leakage is best detected by application of a liquid leak detector.

### NOTE:

**The use of soap, or household detergent, as a leak detector is not recommended, as it may bridge small leaks.**

Repair of leaking valve joints may be attempted by tightening the leaking joint while the valve is still on the stand. If this does not stop the leak, tear down and inspect the leaking joint(s); both the metal surface(s) and gasket(s).

If the valve internals have been disturbed, it is necessary to retest in accordance with the instructions contained in this manual. Otherwise, repeat the back pressure tests, as outlined above.

### 5. Blowdown Adjustment

Blowdown adjustments are made by means of the adjusting ring on Type 1900 valves.

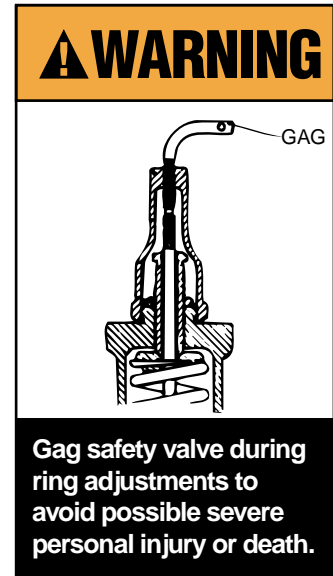
If longer or shorter blowdown is required, it can be obtained as follows:

- To increase the blowdown (lower reseating pressure), the adjusting ring must be raised by moving the notches, from left to right, past the ring pin hole.

- To decrease the blowdown (raise reseating pressure), the adjusting ring must be lowered by moving the notches, from right to left, past the ring pin hole.

### NOTES:

- Unless the test stand capacity is equal to, or greater than, that of the valve, do not attempt to set blowdown. Simply return the adjusting ring to the recommended position. (Tables 12-14).
- The valve will not achieve rated relieving capacity if the adjusting ring is positioned too low.



## XIII. Hydrostatic Testing and Gagging

When hydrostatic tests are required after installation of a safety relief valve, the safety relief valve should be removed and replaced with a blind flange, if the hydrostatic test pressure will not be greater than the operating pressure of the equipment, a test gag may be used. Very little force (i.e., fingertight pressure) on the test gag is sufficient to hold hydrostatic pressures. **Too much force applied to the gag may bend the spindle and damage the seat.** After a hydrostatic test, the gag must be removed and replaced by the sealing plug furnished for this purpose. (Test gags for Consolidated® Safety Relief Valves can be furnished for all types of caps and lifting gears.)

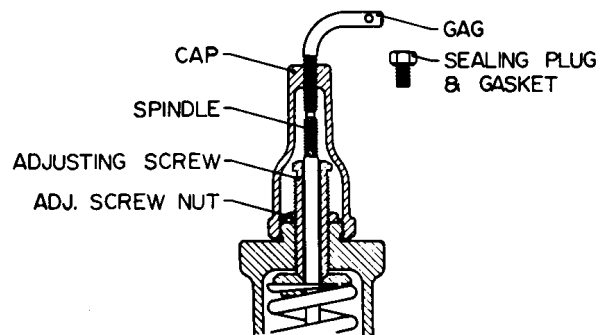


FIGURE 37

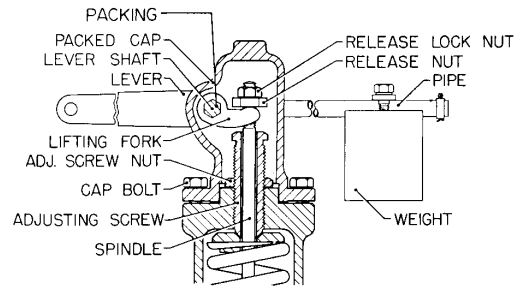
### XIV. Manual Popping of the Valve

Consolidated Safety Relief Valves are furnished, when so ordered, with packed or plain lifting levers for hand popping, or with an air operated lifting device for remote control. (See Figures 38-42, following.)

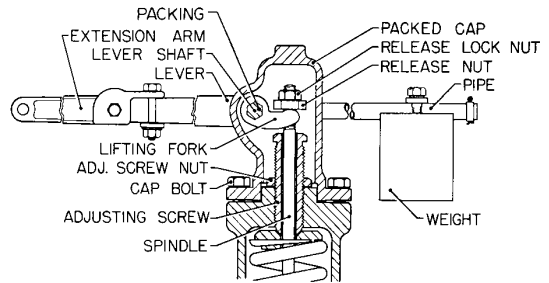
When the valve is to be opened by hand, the pressure at the valve inlet should be at least 75% of the valve's set pressure. Under flowing conditions, the valve must be fully lifted from its seat, so that dirt, sediment and scale will not become trapped on the seating surfaces. When allowing the valve to close under flowing conditions, completely release the lever from maximum lift to snap the valve back on its seat.

Since, in some cases, the dead weight of the lever will have a tendency to lift the valve, the lever should be hung, supported, or counter weighted, so the lifting fork does not contact the release nut.

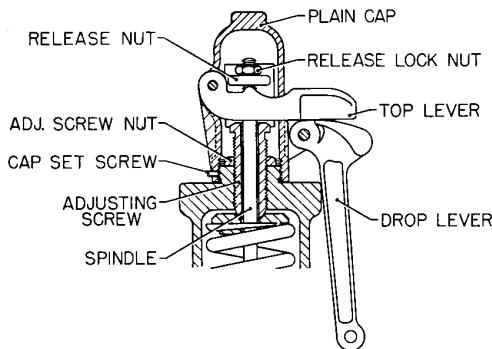
The air operated lifting device is designed to fully open the valve with 75% of set pressure under the valve disc in compliance with ASME Section VIII. For certain applications, the air operator may be designed to fully open the valve with no pressure at the valve inlet. An air operated device can be operated from a remote point and can be used as a "drop out" valve. (A typical design is shown in Figure 42, and can be purchased from DVCD.)



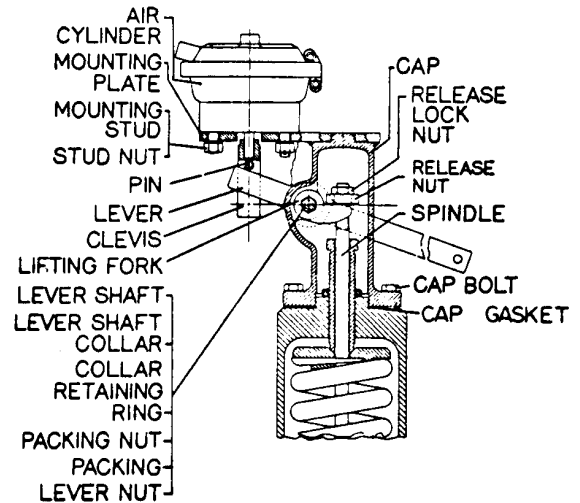
**FIGURE 40**  
**"L" TYPE PACKED LEVER**



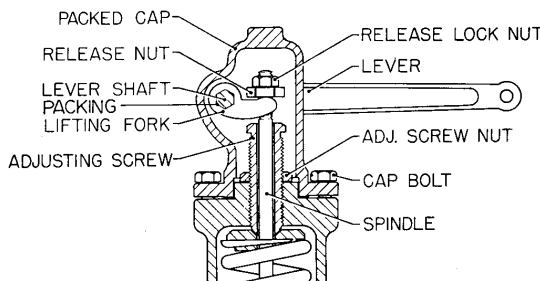
**FIGURE 41**  
**"R" TYPE PACKED LEVER**



**FIGURE 38**  
**PLAIN LEVER**



**FIGURE 42**  
**AIR OPERATED PACKED LEVER**



**FIGURE 39**  
**PACKED LEVER**

## XV. Conversion of Type 1900 Flanged Safety Relief Valves From Conventional to Bellows Type, and Vice Versa

### A. General Information

Consolidated® Type 1900 Flanged Safety Relief Valves can be readily converted from conventional to bellows style, or vice versa, in the customer's repair shops. However, the Type 1901 and 1902 valves were constructed in the conventional type only. Table 16, below, shows the parts necessary for the typical conversion.

#### NOTE:

**With regard to all bellows valves, the bonnet vent plug must be removed and the bonnet vented to a safe area.**

TABLE 19

VALVE ORIFICE SIZE	NEW PARTS TO CONVERT FROM	
	CONVENTIONAL TO BELLOW VALVE	BELLOW TO CONVENTIONAL VALVE
D, E, F, G, H	<ol style="list-style-type: none"> <li>1. Bellows Assembly - Standard Material, AISI 316L Stainless Steel</li> <li>2. Set of gaskets for bellows valve.</li> <li>3. Guide for bellows valve.</li> <li>4. Disc holder for bellows valve.</li> <li>5. Spindle for bellows valve (F, G &amp; H only).</li> <li>6. Spindle retainer for bellows valve.</li> <li>7. Base studs for bellows valve (D, E, F &amp; G only).</li> <li>8. Machine existing lower spring washer. (See Paragraph XV.B. and Figure 43 for F, G &amp; H orifices only.) Upper spring washer, no change.</li> <li>9. Drill 23/32 dia. on bonnet boss and tap 1/2 N.P.T. (as required).*</li> </ol>	<ol style="list-style-type: none"> <li>1. Eductor tube for conventional valve.</li> <li>2. Set of gaskets for conventional valve.</li> <li>3. Guide for conventional valve.</li> <li>4. Disc holder for conventional valve.</li> <li>5. Spindle for conventional valve (F, G &amp; H only).</li> <li>6. Spindle retainer for conventional valve.</li> <li>7. Base studs for conventional valve (D, E, F &amp; G only).</li> <li>8. New lower spring washer for conventional valve. (See Paragraph XV.C. and Figure 44 for F, G &amp; H orifices only.) Upper spring washer, no change.</li> <li>9. Bonnet vent plugged (if desired).</li> </ol>
K, L, M, Q R, T **Also J, N, P manufactured after 1981	<ol style="list-style-type: none"> <li>1. Bellows Assembly - Standard Material, AISI 316L Stainless Steel.</li> <li>2. Set of gaskets for bellows valve.</li> <li>3. Drill 23/32 dia. on bonnet boss and tap 1/2 N.P.T. (as required).*</li> <li>4. Studs (1905-30 K &amp; L, 1906-30 K &amp; L only).</li> </ol>	<ol style="list-style-type: none"> <li>1. Eductor tube for conventional valve.</li> <li>2. Set of gaskets for conventional valve.</li> <li>3. Bonnet vent plugged (if desired).</li> <li>4. Studs (1905 K &amp; L, 1906 K &amp; L only).</li> </ol>
J, N, P **Manufactured prior to 1982	<ol style="list-style-type: none"> <li>1. Bellows Assembly - Standard Material AISI 316L Stainless Steel</li> <li>2. Set of gaskets for bellows valve.</li> <li>3. Guide for bellows valve.</li> <li>4. Disc holder for bellows valve.</li> <li>5. Drill 23/32 dia. on bonnet boss and tap 1/2 N.P.T. (as required).*</li> <li>6. Studs (1905-30 N &amp; P, 1906-30 N &amp; P only).</li> </ol>	<ol style="list-style-type: none"> <li>1. Eductor tube for conventional valve.</li> <li>2. Set of gaskets for conventional valve.</li> <li>3. Bonnet vent plugged (if desired).</li> <li>4. Drill 7/16 dia. thru guide flange 1-13/16 from guide bore centerline (J orifice only).</li> <li>5. Studs (1905 N &amp; P, 1906 N &amp; P only).</li> </ol>
W	<ol style="list-style-type: none"> <li>1. Bellows Assembly</li> <li>2. Set of gaskets for bellows valve</li> <li>3. Guide for bellows valve</li> <li>4. Lift restricting ring</li> <li>5. Studs</li> </ol>	<ol style="list-style-type: none"> <li>1. Set of gaskets for conventional valve</li> <li>2. bonnet vent plug (if desired)</li> </ol>

\* Valves manufactured after 1980 are furnished with bonnet vent machined.

\*\* J, N, P orifice valves manufactured after 1981 are furnished with threaded disc holder and reduced guide bore for balanced bellows conversion.

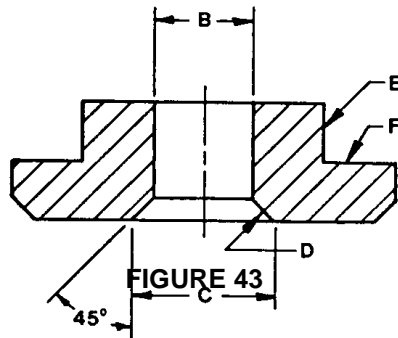


**XV. (Continued)**

**B. Conversion From Conventional to**

**Bellows Type**

The eductor tube is not needed in bellows valves, and it should be entirely removed to provide a flat surface for proper bellows flange seating. To remove the eductor tube from the base, first drill into the bore of the tube (where it is attached to the base) with a drill approximately 1/64" smaller in diameter than the outside diameter of the tube. This will reduce the tube wall thickness to the extent that it can easily be collapsed for removal. The hole in the guide surface, which will remain after the eductor tube is removed, will be covered by the bellows flange. Next, machine the existing lower spring washer in accordance with Figure 43 and Table 20, below.



**TABLE 20**

VALVE TYPE		B	C
1905F	1906F	11/16" 17.5 mm	1" 25.4 mm
1910F	1912F		
1920F	1922F		
1905G	1906G		
1910G	1912G		
1920G	1922G	7/8" 22.2 mm	1-1/4" 31.8 mm
1914F	1916G		
1924F	1926F		
1914G	1916G		
1918G	1924G		
1926G	1928G	1" 25.4 mm	1-7/16" 36.5 mm
1918F	1928F		
1905H	1906H	11/16" 17.5 mm	1-1/8" 28.6 mm
1910H	1911H		
1920H	1922H		
1912H	1924H	7/8" 22.2 mm	1-5/16" 33.3 mm
1914H	1916H	1" 25.4 mm	1-1/2" 38.1 mm
1926			

When indicated at surfaces D and E, run out at surface F is not to exceed .005 full indicator reading.

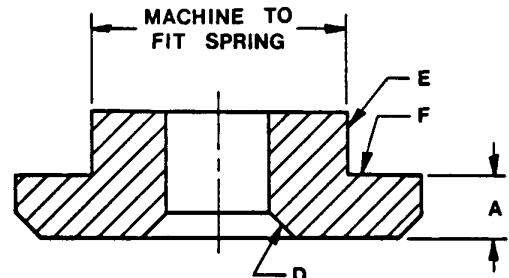
**C. Conversion from Bellows to Conventional Type**

In converting from a bellows to a conventional valve, the eductor tube may be secured in the base by expanding, or swaging, into the hole provided. The upper end of the tube should project above the guide surface of the base approximately 1/8-inch, and the lower end should point directly and squarely toward the valve outlet. When the valve is assembled, the hole at the outer edge of the guide flange must fit loosely around the projection of the eductor tube.

The new lower spring washer must be machined as follows for the F, G, & H valves only. (See Figure 44 and Table 21, below.)

**NOTE:**

**For all Type 1900 valves, Dimension A may not be less than specified in Table 18, below.**



**FIGURE 44**

**TABLE 21**

VALVE TYPE			A
1905-30F	1906-30F	1910-30F	1/4" 6.35 mm
1920-30F	1922-30F	1905-30G	
1906-30G	1910-30G	1920-30G	
1905-30H	1906-30H		
1912-30F		1922-30G	5/16" 7.94 mm
1910-30H	1911-30H	1920-30H	
1922-30H			
1914-30F	1916-30F	1924-30F	3/8" 9.52 mm
1926-30F	1914-30G	1916-30G	
1918-30G	1924-30G	1926-30G	
1928-30G	1912-30H	1924-30H	
1918-30F	1928-30F		7/16" 11.11 mm
1914-30H	1916-30H	1926-30H	1/2" 12.7 mm

When indicated at surfaces D and E, run out at surface F is not to exceed .005 full indicator reading.

## XVI. Trouble Shooting Type 1900 Valves

TABLE 22

MALFUNCTION	CAUSE	SOLUTION
Seat Leakage	Damaged seats	Rework seats or replace part.
	Improper installation	Inspect installation, i.e. piping.
	Operating pressure too close to set pressure Excessive system vibration	Increase differential. Recheck application.
	Misalignment of valve components	Ensure valve is installed vertically. Ensure valve has been properly assembled.
	Trash trapped on seats	Pop valve to clean seats. Rework seats.
Simmer	Damaged seats	Rework seats or replace part.
	Wide nozzle seat	Rework seat.
	Improper adjusting ring setting	Check ring setting.
	Misalignment/binding	Inspect valve and installation.
Chatter	Improper installation or valve sizing	Check for piping restrictions. Check required capacity.
	Built-up back pressure	Check outlet piping.
	Improper ring setting	Check ring setting.

## XVII. Maintenance Tools and Supplies

TABLE 23

ORIFICE	*ORIGINAL NOZZLE		*NEW NOZZLE		**NOZZLE LAP HANDLE	***RING LAP
	NOZZLE BORE DIAMETER	NOZZLE LAP PART NO.	NOZZLE BORE DIAMETER	NOZZLE LAP PART NO.		
D	.393-.398	0543001	.404-.409(*4)	4451501	0544603	1672805
E	.524-.529	0543002	.539-.544(*5)	4451502	0544601	1672805
F	.650-.655	0543003	.679-.674(*6)	4451503	0544601	1672805
G	.835-.840	0543004	.863-.868	4451504	0544601	1672805
H	1.045-1.050	0543005	1.078-1.083	4451505	0544601	1672805
J	1.335-1.340	0543006	1.380-1.385	4451506	0544601	1672805
K	1.595-1.600	0543007	1.650-1.655	4451507	0544601	1672807
M	2.234-2.239	0543102	2.309-2.314	4451602	0544601	1672809
N	2.445-2.450	0543103	2.535-2.540	4451603	0544601	1672809
P	2.965-2.970	0543104	3.073-3.078	4451604	0544602	1672810
Q	3.900-3.905	0543105	4.045-4.050	4451605	0544602	1672812
R	4.623-4.628	0543106	4.867-4.872	4451606	0544602	1672812
T	6.000-6.006	0543107	6.037-6.043	4451607	0544602	1672813
W	10.029	None	10.029-10.034	None	None	4875401

\* Ring Lap on W orifice is an assembly which includes lap handles, the Ring Lap should be used for all lapping operations.

\* After August 1978, all 1900 SRV Nozzles manufactured have increased bore diameter. The above chart shows how each orifice was affected. Nozzles-original vs. new - are interchangeable, but nozzle laps are not. On the O.D. of the new Nozzles, the letter "C" is stamped. If this stamp becomes obliterated, the nozzle bore diameter must be measured to select the correct nozzle lap from above chart.

\*\* Nozzle lap handles are interchangeable between original and new nozzle laps.

\*\*\* Ring laps - One set of three (3) ring laps is recommended for each orifice to assure ample flat laps are available at all times.

(\*4) Use for all D-1 designs.

(\*5) Use for all E-1 designs.

(\*6) Also used for all D-2 & E-2 designs.

## XVII. (Continued)

### LAPPING TOOLS

The following tools are required for proper maintenance of Consolidated® Safety Relief Valve seats, and may be purchased from DVCD upon request.

**Nozzle Lap** - The nozzle lap is used for lapping the nozzle seat and has one flat side and one side with a 5° angle. This lap guides in the bore of the nozzle; therefore, a different size lap is required for each valve orifice.

**Ring Lap** - The ring lap is used for lapping the disc seat and finish lapping of the nozzle seat.

**Lapping Plate** - The lapping plate is used for reconditioning the ring lap. It may also be used for lapping the disc. One 11" diameter plate is required for the entire line of valves (Part No. 0439004).

**Lapping Compound** - Used as a cutting medium when lapping the valve seats (as specified below).

Brand	Grade	Grit	Lapping Function	Size Container	Part No.
Clover	1A	320	General	4 oz	199-3
Clover	3A	500	Finishing	4 oz	199-4
Kwik-Ak-Shun	----	1000	Polishing	1 lb	199-11
				2 lb	199-12

**Drift Pins** - Two pins are required for the removal of the disc from the disc holder. (See Figure 45, below.)

Orifice	A (in.)	A (mm)	B (in.)	B (mm)	Part No.
D, E, F G, H, J, K	1-3/4	44.5	7/32	55.5	0430401
L, M, N, P	2-1/2	63.5	3/8	95.3	0430402
Q, R	3	76.2	5/8	158.7	0430403
T	3-1/2	88.9	7/8	222.2	0430404

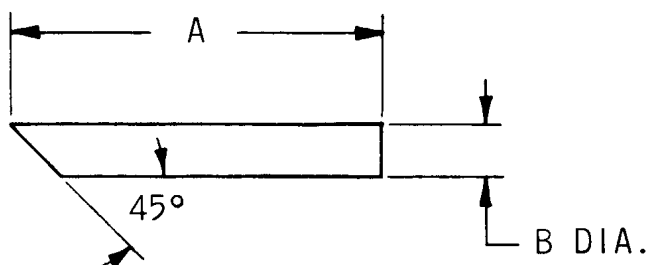


FIGURE 45

**Lifting Tools** - For removal of upper internal parts of larger valves (as specified below).

Orifice	Part No.
M, N	4464602
P, Q, R, T	4464604

**Wrenches** - For removal of bellows from disc holder (as specified below).

Valve Orifice	Description of Wrench	Pin Spanner Wrench No.
F	3/4" Radius - 7/32" Pin	4451801
G	3/4" Radius - 7/32" Pin	4451801
H	7/8" Radius - 15/64" Pin	4451802
J	1-1/8" Radius - 17/64" Pin	4451803
K	1-1/4" Radius - 9/32" Pin	4451804
L	1-3/8" Radius - 19/64" Pin	4451805
M	1-5/8" Radius - 21/64" Pin	4451806
N	1-7/8" Radius - 23/64" Pin	4451807
P	1-7/8" Radius - 23/64" Pin	4451807
Q	2-1/2" Radius - 7/16" Pin	4451808
R	3" Radius - 1/2" Pin	4451809
T	3-3/4" Radius - 1/2" Pin	4451810

## XVIII. Replacement Parts Planning

### A. Basic Guidelines

The following guidelines should be of assistance in developing a meaningful replacement parts plan.

1. The total number of valves in service should be classified by size, type, and temperature class.
2. the parts inventory should be classified by the tendency to require replacement.  
 Class I - Most frequently replaced  
 Class II - Less frequently replaced but critical in an emergency
3. Parts for the valve types covered by this manual are classified on page 46. "Qty. Parts" is the number of parts or sets which is recommended to achieve a desired need-probability, as it relates to the total number of valves in service by size and type. For example, a "Qty. Parts" of 1 for "Valves in Service" of 5 means that 1 part should be stocked for each 5 valves of the same type and size in service.
4. When ordering replacement parts, please specify in accordance with applicable nomenclature (see Figures 1 through 6). Be sure to state the size, type and serial number of the valve for which parts are required.

\* Predicted availability means that percentage of time the user plant will have the right parts to make the proper repair on the product, (i.e. if Class I parts are stocked at the owners facility, the parts needed to repair valve in question will be immediately available in 70% of all instances).

### C. Replacement Parts List

Consult the Recommended Spare Parts list (see Section XX of this manual) to define the parts to be included in the inventory plan.

Select the desired parts and determine those required for proper maintenance of the valve population in the plant.

### D. Identification and Ordering Essentials

When ordering service parts, please furnish the following information to insure receiving the correct replacement parts:

1. **Identify valve by the following nameplate data:**
  - a. Size
  - b. Type
  - c. Temperature Class
  - d. Serial Number
 Example 1: 1-1/2" 1910Fc\*  
 S/N TD-94578

2. **Specify parts required by:**
  - a. Part Name (See Figures 1-6 on pages 6 and 7)
  - b. Part Number (if known)
  - c. Quantity

Contact Parts Marketing: 1-318-640-6044

In addition, the serial number is stamped on the top edge of the outlet flange. Be sure to include the one or two letters preceding the figures in the serial number. Typical valve nameplates are shown in Figures 46-49, below.

CONSOLIDATED SAFETY RELIEF VALVE			
SIZE		TYPE	
○	SET PRESS.	SERIAL NO.	○
U	COLD SET PRESS.	BACK PRESS.	NB
	TEMP.	°F MATL.	
CAP.	LBS./HR. SAT. STEAM	STD. CU FT/ MIN. AIR	
CAP.	G.P.M.		
TAG			
B/M		DATE	

FIGURE 46

RESTRICTED LIFT VALVE	
○	○
RESTRICTED CAPACITY	[ ]
RESTRICTED LIFT	[ ] IN.

○	PSV NUMBER	○
	P.O. NUMBER	
	REQN NUMBER	

FIGURE 47

THIS VALVE CONTAINS AN	
O-RING SEAT SEAL	
○	○
O-RING MATERIAL	
O-RING PART NO.	

FIGURE 48

## XVIII. Replacement Parts Planning (Continued)

- \* In order to determine if the valve contains Glide-Alloy® components (i.e., the disc holder and/or the guide), which will be identified for a particular valve by the coding found on the valve nameplate, please consult the Appendix to this manual for pertinent supplemental information.

When a pressure relief valve is repaired, a metal repair nameplate (see Figure 49, below), stamped with the DVCD insignia, the National Board "VR" symbol and stamp number, and the date of repair is permanently attached to the valve near the original nameplate. This repair nameplate may also contain information regarding altered set pressures, capacities or blowdown, as applicable.

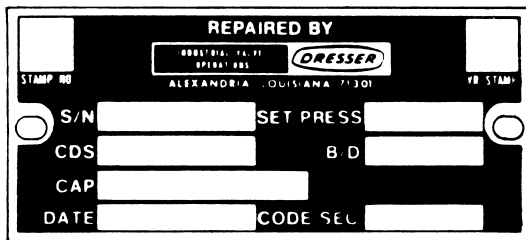


FIGURE 49

## XIX. Genuine Dresser Parts

The next time replacement parts are needed, keep these points in mind:

- DVCD designed the parts
- DVCD guarantees the parts.
- CONSOLIDATED® valve products have been in service since 1879.
- DVCD has worldwide service.
- DVCD has fast response availability for parts.

## XX. Recommended Spare Parts For 1900 Safety Relief Valves

### 1900 CONVENTIONAL & 1900-30 BELLOWS 1900 CONVENTIONAL & 1900-30 BELLOWS WITH LIQUID TRIM (LS) 1900 CONVENTIONAL & 1900-30 BELLOWS WITH THERMODISC® (TD)

CLASS	PART NAME	C-CONVENTIONAL B-BELLOWS	QTY PARTS/ SAME VALVES IN SERVICE	NEED PROBABILITY COVERAGE
I.  Class I Parts should be stocked at the rate described in the column "Qty. Parts". Stocking this class of parts will provide sufficient replacement parts on hand for 70% of all possible maintenance requirements.	Disc (TD) Disc (Standard) Nozzle *Limit Washer Bellows Adj. Ring Pin Disc & Spindle Retainers Gasket (Set) (1) Cap Gasket (1) Bonnet Gasket (1) Guide Gasket (1) Adj. Ring Pin Gasket (1) Bellows Gasket	C & B C & B C & B C & B B C & B C & B C & B C & B C & B C & B C & B C & B B	1/1 1/3 1/10 1/1 1/3 1/3 1 Set/1 1/1 1/1 1/1 1/1 1/1 1/1	70%
II.  Class II parts should be stocked at the rate described in the column "Qty. Parts". Stocking Class II parts, in addition to Class I parts, will provide sufficient replacement parts on hand for 85% of all possible maintenance requirements.	Disc Holder Spindle Guide Studs, Base Nuts, Base Stud	C & B C & B C & B C & B C & B	1/6 1/6 1/6 1 Set/6 1 Set/6	85%

\*Used only in 1905, 1906/1910 & 1918 D & E Orifices, (-2) Design

### YOUR SAFETY IS OUR BUSINESS!!!

DVCD has not authorized any company or any individual to manufacture replacement parts for its valve products.

When ordering replacement valve parts, please specify in your purchase order: "ALL PARTS MUST BE DOCUMENTED AS NEW AND SOURCED FROM DRESSER INDUSTRIAL VALVE & CONTROLS DIVISION"

**XX. (Continued)**

**1900 CONVENTIONAL & 1900-30 BELLOWS WITH O-RING SEAT SEAL DESIGN (DA)  
 1900 CONVENTIONAL & 1900-30 BELLOWS WITH O-RING SEAT SEAL DESIGN AND LIQUID TRIM (DL)**

CLASS	PART NAME	C-CONVENTIONAL B-BELLOWS	QTY PARTS/ SAME VALVES IN SERVICE	NEED PROBABILITY COVERAGE
I.  Class I Parts should be stocked at the rate described in the column "Qty. Parts". Stocking this class of parts will provide sufficient replacement parts on hand for 70% of all possible maintenance requirements.	O-Ring Disc (K-T only) O-Ring Retainer Retainer Lock Screw *Limit Washer Nozzle Adj. Ring Pin Gasket (Set) (1) Cap Gasket (1) Bonnet Gasket (1) Guide Gasket (1) Adj. Ring Pin Gasket (1) Bellows Gasket Bellows Disc Retainer (K-T only) Spindle Retainer	C & B C & B C & B C & B C & B C & B C & B C & B C & B C & B C & B C & B C & B C & B B B C & B C & B	1/1 1/10 1/5 1 Set/1 1/1 1/5 1/1 1 Set/1 1/1 1/1 1/1 1/1 1/1 1/1 1/1 1/3 1/1 1/1	70%
II.  Class II parts should be stocked at the rate described in the column "Qty. Parts". Stocking Class II parts, in addition to Class I parts, will provide sufficient replacement parts on hand for 85% of all possible maintenance requirements.	Disc Holder Spindle Guide Studs, Base Nuts, Base Stud	C & B C & B C & B C & B C & B	1/6 1/6 1/6 1 Set/6 1 Set/6	85%

\*Used only in 1905, 1906/1910 & 1918 D & E Orifices, (-2) Design

**YOUR SAFETY IS OUR BUSINESS!!!**

DVCD has not authorized any company or any individual to manufacture replacement parts for its valve products.

When ordering replacement valve parts, please specify in your purchase order: "ALL PARTS MUST BE DOCUMENTED AS NEW AND SOURCED FROM DRESSER INDUSTRIAL VALVE & CONTROLS DIVISION."

## **XXI. Manufacturer's Warranty Field Service, Training & Repair Program**

### **A. Warranty Information**

\*WARRANTY STATEMENT - Dresser warrants that its products and work will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, and will be free from defects in material and workmanship.

Defective and nonconforming items must be held for Dresser's inspection and returned to the original F.O.B. point upon request.

INCORRECT SELECTION OR MISAPPLICATION OF PRODUCTS - DVCD cannot be responsible for customer's incorrect selection or misapplication of our products.

UNAUTHORIZED REPAIR WORK - DVCD has not authorized any non-Dresser affiliated repair companies, contractors or individuals to perform warranty repair service on new products or field repaired products of its manufacture. therefore, customers, contracting such repair services from unauthorized sources must do so at their own risk.

*\*Refer to Dresser's Standard Terms of Sale for complete details on warranty and limitation of remedy and liability.*

### **B. Field Service**

Utilities and Process Industries expect and demand service on a moment's notice. CONSOLIDATED® Field Service can be depended upon for prompt response, even in extreme off-hour emergency situations.

DVCD maintains the largest and most competent field service staff in the industry. Service Engineers are located at strategic points throughout the United States to respond to customer's requirements for service. Each Service Engineer is factory trained and long experienced in servicing Safety Relief Valves. DVCD Service Engineers restore disc and nozzle critical dimensions which effect valve performance, and are capable of modernizing valves in the field.

It is highly recommended that the professional talents of a DVCD Field Service Engineer be employed to make final field adjustments during the initial setting of all CONSOLIDATED® valves.

All Field Service Engineers' activities are coordinated from the Alexandria, Louisiana, Field Service Office. Upon receipt of a purchase order number authorizing the trip, the engineer is dispatched.

Contact: Field Service Dept., Field Service Supv., (318) 640-6055.

### **C. Factory Repair Facilities**

The factory at Alexandria, Louisiana, maintains a complete CONSOLIDATED repair center. The Repair Department, in conjunction with the manufacturing facilities is equipped to perform specialized repairs and product modifications, e.g. but-weld, bushing replacements, code welding, pilot replacement, etc.

Contact: Customer Service - Valve Repair, (318) 640-6047.

### **D. Safety Relief Valve Maintenance Training**

Rising costs of maintenance and repair in the Utility Process Industries indicate the need for trained maintenance personnel. Dresser Industrial Valve Operation conducts service seminars that can help your maintenance and engineering personnel to reduce these costs.

Seminars, conducted either at your site, or at our Alexandria, Louisiana manufacturing plant, provide participants with an introduction to the basics of preventative maintenance necessary to minimize downtime, reduce unplanned repairs and increase valve safety. While these seminars do not make "instant" experts, they do provide the participants with "hands on" experience with CONSOLIDATED® valves. The seminar also includes valve terminology and nomenclature, component inspection, trouble shooting, setting and testing, with emphasis on the ASME Boiler and Pressure Vessel Code.

**For further information, please contact the Product Training Manager by fax at (318) 640-6041, or telephone (318) 640-6054.**



# **The Self Study Edition of the 1900 and 1900-30 Safety Relief Valve Maintenance Training Program is available for valve shop personnel.**

The Self Study program consists of a Video Tape that is integrated with a participant work book. A participant begins with an introduction to the product and progresses through the various stages of disassembly, cleaning, maintenance repair, reassembly, setting, testing, installation and conversions. The Program can also be used as an instructor led course. The training package includes:

- five Participant Training Manuals.
- five Consolidated® 1900 and 1900-30 Safety Relief Valve Installation, Operation and Maintenance Manuals.
- an integral 1900 SRV video tape.
- a Coaches' Guide to facilitate learning.

Program Kits, as well as additional Training and Maintenance manuals are available through:

Training Department Manager  
Global Aftermarket Group  
Dresser Valve and Controls Division  
PO Box 1430  
Alexandria, LA 71309-1430

Telephone: (318) 640-6054  
Telefax: (318) 640-6041

## Appendix Re:

### Optional Glide-Alloy™ Parts and the Repair Processing of Such Components

Glide-Alloy is a proprietary process of DVCD which is utilized to provide a combination of low coefficient of friction between sliding components and to protect the surfaces of the components to which the process has been applied. A Glide-Alloy™ surface hardened valve component may be readily recognized by its flat, dull gray color and slick surface. The parent metal should not be visible on a new and unused component.

#### NOTE:

**Do not attempt to remove the coating of a Glide-Alloy™ treated component.**

The Glide-Alloy™ reaction bonding process is commonly applied to Consolidated® Type 1900 Safety Relief Valve disc holders and/or guides, when specified. Although the entire surface area of the component is treated, **only** the guiding surface is critical. When Consolidated® Type 1900 valves contain Glide-Alloy™ parts, they may be identified by the coding found on the valve nameplate.

Example: 1905Jc-2-G1  
where the "G" designation indicates  
Glide-Alloy™  
"G1" - Glide-Alloy™ Holder  
"G2" - Glide-Alloy™ Guide  
"G3" - Glide-Alloy™ Holder and Guide

Glide-Alloy™ treated components may be cleaned by low pressure compressed air, microbead blasting, or by brushing. Also, a non-chlorinated hydrocarbon shop solvent may be used. The latter is for personnel safety reasons and **not** because of any incompatibility between chlorides and Glide-Alloy™.

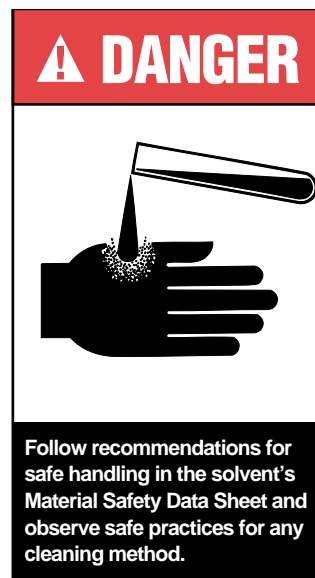
With regard to personnel safety, all personnel should be familiar with the appropriate processes as well as the material safety data sheets supplied by the vendor of any cleaning compounds. Protective gloves, goggles, etc. should be worn so as to avoid contact with materials that may be splashed during the cleaning process.

For a component which has been in service, after the cleaning process has been completed, parts may be visually inspected to ensure that all debris has been removed, and that the components have the required finish. DVCD's experience indicates that if the components have been properly cleaned, adequate coating will remain to ensure proper operation. The coating may appear to be lighter, or even missing, in some areas, but the desired results will be achieved as a result of the coating characteristics which were imparted to the parent metal during the original coating process.

#### NOTE:

**Do not machine guiding surfaces which have been Glide-Alloy™ treated.**

Components which are deeply gouged or galled, and which do not meet dimensional requirements, cannot be cleaned and returned to service. Machining will remove the coating and render the parts unacceptable. The surface hardness approximates that for diamonds, and is only approximately 0.002" thick.



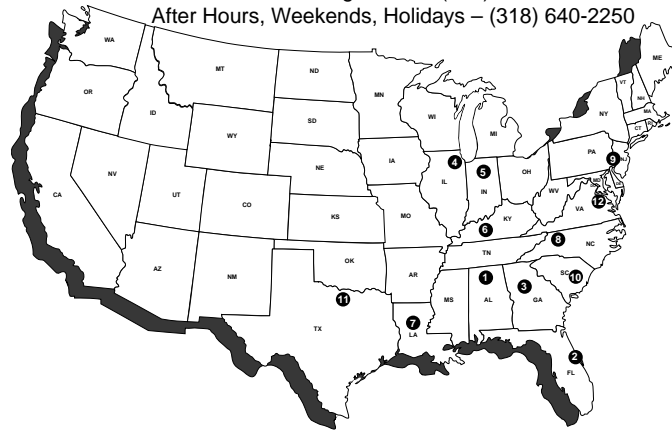
**For more detailed instructions, consult the appropriate Dresser manual.**

## Location of Service Engineers

ALABAMA, Huntsville .....	1
FLORIDA, Jacksonville .....	2
GEORGIA, Cartersville .....	3
ILLINOIS, Chicago .....	4
INDIANA, Crawfordsville .....	5
KENTUCKY, Maysville .....	6
LOUISIANA, Alexandria .....	7
NORTH CAROLINA, Winston-Salem .....	8
PENNSYLVANIA, Philadelphia .....	9
SOUTH CAROLINA, Charleston .....	10
TEXAS, Dallas .....	11
VIRGINIA, Richmond .....	12

### THE DRESSER FIELD SERVICE ORGANIZATION IS UNEQUALED

For prompt field service, please call  
 Dresser Industrial Valve Operations Service Department, Alexandria, Louisiana.  
 Normal Working Hours – (318) 640-6066  
 After Hours, Weekends, Holidays – (318) 640-2250



## Sales Office Locations

### UNITED STATES

Dresser Industries, Inc.  
 Dresser Valve & Controls Division  
 Industrial Valve Operation  
 La. Highway 3225 at U.S. Hwy. 167 North  
 P.O. Box 1430, Alexandria, Louisiana 71309-1430  
 Telephone (\*) 1-318-640-2250, Telex 586423  
 Fax (\*) 1-318-640-6222

Dresser Industries, Inc.  
 Dresser Valve & Controls Division  
 Masonellan North American Operations  
 85 Bodwell Street  
 Avon, Massachusetts 02322  
 Telephone: (\*) 1-508-586-4600  
 Fax: (\*) 1-508-941-5480

### Eastern Region

85 Bodwell Street, Avon  
 Massachusetts 02322  
 Telephone: (\*) 1-508-941-5407  
 Fax: (\*) 1-508-427-8959

### Northern Region

3201 North Wolf Road  
 Franklin Park, Illinois 60131  
 Telephone (\*) 1-847-451-3913  
 Fax (\*) 1-847-451-3997

### Southern Region

15112 Morales Road (77032)  
 P.O. Box 60078, Houston, Texas 77205-0078  
 Telephone (\*) 1-713-986-6600  
 Fax (\*) 1-713-986-6608

### Western Region

1040 South Vail Avenue  
 Montebello, California 90640  
 Telephone (\*) 1-213-722-6731  
 Fax (\*) 1-213-721-9113

### Latin American Region

10556 N.W. 26th Street, Suite D-201  
 Miami, Florida 33172  
 Telephone (\*) 1-305-470-2766  
 Fax (\*) 1-305-470-2743

### CANADA

Dresser Canada, Inc., Valve & Controls Division  
 5010 North Service Road  
 Burlington, Ontario, L7L 5R5 Canada  
 Telephone (\*) 1-905-335-3529  
 Fax (\*) 1-905-336-7628

Dresser Canada, Inc., Valve & Controls Division  
 3530 78th Avenue  
 Edmonton, Alberta, Canada, T6B 2X9  
 Telephone (\*) 403-465-7882  
 Fax (\*) 403-468-0934

### CHINA

Dresser Valve & Controls China  
 Room 1907, Capital Mansion  
 Xi Yuan Nan Road, Chao Yang District  
 Beijing, China 10004  
 Telephone (\*) 86-10-466-7189  
 Fax (\*) 86-10-466-7190

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(\*) The appropriate International Access Code will need to precede the telephone/fax number if you are placing a call to a location outside of your country.



## Dresser Industries, Inc.

Industrial Valve Operation  
 Alexandria, Louisiana 71309-1430 (USA)

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 Dresser Industries, Inc. ©Dresser Industries, Inc.  
 10M – 4/96 CON-2

# Consolidated<sup>®</sup>

INSTALLATION, OPERATION  
AND MAINTENANCE MANUAL

## Consolidated<sup>®</sup> Safety Relief Valve Series 19000



Dresser Equipment Group, Inc.  
Alexandria, Louisiana 71309-1430

Series Types  
Including The  
Following Design  
Options:

O-Ring Seat  
Seal (DA)

CON-16  
2/99

1.

**DANGER** — Immediate hazards which **WILL** result in severe personal injury or death.

2.

**WARNING** — Hazards or unsafe practices which **COULD** result in severe personal injury or death.

3.

**CAUTION** — Hazards or unsafe practices which **COULD** result in minor personal injury.

4.

**ATTENTION** — Hazards or unsafe practices which **COULD** result in product or property damage.

## Product Safety Sign and Label System

If and when required, appropriate safety labels have been included in the rectangular margin blocks throughout this manual. Safety labels are vertically oriented rectangles as shown in the *representative examples* (below), consisting of three panels encircled by a narrow border. The panels can contain four messages which communicate:

- The level of hazard seriousness.
- The nature of the hazard.
- The consequence of human or product interaction with the hazard.
- The instructions, if necessary, on how to avoid the hazard.

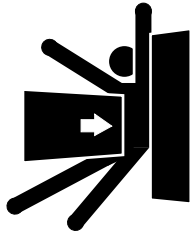
The top panel of the format contains a signal word (DANGER, WARNING, CAUTION or ATTENTION) which communicates the level of hazard seriousness.

The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of human or product interaction with the hazard. In some instances of human hazards the pictorial may, instead, depict what preventive measures to take, such as wearing protective equipment.

The bottom panel may contain an instruction message on how to avoid the hazard. In the case of human hazard, this message may also contain a more precise definition of the hazard, and the consequences of human interaction with the hazard, then can be communicated by the pictorial.

1


**▲ DANGER**



Do not remove bolts if pressure in line, as this will result in severe personal injury or death.

2


**▲ WARNING**



Know all valve exhaust/leakage points to avoid possible severe personal injury or death.

3

**▲ CAUTION**



Wear necessary protective equipment to prevent possible injury.

4

**▲ ATTENTION**



Do not drop or strike valve.

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## I. Safety Notice

*Proper installation, operation and maintenance is essential to the safe and reliable operation of all valve products. The relevant procedures recommended by Dresser Valve and Controls Division (DVCD), and described in this manual, are effective methods of performing the required tasks. Some of these procedures require the use of tools specifically designed for an intended purpose. These special tools should be used when, and as, recommended.*

*It is important to note that this manual contains various "safety messages" which should be carefully read in order to minimize the risk of personal injury, or the possibility that improper procedures will be followed which may damage the involved DVCD product, or render it unsafe. It is also important to understand that these "safety messages" are not exhaustive. DVCD can not possibly know, evaluate, and advise any customer of all of the conceivable ways in which tasks might be performed, or of the possible hazardous consequences of each way. Consequently, DVCD has not undertaken any such broad evaluation and, thus, anyone who uses a procedure and/or tool, which is not recommended by DVCD, or deviates from DVCD recommendations, must be thoroughly satisfied that neither personal safety, nor valve safety, will be jeopardized by the method and/or tools selected. If not so satisfied, contact DVCD (at 318/640-2250) if there are any questions relative to tools/methods. Some of the products manufactured by DVCD may be used in radioactive environments. Consequently, prior to starting any operation in a radioactive environment, the proper "health physics" procedures should be consulted and followed, if applicable.*


**⚠ WARNING**



**RADIATION AREA  
KEEP OUT**  
RWP REQUIRED FOR  
ENTRY.

**Know nuclear "health physics" procedures, if applicable, to avoid possible severe injury or death.**

**⚠ CAUTION**



**Wear necessary protective equipment to prevent possible injury.**

*The installation, operation and maintenance of valves and/or valve products may involve proximity to fluids at extremely high pressure and/or temperature. Consequently, every precaution should be taken to prevent injury to personnel during the performance of any procedure. These precautions should consist of, but are not limited to, ear drum protection, eye protection, and the use of protective clothing. (i.e., gloves, etc.) when personnel are in or around a valve work area. Due to the various circumstances and conditions in which these operations may be performed on DVCD products, and the possible hazardous consequences of each way, DVCD can not possibly evaluate all conditions that might injure personnel or equipment. Nevertheless, DVCD does offer the safety precautions listed on page 3 for customer information only.*

*It is the responsibility of the purchaser or user of DVCD valves/equipment to adequately train all personnel who will be working with the involved valves/equipment. Further, prior to working with the involved valves/equipment, personnel who are to perform such work should become thoroughly familiar with the contents of this manual. Accordingly, should additional copies of this manual be required, they can be purchased, at a minimal cost, by contacting DVCD (in writing) at P.O. Box 1430, Alexandria, LA 71309-1430, or (telephonically) at 318/640-2250.*



## II. Safety Precautions

Follow all plant safety regulations, but be sure to observe the following:

- Do not stand in front of the discharge side of a safety relief valve when testing or operating.
- Hearing protection should be used when testing or operating a valve.
- Exercise care when examining a safety relief valve for visible leakage.
- Never install a safety relief valve in a horizontal position. Safety relief valve internals are designed to move vertically. When installed horizontally, misalignment and galling, or hang-up, may prevent the valve from opening or closing properly.
- Safety relief valves should be mounted to provide adequate access, 360° around the valve plus overhead, to permit removal for testing and maintenance.
- When removing a safety relief valve for disassembly, stand clear and/or wear protective clothing to prevent exposure to splatter of any corrosive process medium which may have been trapped inside the valve. Ensure the valve is isolated from system pressure before the valve is removed.
- When a valve is equipped with a lifting lever, the lever should be positioned to avoid unintentional contact with other equipment, or with personnel, which might cause the valve to lift accidentally.
- All valves require periodic inspection and tests by qualified persons to insure that the valves are in proper working condition, and will function as designed by DVD.
- The owner/operator of the valves must be aware of usage conditions, and must bear the responsibility for determining the appropriate frequency of examination of the valves.

### Warranty Information

#### 1. \*Warranty Statement

Dresser warrants that its products and work will meet all applicable specifications and other specific product and work requirements (including those of performance), if any, and will be free from defects in material and workmanship.

Defective and nonconforming items must be held for Dresser's inspection and returned to the original F.O.B. point upon request.

#### 2. Incorrect Selection or Misapplication of Products

D.V.D. cannot be responsible for customer's incorrect selection or misapplication of our products.

#### 3. Unauthorized Repair Work

D.V.D. has authorized no non-Dresser affiliated repair companies, contractors nor individuals to perform warranty repair services on new products of field repaired products of its manufacture. Therefore, customers contracting such repair service from unauthorized sources must do so at their own risk.

#### 4. Unauthorized Removal of Seals

All new valves and valves repaired in the field by Dresser Field Service are sealed to assure the customer of our guarantee against defective workmanship. Unauthorized removal and/or breakage of this seal will negate our warranty.

\* Refer to Dresser's Standard Terms of Sale for complete details on warranty and limitation of remedy and liability. Telephone (318)640-2250





### **III. Introduction**

The Consolidated® Series 19000 portable pressure relief valves are designed to meet ASME Section VIII requirements for fixed blowdown pressure relief valves and liquid relief valves. They may be used for various media such as air, liquids, process steam and hydrocarbons, and may serve as either a safety valve or a relief valve, depending upon the application.

### **IV. Terminology for Safety Relief Valves**

- **Accumulation**  
Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percentage of that pressure, or actual pressure units.
- **Back Pressure**  
Back pressure is the pressure on the discharge side of a safety relief valve. (Also see “Built-Up Back Pressure” and “Superimposed Back Pressure”, below.)
- **Blowdown**  
Blowdown is the difference between set pressure and reseating pressure of a pressure relief valve, expressed as a percentage of the set pressure, or actual pressure units.
- **Built-up Back Pressure**  
Built-up back pressure is pressure which develops at the valve outlet as a result of flow, after the safety relief valve has been opened.
- **Chatter**  
Chatter is the abnormal, rapid reciprocating motion of the movable parts of a valve in which the disc contacts the seat.
- **Closing Pressure**  
Closing pressure is the point at which the valve recloses.
- **Cold Differential Set Pressure**  
Cold differential set pressure is the pressure at which the valve is adjusted to open on the test stand. This pressure includes the corrections for back pressure and/or temperature service conditions.
- **Differential Between Operating and Set Pressures**  
Valves in process service will generally give best results if the operating pressure does not exceed 90% of the set pressure. However, on pump and compressor discharge lines, the differential required between the operating and set pressures may be greater because of pressure pulsations coming from a reciprocating piston. It is recommended that the valve be set as high above the operating pressure as possible.

---

## IV. (Continued)

- **Flutter**  
Flutter is the abnormal, rapid reciprocating motion of the movable parts of a valve in which the disc does not contact the seat.
- **Lift**  
Lift is the actual travel of the disc away from the closed position when a valve is relieving.
- **Maximum Allowable Working Pressure**  
Maximum allowable working pressure is the maximum gauge pressure permissible in a vessel at a designated temperature. A vessel may not be operated above this pressure, or its equivalent, at any metal temperature other than that used in its design. Consequently, for that metal temperature, it is the highest pressure at which the primary safety relief valve is set to open.
- **Operating Pressure**  
The operating pressure is the gauge pressure to which the vessel is normally subjected in service.
- **Overpressure**  
Overpressure is a pressure increase over the set pressure of the primary relieving device. Overpressure is similar to accumulation when the relieving device is set at the maximum allowable working pressure of the vessel. Normally, overpressure is expressed as a percentage of set pressure.
- **Rated Capacity**  
Rated capacity is the percentage of measured flow at an authorized percent overpressure permitted by the applicable code. Rated capacity is generally expressed in pounds per hour (lb/hr) for vapors; standard cubic feet per minute (SCFM) or m<sup>3</sup>/min for gases; and in gallons per minute (GPM) for liquids.
- **Relief Valve**  
A relief valve is an automatic pressure-relieving device, actuated by static pressure upstream from the valve. This type of valve is used primarily for liquid service.
- **Safety Relief Valve**  
A safety relief valve is an automatic pressure-relieving device which may be used as either a safety or relief valve, depending upon application.
- **Safety Valve**  
A safety valve is an automatic pressure-relieving device actuated by the static pressure upstream of the valve, and characterized by rapid opening or pop action. This type of valve is used for steam, gas or vapor service.
- **Seat Tightness Pressure**  
Seat tightness pressure is the specified inlet static pressure at which a quantitative seat leakage test is performed in accordance with a standard procedure.

---

## **IV. (Continued)**

- **Set Pressure**  
Set pressure is the gauge pressure at the valve inlet, for which the safety relief valve has been adjusted to open under service conditions. In liquid service, set pressure is determined by the inlet pressure at which the valve starts to discharge. In gas or vapor service, the set pressure is determined by the inlet pressure at which the valve pops.
- **Simmer**  
Simmer is characterized by the audible passage of a gas or vapor across the seating surfaces just prior to "pop". The difference between this "start to open pressure" and the set pressure is simmer, and is generally expressed as a percentage of set pressure.
- **Superimposed Back Pressure**  
Superimposed back pressure is the pressure in the discharge header before the safety relief valve opens. This can be further defined as follows:  
**Constant Superimposed** - This type of back pressure remains essentially at a fixed value (constant) and exists (superimposed) continuously prior to and during opening of the valve. (e.g., 20 psig/1.38 bar).  
**Variable Superimposed** - This type of back pressure varies or changes over a range from a minimum to a maximum, or vice versa. (e.g., 0 to 20 psig/1.38 bar). The actual back pressure at any specific time depends on conditions in the piping system to which the outlet of the valve is connected.
- **Valve Trim**  
Valve trim includes the nozzle and disc.

## **V. Design Features and Nomenclature**

### **A. Design Features**

#### **1. General Information**

The Series 19000 portable safety relief valve has 316 stainless steel trim as standard material. Reliable performance and easy maintenance procedures are characteristics of this valve, when properly installed in suitable applications for its design.

The 19000 Series SRV has three pressure classes, 19000L 5-290 psig, 19000M 291-2000 psig, and 19000H 2001 and up. Standard 19000 parts are used for both liquid applications and gas applications. It is designed for short blowdown on all medias, typically less than 10%.

---

## V.A. (Continued)

All 19000 Series safety relief valves have fixed blowdown. This means that the parts are designed so that there is no blowdown adjustment required when setting or testing the valve.

### 2. Design Options

#### a. O-ring seat seal valves

All 19000 Series Valves are available with an O-ring seat seal, as a design option. This optional design provides a bubble tightness in excess of 97% of the valve set pressure, in order to meet application requirements beyond the normal capabilities of metal to metal seat valves. Consolidated® Series 19000 Valves with the O-ring seat seal option are identified by the suffix DA (e.g., 1-19096L-DA).

#### b. Lifting Levers, Caps and Gags

All 19000 Series Valves are designed so that field conversion from the standard screwed cap to a plain lifting lever cap, or to a packed lifting lever cap (or vice versa) does not require valve disassembly or resetting. The lifting lever option is designed to open the valve at 75% of the valve set pressure, in compliance with ASME Code Section VIII. Further, all available 19000 Series Valve caps may be equipped with a gag, upon customer request.

#### c. Inlet/Outlet Connections

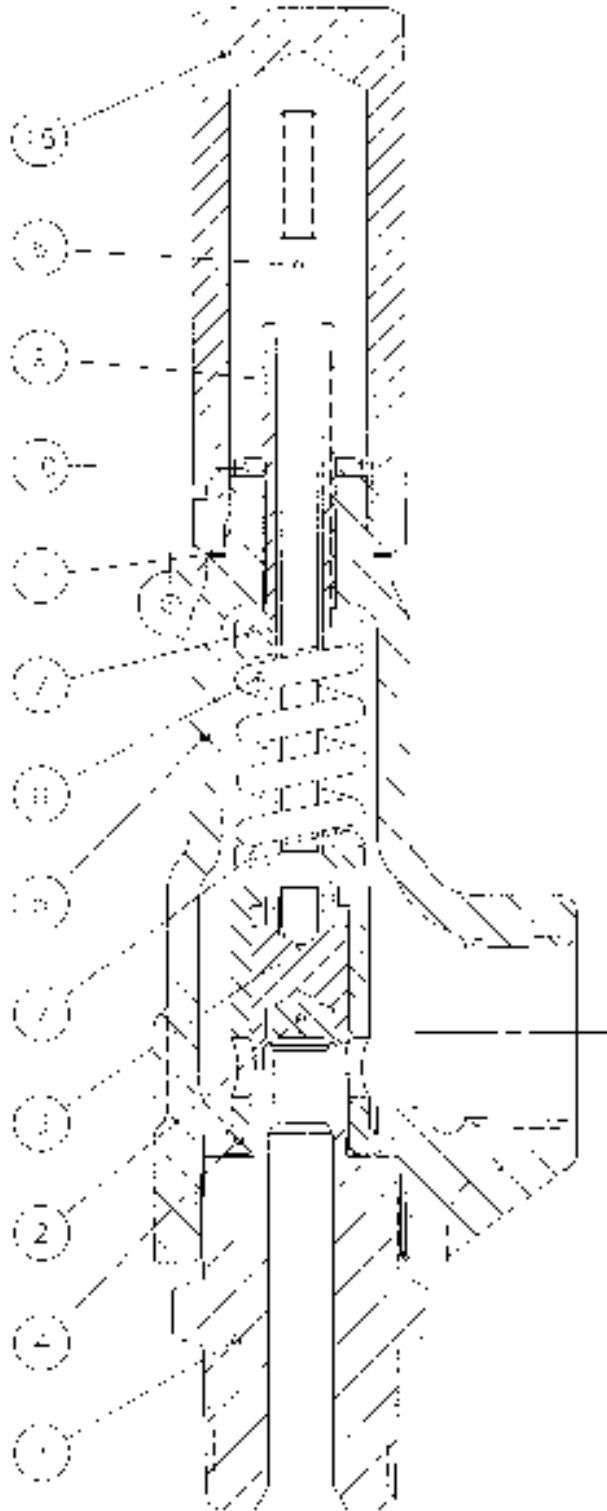
All 19000 Series Valves can be provided by DVD with flanged, or socket weld inlet and outlet connections, upon customer request.

## B. Nomenclature

Applicable valve nomenclature for Types 19000 Male and Female inlet configurations are illustrated in figures 1 through 3. Relevant parts nomenclature for optional lifting levers, caps, and the gag, as applicable, is provided in Figures 4 through 7.

**V.B. (Continued)**

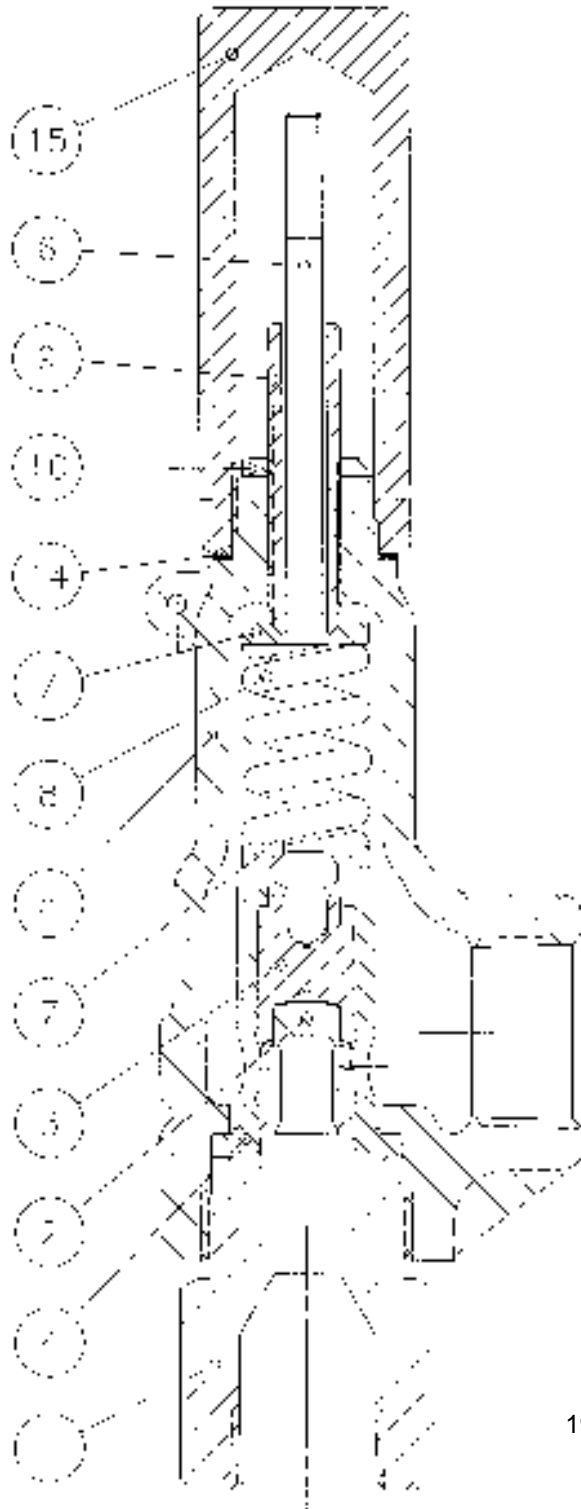
Part No.	Nomenclature
1	Base
2	Disc
3	Disc Holder
4	Guide
5	Bonnet
6	Spindle
7	Spring Washers
8	Spring
9	Adjusting Screw
10	Adjusting Screw Lock-nut
14	Cap Gasket
15	Screwed Cap



Metal Seat (MS) Valves  
 19096L, 19126L, 19226L  
 19096M, 19126M, 19226M

**FIGURE 1**

V.B. (Continued)

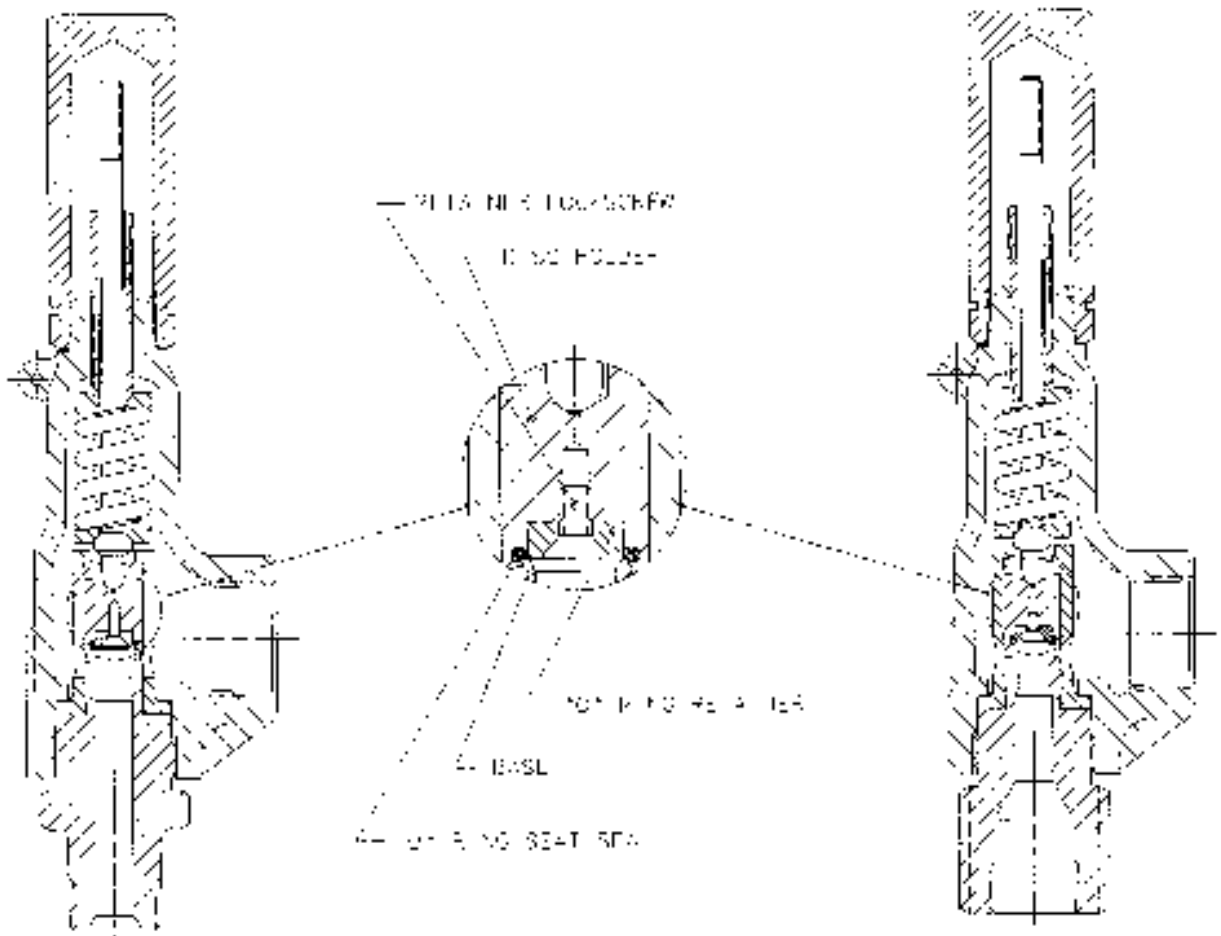


Part No.	Nomenclature
1	Base
2	Disc
3	Disc Holder
4	Guide
5	Bonnet
6	Spindle
7	Spring Washers
8	Spring
9	Adjusting Screw
10	Adjusting Screw Lock-nut
14	Cap Gasket
15	Screwed Cap

Metal Seat (MS) Valves  
 19096L, 19126L, 19226L, 19357L, 19567L  
 19096M, 19126M, 19226M, 19357M, 19567M  
 19096H, 19126H, 19226H

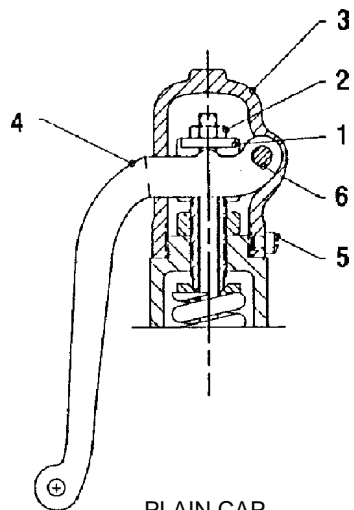
**FIGURE 2**

V.B. (Continued)

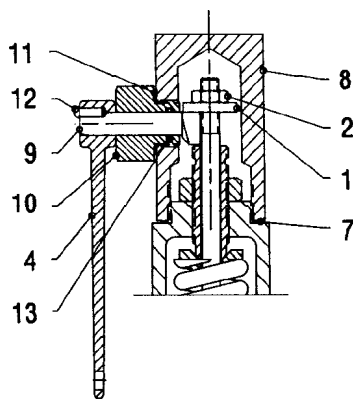


O Ring Soft Seat (DA) Valves  
TYPES 19000-DA  
**FIGURE 3**

V.B. (Continued)

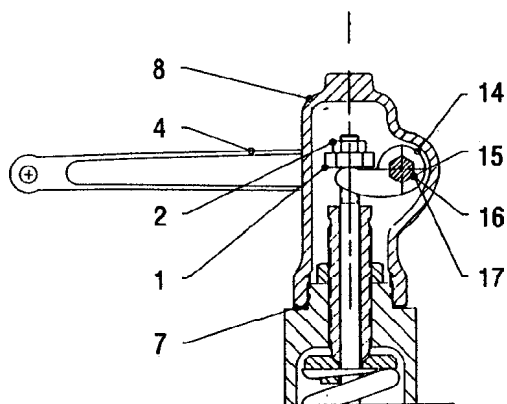


PLAIN CAP  
WITH LIFTING LEVER FOR  
ALL SERIES 19000 VALVES  
**FIGURE 4**

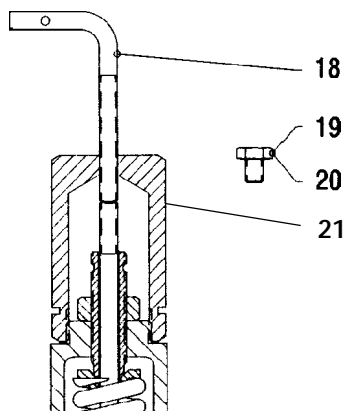


PACKED CAP  
WITH LIFTING LEVER FOR TYPES  
19096L, 19096M, 19096H,  
19126L, 19126M, 19226L, 19226M  
**FIGURE 5**

Part No.	Nomenclature
1	Release Nut
2	Release Locknut
3	Plain Cap
4	Lifting Lever
5	Cap Screw
6	Lever pin
7	Cap Gasket
8	Packed Cap
9	Cam Shaft
10	Bushing
11	Bushing Gasket
12	Drive Pin
13	O-ring
14	Lifting Fork
15	Lifting Shaft
16	Packing
17	Packing Nut
18	Gag Bolt
19	Sealing Plug
20	Sealing Plug Gasket
21	Standard Screwed Cap



PACKED CAP WITH LIFTING  
LEVER FOR TYPES 19126H,  
19226H, 19357L, 19357M,  
19567L, 19567M  
**FIGURE 6**



TYPICAL  
CAP WITH GAG  
**FIGURE 7**

\* Both the standard screwed cap and the optional caps can be provided with a gag, if required.





## VI. *Handling, Storage and Pre-Installation*

### A. **Handling**

Safety relief valves, either crated or uncrated, should never be subjected to sharp impact. This would be most likely to occur by bumping or dropping during loading or unloading from a truck. While hoisting to the installation, care should be taken to prevent bumping the valve against steel structures and other objects.

#### **NOTE:**

**Never lift the full weight of the valve by the lifting lever (if the valve is so equipped).**

### B. **Storage**

Safety relief valves should be stored in a dry environment to protect them from the weather. They should not be removed from the crates until immediately prior to installation.

Protectors and sealing plugs (both inlet and outlet) should not be removed until the valve is ready to be installed.

### C. **Pre-installation**

When safety relief valves are uncrated, and the protectors or sealing plugs have been removed (immediately prior to installation), meticulous care should be exercised to prevent dirt and other foreign materials from entering the inlet and outlet ports.

## VII. Recommended Installation Practices

### A. Mounting Position

Safety relief valves should be mounted in only a vertical upright position (per API RP520). Installing a safety relief valve in other than a vertical position ( $\pm 1$  degree) will adversely affect its operation in varying degrees, as a result of induced misalignment of moving parts.

A stop valve may be placed between the pressure vessel and its relief valve only as permitted by code regulations. If a stop valve is located between the pressure vessel and safety relief valve, the stop valve port area should equal or exceed the nominal internal area associated with the pipe size of the safety relief valve inlet. The pressure drop from the vessel to the safety relief valve shall not exceed 3% of the valve's set pressure, when flowing at full capacity.

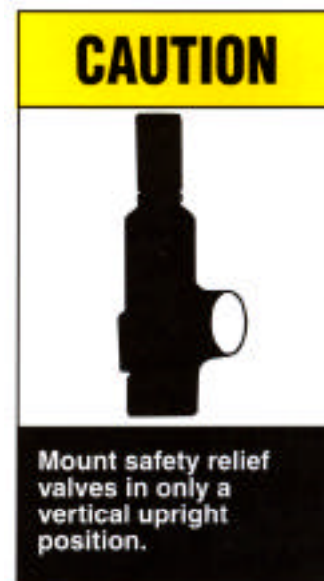
The inlet and outlet ports, and sealing faces, of the valve and all connecting piping must be free from dirt, sediment and scale.

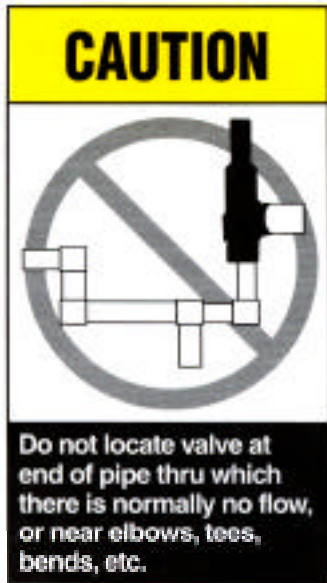
Safety relief valves should be located for easy access and/or removal so that servicing can be properly performed. Sufficient working space should be provided around, and above, the valve.

### B. Inlet Piping

The inlet piping (see Figure 8), to the valve should be short and direct from the vessel, or equipment, being protected. The connection to the vessel should be provided with a radius to permit smooth flow to the valve. Sharp corners should be avoided. If this is not practical, then the inlet should be bored at least one additional pipe diameter. In any event, the pressure drop from the vessel to the valve should not exceed 3% of valve set pressure when the valve is flowing full capacity. In no event should the inlet piping be smaller in diameter than the inlet connection of the valve. Excessive pressure loss at the inlet of a pressure relief valve in gas, vapor, or flashing-liquid service will cause extremely rapid opening and closing of the valve, which is known as "chattering". Chattering will result in lowered capacity and damage to the seating surfaces. The most desirable installation is that in which the nominal size of the inlet piping is the same as, or greater than, the nominal size of the valve inlet, and in which the length does not exceed the face-to-face dimensions of a standard tee of the required pressure class.

Safety relief valve inlets should not be located at the end of a long horizontal pipe through which there is normally no flow. Foreign matter may accumulate, or liquid may be trapped, and may interfere with the operation of the valve, or be the cause of more frequent valve maintenance.

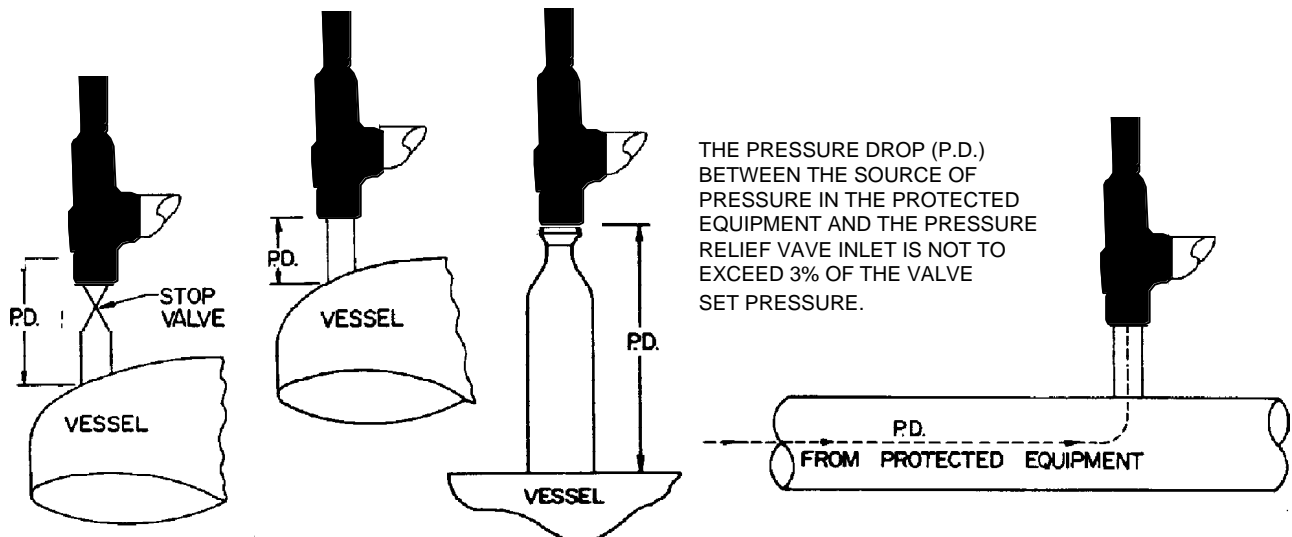




**VII.B. (Continued)**

Safety relief valve inlets should not be located where excessive turbulence is present such as near elbows, tees, bends, orifice plates, or throttling valves.

Section VIII of the ASME Boiler and Pressure Vessel Code requires that the design of the inlet connection consider stress conditions included by reaction forces during valve operation, by external loading, by vibration and by loads due to thermal expansion of discharge piping.



**FIGURE 8**

1. The determination of reaction forces during valve discharge is the responsibility of the vessel and/or piping designer. DVD publishes certain technical information about reaction forces under various fluid flow conditions, but assumes no liability for the calculations and design of the inlet piping.
2. External loading by poorly designed discharge piping and support systems can be the cause of excessive stresses and distortions in the valve as well as the inlet piping. The stresses set up in the valve may cause malfunctioning or leakage of the valve. Forced alignment of the discharge piping will also induce such stresses. Discharge piping should be independently supported and carefully aligned.

## VII.B. (Continued)

3. Vibrations in the inlet piping systems may cause valve seat leakage and/or fatigue failure of the piping. These vibrations may cause the disc seat to slide back and forth across the nozzle seat and result in damage to the seating surfaces. Vibration may also cause separation of the seating surfaces and premature wear to certain valve parts. High-frequency vibrations are more detrimental to pressure relief valve tightness than low-frequency movements. This effect can be minimized by providing a larger difference between the operating pressure of the system and the set pressure of the valve, particularly under high-frequency conditions.
4. Temperature changes in the discharge piping may be caused by fluid flowing from the discharge of the valve, prolonged exposure to the sun, or heat radiated from nearby equipment. Any change in temperature of the discharge piping will cause a change in the length of the piping. The resulting change in length may cause stresses which will be transmitted to the pressure relief valve and its inlet piping. Stresses caused by thermal changes in the discharge piping can be avoided by proper support, anchoring, or provision for flexibility of the discharge piping. **Fixed supports should not be used.**

## C. Outlet Piping

Alignment of the internal parts of a safety relief valve is important to ensure proper operation (see Figure 9). Although the valve body will withstand a considerable mechanical load, unsupported discharge piping consisting of more than a companion flange, long radius elbow and a short vertical pipe is not recommended. Care should be taken to ensure thermal expansion of piping and support system does not produce strains in a valve. Spring supports are recommended where this may be the case. The discharge piping should be designed to allow for vessel expansion as well as expansion of the discharge pipe itself. This is particularly important on long distance lines.

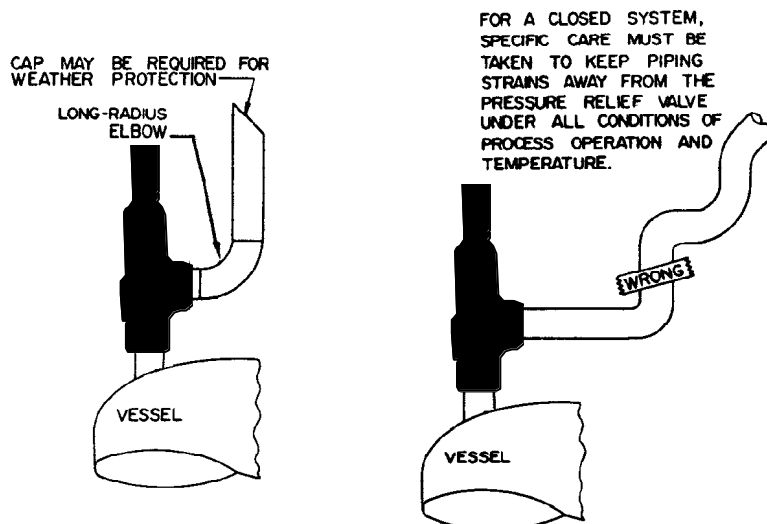


FIGURE 9



### VII.C. (Continued)

Consideration should be given to discharge pipe movement resulting from wind loads, since a continual oscillation of the discharge piping introduces stress distortion in the valve body, and the resultant movement of the internal parts may cause leakage.

As a final point, the discharge piping size is never less than the size of the valve outlet, it shall not be heavier than schedule 40 pipe size, and the discharge piping must be designed to limit the total backpressure to a maximum of 10% of the valve set pressure, or 400 psi, whichever is smaller.

### VIII. Disassembly Instructions

#### A. General Information

Consolidated® Safety Relief Valves can be easily disassembled for inspection, reconditioning seats, or replacing internal parts. Appropriate set pressure can be established after reassembly. (Refer to Figure 1 thru Figure 7 for Parts Nomenclature.)

#### NOTES:

- Before starting to disassemble the valve, be sure that there is no media pressure in the vessel.
- Many pressure vessels that are protected by Consolidated® Safety Relief Valves contain dangerous materials. Decontaminate and clean the valve inlet and outlet and all external surfaces in accordance with the cleaning and decontaminating recommendations in the appropriate Material Safety Data Sheet.
- Parts from one valve should not be interchanged with parts from another valve.

#### B. Metal Seat Valves

1. Remove the cap (including lifting gear, if any); then, remove the cap gasket.
2. Loosen the adjusting screw locknut.
3. Measure the position of the valve compression screw before removal. Measure from the top of the screw to the machined top surface of the bonnet.
4. Unscrew the bonnet from the base.
5. Remove the spindle, spring, and spring washers.
6. Remove the guide, disc holder, and disc from the base.

## VIII. (Continued)

### C. O-Ring Seat Seal Valves (DA)

1. Remove the cap (including lifting gear, if any); then, remove the cap gasket.
2. Loosen adjusting screw locknut.
3. Remove the adjusting screw. Count, and record, the number of turns necessary to barely remove all spring compression. (Removal of the spring compression is indicated when the spindle stops rotating.)
4. Unscrew the bonnet from the base.
5. Remove the spindle, spring, and spring washers.
6. Remove the guide and O-ring disc holder assembly from the base.
7. Remove the lock screw and the O-ring retainer.
8. Carefully remove the O-ring. Be sure not to damage the O-ring groove in the disc holder.

## IX. Cleaning

19000 Series Safety Relief Valve internal parts may be cleaned with industrial solvents, cleaning solutions and wire brushes. If you are using cleaning solvents, take precautions to protect yourself from potential danger from breathing fumes, chemical burns, or explosion. See the solvent's Material Safety Data Sheet for safe handling recommendations and equipment. It is not recommended to "sand blast" internal parts as it can reduce the dimensions of the parts. The base, bonnet and cap castings may be sand blasted with care not to erode internal surfaces, or damage machined surfaces.

## X. Parts Inspection

### A. BASE –

The Base should be replaced if:

1. Seat Surface
  - a. Metal Seated-Seat surface "N" (see Figure 12), is scratched, nicked, corroded, leaks or is too wide and can not be machined(see Table).
  - b. "O" ring Seat surface "N" (see insert, Figure 12), is scratched, nicked, corroded, or leaks.
2. Threads (all) are torn, stripped or galled.



---

**X. (CONTINUED)**

3. Guide seating surface "U" is scratched, nicked, corroded, or dimension "L" is less than "L" minimum, (see Figure 12 and Table II).

**B. METAL SEAT DISC -**

The Metal Seat Disc should be replaced if:

1. Seat surface "Y" (see figure 13), is damaged beyond lapping or machining limits.
2. Seat relief height R is less than R minimum. (see Table III).
3. Length S is less than S minimum (see table III).

**C. "O" RING SEAT SEAL ASSEMBLY -**

The "O" ring Seal Assembly parts should be replaced as follows:

1. "O" ring Seat Seal- always replace.
2. "O"ring retainer
  - a. Lapped seat relief height R is less than R minimum (see table III).
  - b. Length S is less than S minimum (see Table III).
  - c. Retainer Lock Screw - Always replace.

**D. BONNET -**

The bonnet should be replaced if:

1. Threads are stripped, torn, or galled.
2. The guide seating surface is scratched, nicked, corroded or leaks.
3. Condition is porous, corroded, or distorted.

**E. METAL SEAT DISC HOLDER -**

The disc holder should be replaced if:

1. The outside surface is worn, egged, or galled.
2. The spindle pocket bearing surface is galled or pitted.
3. The disc seating surface "Y" is galled or pitted. (See Figure 15).

**F. "O" RING DISC HOLDER -**

The "O" ring Disc Holder should be replaced if :

1. The outside surface is worn, egged or galled. (See Figure 15).
2. The spindle pocket bearing surface is galled or pitted.
3. The "O" ring groove is nicked, scratched or pitted.
4. The "O" ring retainer screw threads torn, stripped or galled.

**G. GUIDE -**

Replace the Guide if :

1. The inside surface is worn, egged or galled.
2. Base and bonnet seating surfaces are scratched, nicked, corroded or leaks.
3. Hole dimension K is out of tolerance. (See Figure 16

- 
- and Table V ).
  4. Guide Height Dimension "L" is out of tolerance. (See Figure 16 and Table V).

#### H. **SPINDLE -**

Replace the Spindle if :

1. The bearing surfaces are galled, pitted, scratched.
2. Threads are torn, stripped, or galled.
3. The stem is bent.(See Figure 14).

#### I. **SPRING -**

Replace the spring if:

1. The ends are not ground flat and parallel.
2. The coils are bent, pitted or unevenly spaced.

Note: Portable valve springs do not have sufficient wire diameter to allow permanent spring marking.

#### J. **Spring Washers -**

Replace the Spring Washers if:

1. The bearing surface is galled, pitted or scratched.
2. Corrosion affects the centering of the spring.

#### K. **COMPRESSION SCREW -**

Replace Compression Screw if:

1. Threads are torn, stripped, or galled.
2. The bearing surfaces are galled, pitted or scratched.

## **XI. MAINTENANCE INSTRUCTIONS**

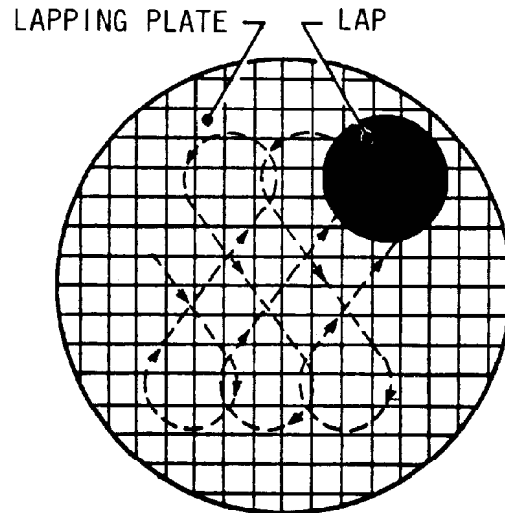
### **A. *Metal Seat Valves (MS)***

#### **1. Precautions and Hints for Lapping Seats**

Reconditioning of the seat surface may be accomplished by lapping with a flat cast iron ring lap coated with Grade No.1000 Kwik-Ak-Shun Silicone Carbide compound or its equivalent. The following precautions and hints will enable maintenance personnel to do a "professional" job of lapping seats:

- a. Keep work materials clean.
- b. Always use a fresh lap. If signs of wearing (out of flatness) are evident, recondition the lap. Reconditioning of laps is accomplished by lapping them on a flat lapping plate. The lapping should be done with a figure-eight motion as indicated in Figure 10. To assure the best results when lapping seats, the laps should be reconditioned after each usage.



**XI.A. (Continued)****FIGURE 10**

- c. Apply a very thin layer of compound to the lap. This will prevent rounding off the edges of the seat.
- d. Keep the lap squarely on the flat surface, and avoid any tendency to rock the lap which causes rounding of the seat.
- e. When lapping, keep a firm grip on the part to prevent the possibility of dropping it and damaging the seat.
- f. Lap, using an eccentric, or figure-eight motion, in all directions, while at the same time, applying uniform pressure and rotating the lap slowly, see Figure 10.
- g. Replace the compound frequently after wiping off the old compound, and apply more pressure to speed the cutting action of the compound.
- h. To check the seating surfaces, remove all compound from both the seat and the lap. Then, shine the seat with the same lap using the lapping motion described above. Low sections on the seating surface will show up as a shadow in contrast to the shiny portion. If shadows are present, further lapping is necessary and only laps known to be flat should now be used. Only a few minutes will be required to remove the shadows.
- i. When the lapping is completed, any lines appearing as cross scratches can be removed by rotating the lap (which has been wiped clean of compound) on the seat about its own axis.
- j. The seat should now be thoroughly cleaned using a lint-free cloth and a cleansing fluid.

**2. Lapping the Base Seat**

The base seat may be reconditioned using the lapping procedure; however, the dimensions provided in Table I, should be used to determine the seat width.

## XI.A. (Continued)

TABLE I

19000 SERIES SAFETY RELIEF VALVE			
SET PRESSURE		NOMINAL LAPPED SEAT WIDTH	
psig	barg	inches	mm
21-100	1.448-6.896	.010-.013	.254-.330
101-300	6.965-20.689	.014-.018	.356-.457
301-800	20.758-55.172	.019-.023	.483-.584
801-900	55.269-62.100	.024-.028	.609-.711
901-1000	62.169-69.000	.029-.033	.737-.838
1001-1100	69.069-75.900	.034-.038	.864-.965
1101-1200	75.969-82.800	.039-.043	.991-1.092
1201-1300	82.869-89.700	.044-.048	1.118-1.219
1301-1400	89.769-96.600	.049-.053	1.245-1.346
1401-1500	96.669-103.500	.054-.058	1.372-1.473
1501-1600	103.569-110.400	.059-.063	1.499-1.600
1601-1700	110.469-117.300	.064-.070	1.626-1.778
1701 +	117.369 +	.070 Maximum	1.778 Maximum

The seat width can be measured by the use of a "Measuring Magnifier" (see Figure 11.A). DVD recommends the use of Model S1-34-35-37 (which is manufactured by Bausch and Lomb Optical Co., Rochester, N.Y.). This is a seven power glass, with a three quarter inch scale showing graduations of 0.005 inch. The use of this scale in measuring the seat width is shown in Figure 11.B.

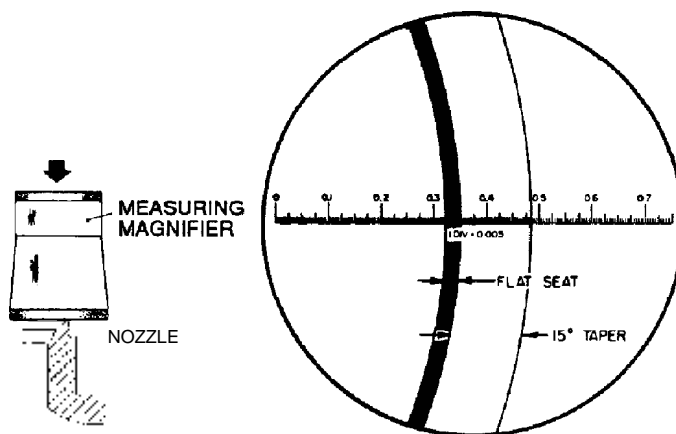


FIGURE 11.A

FIGURE 11.B

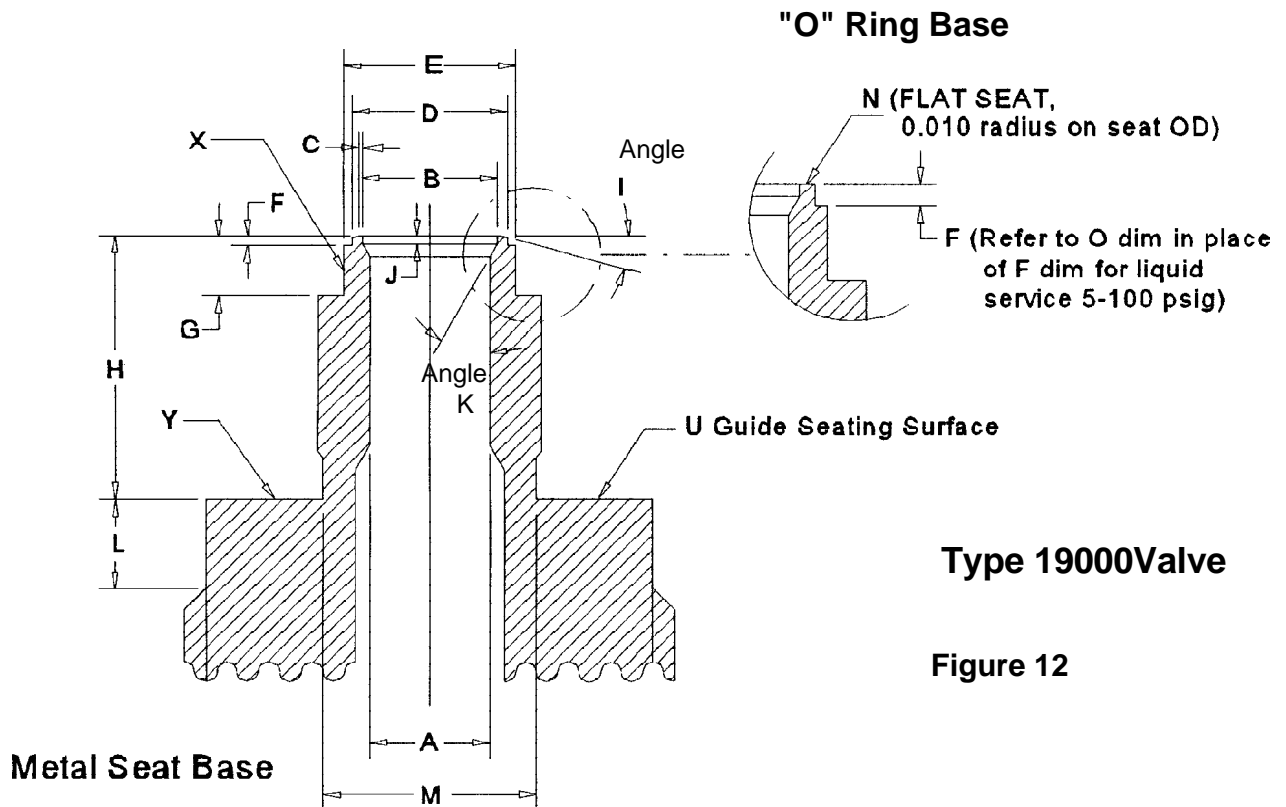
If additional lighting is required for measuring the seat, DVD suggests a goose-neck flashlight similar to the Type A Lamp Assembly Flashlight (which is manufactured by Standard Molding Corporation, Dayton, Ohio).

### XI.A. (Continued)

#### 3. Machining the Base Seat

- a. When the base seat cannot be repaired by lapping, it can be machined as shown in Figure 12, using the dimensions provided in Table II.
- b. DVD recommends that the following procedure be adhered to when machining the base seat:
  - (1) Using a four-jaw chuck, align the base so that surfaces marked X and Y run true within .001" on an indicator.
  - (2) Take light cuts on the seat surface until all damage is removed. Re-establish seat dimensions. When L (min.) is obtained, the base should be replaced.
  - (3) After all machining has been accomplished, lap the seat using same procedure for base seat.

Note: 19000H and 19000 DA bases have flat seats (90° angle) across the entire seating surface from B diameter to D diameter.



## XI.A. (Continued)

TABLE II

VALVE TYPE	ORIFICE DIA. SQ.IN. SQ.CM.	A IN.(REF) MM.(REF)	B IN.(+.002) MM.(+.05)	C (MIN) IN. MM.	D IN. (+-.002) MM. (-.05)	E IN. (+-.003) MM. (+.08)	F* IN. (+.005) MM. (+.13)	G IN. (+.005) MM. (+.13)	H IN.(+.002 -.003) MM.(+.05 -.08)	I **	J IN. (+.005) MM. (+.13)	K **	L IN. (MIN) MM.(MIN)	M IN.(+1/64) MM(+.40)	O* IN.(+.003 -.002) MM.(+.08 -.05)
19096L-MS	.096 .621	.350 8.89	.395 10.03	.010 .25	.457 11.61	.503 12.78	.030 .762	.188 4.78	.784 19.91	15	.020 .508	30	1/4 6.35	5/8 15.88	--
19096L-DA	.096 .621	.350 8.89	.395 10.03	Flat	.457 11.61	.503 12.78	.045* 1.143	.188 4.78	.784 19.91	Flat	.020 .508	30	1/4 6.35	5/8 15.88	.032* .813
19126L-MS	.126 .815	.401 10.19	.453 11.51	.010 .25	.523 13.28	.579 14.71	.030 .762	.216 5.49	.784 19.91	15	.023 .584	30	1/4 6.35	23/32 18.26	--
19126L-DA	.126 .815	.401 10.19	.453 11.51	Flat	.523 13.28	.579 14.71	.045* 1.143	.216 5.49	.784 19.91	Flat	.023 .584	30	1/4 6.35	23/32 18.26	.032* .813
19226L-MS	.226 1.461	.537 13.64	.606 15.39	.010 .25	.701 17.81	.781 19.84	.030 .762	.289 7.34	1.034 26.26	15	.030 .762	30	1/4 6.35	31/32 24.61	--
19226L-DA	.226 1.461	.537 13.64	.606 15.39	Flat	.701 17.81	.781 19.84	.050* 1.270	.289 7.34	1.034 26.26	Flat	.030 .762	30	1/4 6.35	31/32 24.61	.032* .813
19357L-MS	.357 2.309	.675 17.15	.762 19.35	.010 .25	.881 22.38	.987 25.07	.038 .965	.363 9.22	1.503 38.18	5	.038 .965	30	5/16 7.94	1 15/64 31.35	--
19357L-DA	.357 2.309	.675 17.15	.762 19.35	Flat	.893 22.68	.987 25.07	.060* 1.524	.363 9.22	1.503 38.18	Flat	.038 .965	30	5/16 7.94	1 15/64 31.35	.040* 1.016
19567L-MS	.567 3.661	.850 21.59	.960 24.38	.010 .25	1.109 28.17	1.247 31.67	.048 1.219	.457 11.61	1.503 38.18	5	.048 1.219	30	5/16 7.94	1 9/16 39.69	--
19567L-DA	.567 3.661	.850 21.59	.960 24.38	Flat	1.109 28.17	1.247 31.67	.060* 1.524	.457 11.61	1.503 38.18	Flat	.048 1.219	30	5/16 7.94	1 9/16 39.69	.050* 1.270
19096M-MS	.096 .621	.350 8.89	.395 10.03	.010 .25	.457 11.61	.503 12.78	.030 .762	.188 4.78	.784 19.91	15	.030 .762	30	1/4 6.35	5/8 15.88	--
19096M-DA	.096 .621	.350 8.89	.395 10.03	Flat	.457 11.61	.503 12.78	.045 1.143	.188 4.78	.810 20.57	Flat	.030 .762	30	1/4 6.35	5/8 15.88	--
19126M-MS	.126 .815	.401 10.19	.453 11.51	.010 .25	.523 13.28	.579 14.71	.030 .762	.216 5.49	.784 19.91	15	.030 .762	30	1/4 6.35	23/32 18.26	--
19126M-DA	.126 .815	.401 10.19	.453 11.51	Flat	.523 13.28	.579 14.71	.080 2.032	.180 4.57	.810 20.57	Flat	.030 .762	30	1/4 6.35	23/32 18.26	--
19226M-MS	.226 1.461	.537 13.64	.606 15.39	.010 .25	.701 17.81	.781 19.84	.030 .762	.289 7.34	1.034 26.26	15	.030 .762	30	1/4 6.35	31/32 24.61	--
19226M-DA	.226 1.461	.537 13.64	.606 15.39	Flat	.701 17.81	.771 19.58	.080 2.032	.210 5.33	1.098 27.89	Flat	.030 .762	30	1/4 6.35	31/32 24.61	--
19357M-MS	.357 2.309	.675 17.15	.762 19.35	.010 .25	.881 22.38	.987 25.07	.038 .965	.363 9.22	1.503 38.18	5	.038 .965	30	5/16 7.94	1 15/64 31.35	--
19357M-DA	.357 2.309	.675 17.15	.762 19.35	Flat	.893 22.68	.987 25.07	.090 1.524	.363 9.22	1.594 40.49	Flat	.038 .965	30	5/16 7.94	1 15/64 31.35	--
19567M-MS	.567 3.661	.850 21.59	.960 24.38	.010 .25	1.109 28.17	1.247 31.67	.048 1.219	.457 11.61	1.503 38.18	5	.048 1.219	30	5/16 7.94	1 9/16 39.69	--
19567M-DA	.567 3.661	.850 21.59	.960 24.38	Flat	1.109 28.17	1.247 31.67	.125 3.175	.300 7.62	1.596 40.54	Flat	.048 1.219	30	5/16 7.94	1 9/16 39.69	--
19096H-MS	.096 .621	.350 8.89	.395 10.03	Flat	.457 11.61	.503 12.78	.030 .762	.188 4.78	1.034 26.26	Flat	.030 .762	30	1/4 6.35	13/16 20.64	--
19096H-DA	.096 .621	.350 8.89	.395 10.03	Flat	.457 11.61	.503 12.78	.045 1.143	.188 4.78	1.060 26.92	Flat	.030 .762	30	1/4 6.35	13/16 20.64	--
19126H-MS	.126 .815	.401 10.19	.453 11.51	Flat	.523 13.28	.579 14.71	.030 .762	.156 3.96	1.524 38.71	Flat	.030 .762	30	5/16 7.94	15/16 23.81	--
19126H-DA	.126 .815	.401 10.19	.453 11.51	Flat	.523 13.28	.579 14.71	.045 1.143	.156 3.96	1.524 38.71	Flat	.030 .762	30	5/16 7.94	15/16 23.81	--
19226H-MS	.226 1.461	.537 13.64	.606 15.39	Flat	.701 17.81	.781 19.84	.030 .762	.210 5.33	1.504 38.20	Flat	.030 .762	30	5/16 7.94	1 5/8 41.28	--
19226H-DA	.226 1.461	.537 13.64	.606 15.39	Flat	.701 17.81	.781 19.84	.050 1.270	.210 5.33	1.504 38.20	Flat	.030 .762	30	5/16 7.94	1 5/8 41.28	--

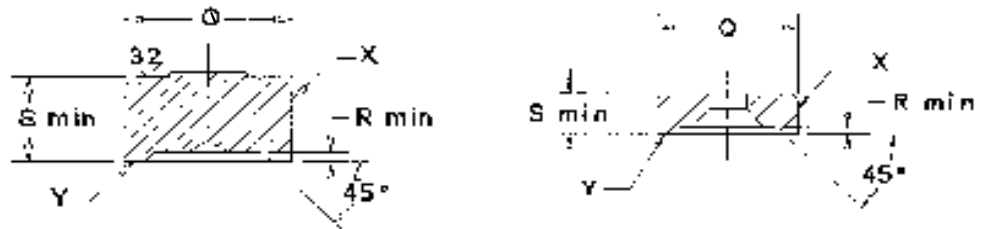
\* SOFT SEAT (DA) VALVES FOR LIQUID SERVICE FROM 5-100 PSIG REQUIRE A SPECIAL BASE. REFER TO DIMENSION O INSTEAD OF DIMENSION F IN THIS CASE.

\*\* ANGLES IN DEGREES

## 4. Machining the Disc Seat

- a. When the disc seat cannot be repaired by lapping, it can be machined as shown in Figure 13, using the dimensions provided in Table III.

**XI.A. (Continued)**



**Disc, O-Ring Retainer**

**Figure 13.**

**TABLE III**  
**REWORKING DIMENSIONS OF THE DISC SEAT**

VALVE TYPE	ORIFICE DIA. SQ.IN. SQ.CM.	Disc (Metal Seat)			O-Ring Retainer (Soft Seat)		
		Q(REF) IN. MM.	R(MIN) IN. MM.	S(MIN) IN. MM.	Q(REF) IN. MM.	R(MIN) IN. MM.	S(MIN) IN. MM.
19096L,M&H	.096	.461	.025	.248	.426	---	.156
	.621	11.71	.64	6.30	10.82	---	3.96
19126L,M&H	.126	.527	.025	.248	.489	---	.156
	.815	13.39	.64	6.30	12.42	---	3.96
19226L,M&H	.226	.705	.025	.308	.676	.025	.204
	1.461	17.91	.64	7.82	17.17	.64	5.18
19357L&M	.357	.885	.025	.495	.852	.025	.249
	2.309	22.48	.64	12.57	21.64	.64	6.32
19567L&M	.567	1.113	.025	.495	1.058	.025	.249
	3.661	28.27	.64	12.57	26.87	.64	6.32

- b. DVD recommends that the following procedure be adhered to when machining the disc seat:
1. Grip the disc in a collet.
  2. True up the disc so that surfaces marked X and Y run true within .001" on an indicator.
  3. Take light cuts across the seating surface until the damage is removed.
  4. The disc is now ready for lapping.
  5. When the minimum dimension is reached, the disc should be replaced.

**B. O-Ring Seat Seal Valves (DA)**

**1. Replacing the Disc**

If slight damage is present, the disc can be refurbished by either lapping or machining; disc should be replaced if severely damaged or if dimension S (min) is exceeded.

---

## **XI.B. (Continued)**

### **2. Polishing the Base Seat**

Normally the base seating area on this type of valve is not damaged, since the “O” ring absorbs the impact when foreign material is trapped between the “O” ring and the base seating area. The “O” ring will therefore hold a bubble tight seal with slight indications on the base seating surface. Nevertheless, slight indications on the base seat surface may be removed by lapping the base.

#### **NOTE:**

**The O-ring should be replaced during “Reassembly.”**

## **C. Checking Spindle Concentricity**

### **1. General Information**

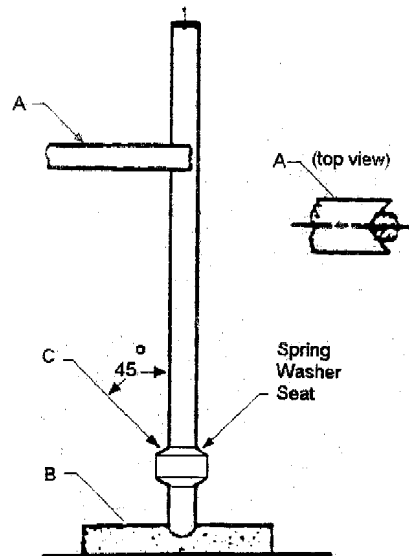
It is important that the spindle of a safety relief valve be straight, in order to transmit the spring load to the disc without lateral binding. Over-gagging is one of the common causes of bent spindles. To check the essential working surfaces of the spindle, the method stated in paragraph XI.C.2 is recommended.

### XI.C. (Continued)

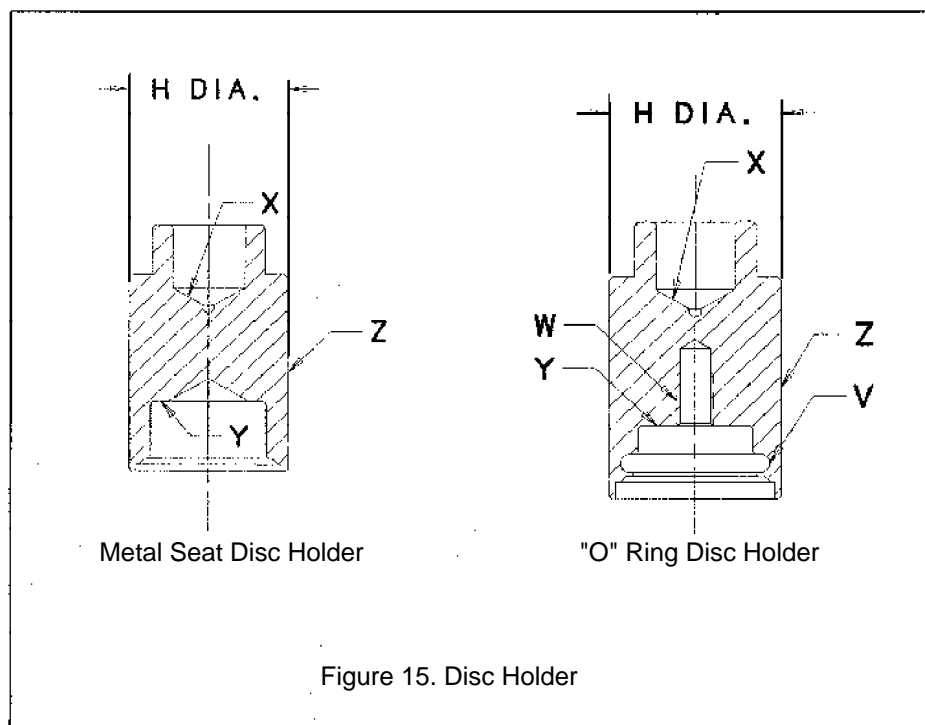
#### 2. V-Block Support Set Up

- a. The ball pointed spindles should be placed in a piece of material, B, that has been recessed to permit free rotation of the spindle. (See Figure 14.)

FIGURE 14



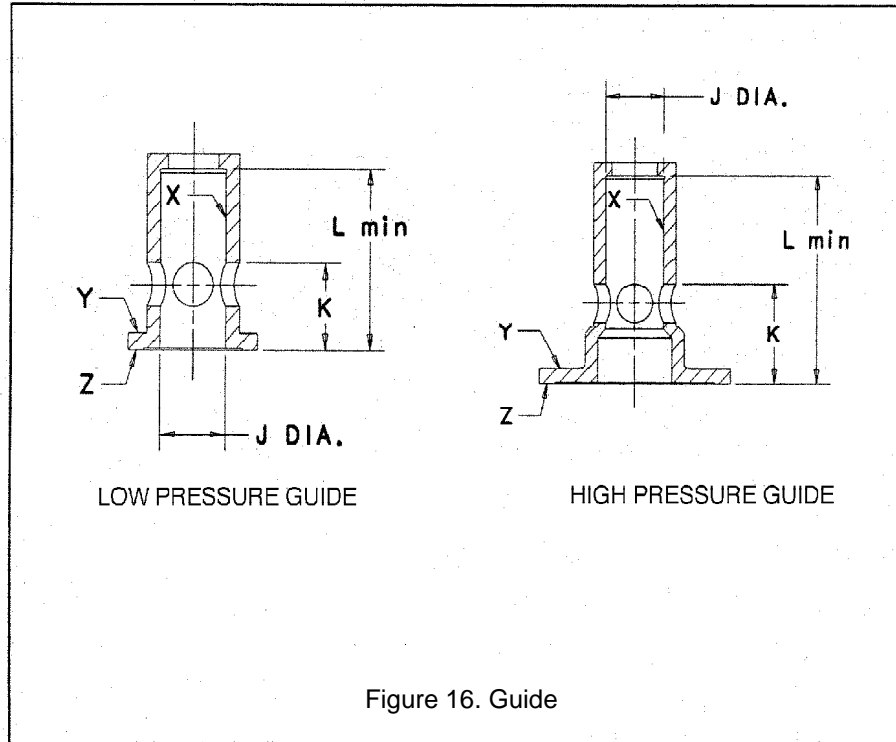
- b. Support the spindle with a V-block A, placed near the upper end of the spindle, but below the threads.
- c. Apply a machinist's indicator at approximately 45° to the outer edge of the spring washer seat at C. Rotate the spindle. The total indicator reading should not exceed .005". Straighten the spindle, if necessary.



**TABLE IV  
DISC HOLDER DIMENSIONS**

Valve Type	H DIA IN (±.001) MM (±.03)
19096L	.654 16.61
19126L	.747 18.97
19226L	1.000 25.40
19357L	1.257 31.93
19567L	1.583 40.21
19096M	.654 16.61
19126M	.747 18.97
19226M	1.000 25.40
19357M	1.257 31.93
19567M	1.583 40.21
19096H	.654 16.61
19126H	.747 18.97
19226H	1.000 25.40





**TABLE V  
GUIDE DIMENSIONS**

Valve Type	J DIA IN ( $\pm 0.01$ ) MM ( $\pm 0.3$ )	K (MS-Metal Seat) IN MM	K (DA-Soft Seat) IN MM	L min (MS-Metal Seat) IN MM	L min (DA-Soft Seat) IN MM
19096L	.661 16.79	.810 $\pm 0.07$ 20.57 $\pm 1.8$	.810 $\pm 0.07$ 20.57 $\pm 1.8$	1.701 43.21	1.701 43.21
19126L	.754 19.15	.804 $\pm 0.07$ 20.42 $\pm 1.8$	.804 $\pm 0.07$ 20.42 $\pm 1.8$	1.717 43.61	1.717 43.61
19226L	1.007 25.58	1.109 $\pm 0.09$ 28.17 $\pm 2.3$	1.109 $\pm 0.09$ 28.17 $\pm 2.3$	2.267 57.58	2.267 57.58
19357L	1.264 32.11	1.623 $\pm 0.12$ 41.22 $\pm 3.0$	1.623 $\pm 0.12$ 41.22 $\pm 3.0$	3.105 78.87	3.105 78.87
19567L	1.590 40.39	1.671 $\pm 0.12$ 42.44 $\pm 3.0$	1.671 $\pm 0.12$ 42.44 $\pm 3.0$	3.159 80.24	3.159 80.24
19096M	.661 16.79	.810 $\pm 0.07$ 20.57 $\pm 1.8$	.810 $\pm 0.07$ 20.57 $\pm 1.8$	1.727 43.87	1.727 43.87
19126M	.754 19.15	.804 $\pm 0.07$ 20.42 $\pm 1.8$	.804 $\pm 0.07$ 20.42 $\pm 1.8$	1.743 44.27	1.743 44.27
19226M	1.007 25.58	1.109 $\pm 0.09$ 28.17 $\pm 2.3$	1.109 $\pm 0.09$ 28.17 $\pm 2.3$	2.267 57.58	2.292 58.22
19357M	1.264 32.11	1.623 $\pm 0.12$ 41.22 $\pm 3.0$	1.623 $\pm 0.12$ 41.22 $\pm 3.0$	3.105 78.87	3.196 81.18
19567M	1.590 40.39	1.671 $\pm 0.12$ 42.44 $\pm 3.0$	1.627 $\pm 0.12$ 41.33 $\pm 3.0$	3.159 80.24	3.251 82.58
19096H	.661 16.79	1.060 $\pm 0.07$ 26.92 $\pm 1.8$	1.060 $\pm 0.07$ 26.92 $\pm 1.8$	2.227 56.57	2.227 56.57
19126H	.754 19.15	1.523 $\pm 0.07$ 38.68 $\pm 1.8$	1.523 $\pm 0.07$ 38.68 $\pm 1.8$	2.707 68.76	2.707 68.76
19226H	1.007 25.58	1.515 $\pm 0.09$ 38.48 $\pm 2.3$	1.515 $\pm 0.09$ 38.48 $\pm 2.3$	3.027 76.88	3.027 76.88

---

## **XII. Reassembly and Lubrication**

### **A. Metal Seat Valves (MS)**

1. Bearing surfaces should be ground together using Clover 1A compound. These surfaces are: (a) the disc holder spindle pocket and spindle spherical nose radius, (b) the lower spring washer and spindle spring washer radius and (c) the upper spring washer and adjusting screw spherical radius. Remember that, before assembly, all parts should be cleaned.
2. Apply small amount of "Molykote®" to the guide bonnet seating surface and the bonnet threads. When a stainless steel bonnet and base are used, or a standard bonnet for service above 500°F temperature, apply "Molykote®" to the bonnet threads on the base.
3. Use a clean base lapped for the valve set pressure, (see seat width requirement Table II.) Place a lapped disc on the base, with lapped surfaces facing each other. Place the disc holder onto the disc and base. Place guide over disc holder onto base. Lubricate the disc holder spindle bearing surface, with "Molykote®."
4. Lubricate the spindle nose with a small amount of "Molykote®," and insert the spindle into the disc holder spindle pocket.
5. Apply a small amount of "Molykote®" on the bearing surface of the lower spring washer, and slip it over the spindle. Install the spring and upper spring washer.
6. Apply a small amount of "Molykote®" to the bonnet base threads and guide seating surface. When a stainless steel bonnet and base are used, and/or a standard bonnet for service above 500° temperature, apply "Molykote®" to the bonnet base threads and guide seating surface. Before tightening the bonnet completely, adjust the position of the guide so that one of the holes is lined up with the discharge of the valve. Tighten the bonnet on the base using torque specified in Table VI.

**TABLE VI**  
BASE TORQUE SPECIFICATIONS

VALVE TYPE	RECOMMENDED TORQUE (FT-LB)	MAXIMUM TORQUE (FT-LB)
19096L	125	250
19126L	125	250
19226L	200	400
19357L	625	1000
19567L	625	1000
19096M	175	300
19126M	175	300
19226M	500	750
19357M	650	1200
19567M	650	1200
19096H	500	750
19126H	1000	1500
19226H	1000	1500

### ***XII.A. (Continued)***

7. Thread the adjusting screw locknut on the adjusting screw. Apply a light coat of "Molykote®" to the adjusting screw threads and spherical radius. Install the adjusting screw in the bonnet, rotating the number of times required to compress the spring slightly. When the spindle begins to turn, use pliers to hold it in position and rotate the adjusting screw the number of turns recorded at disassembly (See Paragraph VIII.B.3).
8. The valve is now ready for setting. After the set pressure has been adjusted, tighten the adjusting screw locknut. Install the cap and cap gasket, or lifting gear, on the valve after applying a small amount of "Molykote®" to the gasket seal surfaces, as well as to the cap and bonnet threads.

### **B. O-Ring Seat Seal Valves (DA)**

1. All bases shall be lapped flat enough to remove nicks and burrs.
2. Bearing surfaces should be ground together using Clover® 1A compound. These surfaces are: (a) the disc holder spindle pocket and spindle spherical nose radius, (b) the lower spring washer and spindle spring washer radius and (c) the upper spring washer and adjusting screw spherical radius. Remember that, before assembly, all parts should be cleaned.

3. Carefully insert a new O-ring seal into the disc holder. Make sure the O-ring is the right size, material and hardness for the application. Refer to the valve nameplate for information required when ordering an O-ring.
4. Install the O-ring retainer and a new retainer lock screw.
5. Place the disc holder assembly onto the base and place the guide onto base. The guide seating surfaces should be free of any nicks or scratches.
6. Lubricate the spindle nose with a small amount of "Molykote®", and insert the spindle into the disc spindle pocket.
7. Apply a small amount of "Molykote®" on the bearing surface of the lower spring washer, and slip it over the spindle. Install the spring and upper spring washer.
8. The guide bonnet seating surfaces should be free of any nicks or scratches, with a 63 rms finish (maximum.) Apply "Molykote®" to the bonnet threads and guide seating surfaces. Install the bonnet on the base using torque from Base Torque Specifications (Table VI). When a stainless steel bonnet and base are used, apply "Molykote®", to the bonnet threads on the base and, then, install the bonnet on the base. Before tightening the bonnet completely adjust the position of the guide so that one of the holes in the guide is in line with the discharge of the valve. Tighten the bonnet using sufficient torque from Base Torque Specification, (Table VI).
9. Thread the adjusting screw locknut onto the adjusting screw. Apply a small amount of "Molykote" to the tip of the adjusting screw. Install the adjusting screw in the bonnet, rotating the number of times required to compress the spring slightly. Use pliers to hold the spindle in position and prevent galling. Adjust the compression screw to the measurement recorded during disassembly. (See Paragraph VIII.C.3).
10. The valve is now ready for setting. After the valve set pressure has been adjusted, tighten the adjusting screw locknut. Install the cap gasket and cap, or lifting gear, on the valve after applying a small amount of "Molykote®" to the gasket seal surfaces, as well as to the cap and bonnet threads.

### ***XIII. Setting and Testing After Reconditioning***

#### **A. General Information**

Before putting the reconditioned valve into service, it must be set to open at the required set pressure. Although the valve can be set on the service installation, it is more convenient to set the valve, and check seat tightness, on a test stand. Any spring replacement shall be in accordance with current DVD guidelines.

#### **B. Test Equipment**

Test stands for testing DVD Safety Relief Valves normally consist of a pressure source, a supply line with a throttle valve, and a receiver having the following features:

1. Outlet for attaching valve to be tested.
2. Pressure gauge with a shut-off valve.
3. Drain line with a shut-off valve.
4. A volume in receiver adequate for the valve to be tested to achieve proper operation.

#### **C. Test Media**

Steam valves should be tested on saturated steam; there is no conversion factor supplied to test steam valves on air. Air or gas valves are to be tested on air or gas, at ambient temperature. Liquid valves are to be tested on water, at ambient temperature.

#### **D. Setting the Valve**

The valve should be set to open at the set pressure as shown on the nameplate. If a cold differential test pressure is indicated on the nameplate, the valve should be set to open at that pressure. The cold differential test pressure is the set pressure corrected to compensate for back pressure and/or operating temperature.

If changes are to be made to the set pressure or back pressure or the service temperature changes, a new cold differential test pressure may need to be determined.

#### **E. Set Pressure Compensation**

##### **1. Cold Differential Test Pressure For Temperature Compensation**

During production testing of safety and safety relief valves, the valves are often tested at temperatures that are different from the temperature the valve will be exposed to in service. Increasing the temperature from ambient causes the set pressure to decrease. This decrease in set pressure is due to thermal expansion of the seating area and spring relaxation.

Therefore, it is important to compensate for the difference between production test temperature and service temperature. The service temperature is the normal operating temperature of the valve. If the operating temperature is unavailable, no correction due to temperature will be made to valve set pressure.

### XIII.E (Continued)

Table VII gives the set pressure multipliers that should be used when computing the cold differential test pressure for valves being set on an air or water test stand at ambient temperatures.

**TABLE VII**

Set Pressure Multipliers for CDTP			
Operating Temp (F)	Multiplier	Operating Temp (F)	Multiplier
250	1.003	900	1.044
300	1.006	950	1.047
350	1.009	1000	1.050
400	1.013	1050	1.053
450	1.016	1100	1.056
500	1.019	1150	1.059
550	1.022	1200	1.063
600	1.025	1250	1.066
650	1.028	1300	1.069
700	1.031	1350	1.072
750	1.034	1400	1.075
800	1.038	1450	1.078
850	1.041	1500	1.081

Valves to be used in saturated steam service are tested on saturated steam and, therefore, no CDTP is required. However, valves in superheated steam service are tested on saturated steam and, therefore, require a CDTP.

Table VIII, below, shows the multiplier that should be used based on temperature above the saturated temperature (degrees of superheat).

**TABLE VIII**

Set Pressure Multipliers for CDTP (Superheat Temperature)	
Degrees of Superheat (F)	Multiplier
100	1.006
200	1.013
300	1.019
400	1.025
500	1.031
600	1.038
700	1.044
800	1.050

### XIII.E. (Continued)

#### 2. Cold Differential Test Pressure For Back Pressure Compensation

When a conventional Series 19000 valve is to operate with a constant back pressure, the cold differential test pressure is the set pressure minus the constant back pressure.

#### 3. Sample Calculations For Series 19000 Consolidated® Safety Relief Valves (refer to preceding Tables VII and VIII)

- a. Set pressure 2500 psig, temperature 500 F,  
back pressure atmospheric.
- |                                       |               |      |
|---------------------------------------|---------------|------|
| Set Pressure .....                    | 2500          | psig |
| Multiplier from Table VII .....       | <u>X1.019</u> |      |
| Cold Differential Test Pressure ..... | 2548          | psig |
- b. Set pressure 2500 psig, temperature 500 F,  
constant back pressure 150 psig
- |                                       |               |      |
|---------------------------------------|---------------|------|
| Set Pressure .....                    | 2500          | psig |
| Minus Constant Back Pressure .....    | <u>-150</u>   | psig |
| Differential Pressure .....           | 2350          | psig |
| Multiplier from Table VII .....       | <u>X1.019</u> |      |
| Cold Differential Test Pressure ..... | 2395          | psig |
- c. Set pressure 2500 psig, temperature 100 F,  
constant back pressure 150 psig
- |                                       |             |      |
|---------------------------------------|-------------|------|
| Set Pressure .....                    | 2500        | psig |
| Minus Constant Back Pressure .....    | <u>-150</u> | psig |
| Cold Differential Test Pressure ..... | 2350        | psig |
- d. Set pressure 400 psig, temperature 650 F,  
back pressure atmospheric
- |   |               |      |
|---|---------------|------|
| Operating Temperature.....                        | 650           | F    |
| Minus Temperature of Sat. Steam at 400 psig ..... | <u>-448</u>   | F    |
| Degrees of Superheat.....                         | 202           | F    |
| Set Pressure .....                                | 400           | psig |
| Multiplier from Table VIII .....                  | <u>x1.013</u> |      |
| Cold Differential Test Pressure .....             | 405           | psig |

#### F. Blowdown

The blowdown for all series 19000 valves is fixed. **Do not attempt to adjust the blowdown on these valves.** Typical blowdown is less than 10%.

#### G. Simmer

If simmer causes erratic valve opening, refer to the Trouble Shooting Guide in Section XVI.

### XIII. (Continued)

#### H. Seat Leakage

##### 1. Air

The air-leakage test shall be performed with all connections and openings in the body and bonnet pressure-tight. The cap, with the gasket which covers the adjusting screw, must be installed. Test the valve for leakage using an API test fixture. The API leakage test procedure is described below:

- a. Per API Standard 527, (ANSI B147.1-72), a standard test fixture consists of a piece of tubing 5/16" (7.94mm) x .035" (0.89mm) wall, one end of which is joined to an adaptor on the valve outlet, and the other end of which is immersed 1/2" (12.70mm) below the surface of a reservoir of water.
- b. The leakage rate for a valve with metal to metal seats shall be determined with the valve mounted vertically and using a standard test fixture, as described above. "The leakage rate, in bubbles per minutes, shall be determined with the pressure at the safety relief valve inlet held at 90 percent of the set pressure, immediately after popping, for valves set 51 psig (3.517 bar) and above. On valves set at 50 psig (3.448 bar) and below, test for leakage at 5 psig (0.345 bar) below the set pressure, immediately after popping. The test pressure shall be applied for a maximum of 1 minute."
- c. The "Tightness Standard" is the leakage rate in bubbles per minute, and shall not exceed that shown in Table IX for metal seat valves or Table X for "O" ring seat seal valves.

**TABLE IX**

<b>Max. Leakage Rate (Bubbles Per Minute)</b>	<b>Approx. Leakage Rate (Std. Cu. Ft. Per 24 Hr.)</b>
40	0.60 (16.99 liters)

A valve with a seat of resilient material (i.e., an O-ring valve) shall show no leakage at pressures less than those indicated in Table X, when the test medium is either air or water.

**TABLE X**

<b>Set Pressure PSIG</b>	<b>Min. Leak Point (% of Set Pressure)</b>
15/(1.034 bar) to 30 psig (2.069)	90%
31/(2.138 bar) to 50 psig (3.448 bar)	92%
51/(3.517 bar) to 100 psig (6.897)	94%
101/(6.966 bar) psig or greater	97%



### XIII.H. (Continued)

**2. Water**

When a metal-to-metal seat valve is tested using water as the test medium, there shall be no leakage, as determined by sight when the pressure is held at 90% of set pressure.

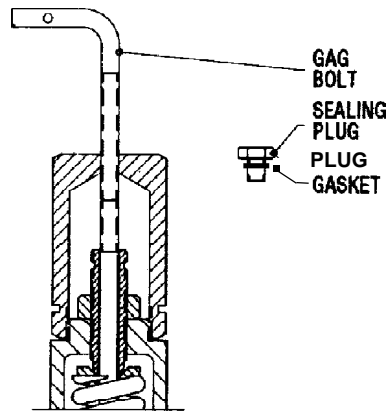
**3. Steam**

When a valve is checked for tightness using steam as the test medium (at 90% of the set pressure), there shall be no visual or audible leakage after the interior of the valve is allowed to dry after popping. If there is no visual or audible leakage, the valve is acceptable.



### XIV. Hydrostatic Testing and Gagging

When hydrostatic tests are required after installation of a safety relief valve, a test gag must be used (see Figure 17 ). Very little force (i.e., fingertight pressure) on the test gag is sufficient to hold hydrostatic pressures. **Too much force applied to the gag may bend the spindle and damage the seat.** After a hydrostatic test, the gag must be removed and replaced by the sealing plug furnished for this purpose. (Test gags for Consolidated® Safety Relief Valves can be furnished for all types of caps and lifting gears.)



TYPICAL  
CAP WITH GAG  
FIGURE 17

### XV. Manual Popping of the Valve

Consolidated Safety Relief Valves are furnished, when so ordered, with packed or plain lifting levers for hand popping.

When the valve is to be opened by hand, the pressure at the valve inlet should be at least 75% of the valve's set pressure. Under flowing conditions, the valve must be fully lifted from its seat, so that dirt, sediment and scale will not become trapped on the seating surfaces. When allowing the valve to close under flowing conditions, completely release the lever from maximum lift to snap the valve back on its seat.

## XV. (Continued)

Since, in some cases, the dead weight of the lever may have a tendency to lift the valve disc, the lever should be hung, supported, or counter weighted, so the lifting fork does not contact the release nut.

## XVI. Trouble Shooting Guide

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
Valve leaking	A. Damaged seat or O-ring. B. Bearing point damage. C. Part misalignment. D. Seat is too wide E. Discharge stack binding on outlet	A. Disassemble valve, lap seating surfaces, replace disc or O-ring, if required, as outlined in this manual. B. Grind and polish. C. Disassemble, valve, inspect contact area of disc and nozzle, lower spring washer or spindle, compression screw, spindle straightness, etc.as outlined in the manual. D. Rework as specified in this manual. E. Correct as required.
Simmer	A. Line vibrations. B. Lapped seat too wide.	A. Investigate and correct cause. B. Rework seat as specified in this manual.
Chatter	A. Improper installation or valve sizing. B. Built-up back pressure.	A. Check for piping restrictions; check required capacity. B. Check outlet piping for flow restriction.
No action; valve does not go into full lift; Valve does not close from full lift.	A. Foreign material trapped between disc holder and guide.	A. Disassemble valve and correct any abnormality as outlined in this manual. Inspect system for cleanliness.

## XVII. Maintenance Tools and Supplies

- The laps\* identified in Table XI, are required for proper maintenance of Consolidated® Series 19000 seats.

**TABLE XI**

LAPS	
VALVE	PART NUMBER
19096L, 19126L, 19096M, 19126M, 19096H, 19126H	1672802
19226L, 19226M, 19226H	1672803
19357L, 19567L, 19357M, 19567M	1672805

**NOTE:**

**One set of three (3) laps is recommended for each size to assure ample flat laps are available at all times.**

- The Lap Resurfacing Plate\* is part number 0439003
- Lapping compounds are identified in Table XII.
- Laps and the lapping plate may be purchased from DVD.

**XVII. (Continued)**

TABLE XII

Brand	Grade	Grit	Lapping Function	Size Container	Part No.
Clover	1A	320	General	4 oz.	199-3
Clover	3A	500	Finishing	4 oz.	199-4
Kwik-Ak-Shun	—	1000	Polishing	1 lb.	199-11
				2 oz.	199-12

**XVIII. Inventory Philosophy****A. General Information**

The importance of maintenance planning is the key to good plant operations. Part of that planning involves making sure that replacement parts needed to repair valves are available at the jobsite when required. Developing and implementing a standard valve maintenance plan will quickly pay for itself by eliminating costly downtime, unscheduled outages, etc.

**B. Inventory Planning**

The basic objectives in formulating a replacement parts plan are:

PROMPT AVAILABILITY  
 MINIMUM DOWNTIME  
 SENSIBLE COST  
 SOURCE CONTROL

Having parts immediately available from plant storeroom inventory is obviously the best way to accomplish those objectives. Since it is impractical to have every part that might be needed to accomplish a given repair in stock at all times, guidelines for establishing meaningful inventory levels are summarized in the table XIII.

TABLE XIII

PART CLASSIFICATION	REPLACEMENT FREQUENCY	Need Coverage Probability *
CLASS I	MOST FREQUENT	70%
CLASS II	LESS FREQUENT BUT CRITICAL	85%
CLASS III	SELDOM REPLACED	95%
CLASS IV	HARDWARE	99%

\* Need Coverage Probability means that percentage of time the user plant will have the right parts to make the proper repair on the product, (i.e. if Class I parts are stocked at the owners facility, the parts needed to repair valve in question will be immediately available in 70% of all instances).

---

## **XVIII. (Continued)**

### **C. Replacement Parts List**

Consult the Recommended Spare Parts list (see Section XIX of this manual) to determining the parts to be included in the inventory plan.

Select the desired parts and determine those required for proper maintenance of the valve population in the plant.

### **D. Identification and Ordering Essentials**

When ordering service parts, please furnish the following information to insure receiving the correct replacement parts:

1. Identify valve by the following nameplate data:
  - a. Size
  - b. Type
  - c. Temperature Class (Spring Selection)
  - d. Serial NumberExample:  
3/4"-19096LC-1  
S/N TC75834
2. Specify parts required by:
  - a. Part Name
  - b. Part Number (if known)
  - c. Quantity

**XIX. Recommended Spare Parts  
For Series 19000  
Safety Relief Valves**

**TABLE XIV. A.  
METAL TO METAL SEAT VALVES**

<b>CLASS</b>	<b>PART NAME</b>	<b>Qty. Parts/Size, Type &amp; Material Valves in Service</b>	<b>Need Coverage Probability</b>
I	Disc Gaskets, Cap	1/1 1/1	70%
II	Disc Holder Spindle Guide	1/5 1/5 1/5	85%
III	Spring Assembly Compression Screw	1/5* 1/5	95%
IV	Compression Screw Locknut Cap (Specify Screwed, Packed, Plain) Release Nut (Used on Packed or Plain Lever Only) Release Locknut (Used on Packed or Plain Lever Only)	1/5 1/5 1/5 1/5	99%

\* Consult Spring Selection Chart before ordering Springs to determine actual quantities required in view of pressure setting potential in each spring range.

**YOUR SAFETY IS OUR BUSINESS!!!**

DVD has not authorized any company or any individual to manufacture replacement parts for its valve products.

When ordering replacement valve parts, please specify in your purchase order: "ALL PARTS MUST BE DOCUMENTED AS NEW AND SOURCED FROM DRESSER VALVE DIVISION."

**BE SURE! BE SURE!**

**XIX. (Continued)****TABLE XIV. B.  
O-RING SEAT SEAL VALVES**

<b>CLASS</b>	<b>PART NAME</b>	<b>Qty. Parts/Size, Type &amp; Material Valves in Service</b>	<b>Need Probability Coverage</b>
I	O-Ring Retainer O-Ring Lock Screw Gaskets, Cap	1/1 1/1 1/1 1/1	70%
II	Disc Holder Spindle Guide	1/5 1/5 1/5	85%
III	Spring Assembly Compression Screw	1/5* 1/5	95%
IV	Compression Screw Locknut Cap (Specify Screwed, Packed, Plain) Release Nut (Used on Packed or Plain Lever Only) Release Locknut (Used on Packed or Plain Lever Only)	1/5 1/5 1/5 1/5	99%

\* Consult Spring Selection Chart before ordering Springs to determine actual quantities required in view of pressure setting potential in each spring range.

**YOUR SAFETY IS OUR BUSINESS!!!**

DVD has not authorized any company or any individual to manufacture replacement parts for its valve products.

When ordering replacement valve parts, please specify in your purchase order: "ALL PARTS MUST BE DOCUMENTED AS NEW AND SOURCED FROM DRESSER VALVE DIVISION."

**BE SURE! BE SURE!**

## **XX. Genuine Dresser Parts**

The next time replacement parts are needed, keep these points in mind:

- DVD designed the parts.
- DVD guarantees the parts.
- CONSOLIDATED® valve products have been in service since 1877.
- DVD has worldwide service.
- DVD has fast response availability for parts.

## **WHERE CAN I BUY PARTS ?**

To find the nearest Green Tag Sales, Service and Repair Center in the U.S.  
1-800-245-VALV

For International listings see the back cover.

Dresser Valve Division  
P.O. Box 1430  
Alexandria, LA 71309-1430  
Customer Service (318) 640-6047

Fast Response Parts  
1-318-640-6044

## **XXI. Manufacturer's Field Service & Repair Program**

### **A. Factory Setting Vs. Field Setting**

Every CONSOLIDATED® Safety Relief Valve is set and adjusted before shipment from the factory, or at an authorized facility. However, it must be recognized that actual field operating conditions may vary considerably from factory or authorized facility test conditions.

Conditions beyond the manufacturer's control that affect Safety Relief Valve operation are:

1. Quality of media being discharged.
2. Discharge piping stresses and back pressure.
3. Ambient temperature.
4. Shipping or storage damage.
5. Improper gagging.
6. Improper bolting of flanges.
7. Damage due to foreign material in the media.

Final Safety Relief Valve adjustments made on the actual installation are the best means of insuring that the valves perform in compliance with the ASME Code and/or other applicable code requirements.

### **B. Field Service**

Utilities and Process Industries expect and demand service on a moment's notice. CONSOLIDATED® Field Service can be depended upon for prompt response, even in extreme off-hour emergency situations.

DVD maintains the largest and most competent field service staff in the Industry. Service Engineers are located at strategic points throughout the United States to respond to customer's requirements for service. Each Service Engineer is factory trained and long experienced in servicing Safety Relief Valves. DVD Service Engineers restore disc and nozzle critical dimensions which effect valve performance, and are capable of modernizing valves in the field.

All Field Service Engineers' activities are coordinated from the Alexandria, Louisiana, Field Service Office. Upon receipt of a purchase order number authorizing the trip, the engineer is dispatched.

Contact: Field Service Dept., Field Service Supv., (318) 640-6055.

### **C. Factory Repair Facilities**

If downtime permits, it may be desirable to return the valves to the factory for repair or modernizing. The factory at Alexandria, Louisiana, maintains a complete CONSOLIDATED® repair center. The Repair Department is staffed to provide you rapid repair that meets your needs.

Contact: Repair Dept., Mgr. Valve Repair, (318) 640-6057.



#### **D. Safety Relief Valve Maintenance Training**

Rising costs of maintenance and repair in the Utility and Process Industries indicate the need for trained maintenance personnel. Dresser Industrial Valve Operation conducts service seminars that can help your maintenance and engineering personnel to reduce these costs.

Seminars, conducted either at your site, or at our Alexandria, Louisiana manufacturing plant, provide participants with an introduction to the basics of preventative maintenance necessary to minimize downtime, reduce unplanned repairs and increase valve safety. While these seminars do not make "instant" experts, they do provide the participants with "Hands On" experience and nomenclature, component inspection, trouble shooting, setting and testing, with emphasis on the ASME Boiler and pressure Vessel Code.

For further information, **Please contact the Product Training Manager by fax at (318) 640-6041, or telephone (318) 640-6054.**

For service please contact the appropriate sales office below.

## Service Department

### Location of Service Engineers

LOUISIANA, Alexandria .....	1
FLORIDA, Jacksonville .....	2
GEORGIA, Atlanta .....	3
ILLINOIS, Chicago .....	4
INDIANA, Crawfordsville .....	5
KENTUCKY, Maysville .....	6
NORTH CAROLINA, Charlotte .....	7
PENNSYLVANIA, Philadelphia .....	8
SOUTH CAROLINA, Charleston .....	9
VIRGINIA, Richmond .....	10

### THE DRESSER FIELD SERVICE ORGANIZATION IS UNEQUALED

For prompt field service, please call  
Dresser Valve Division Service Department, Alexandria, Louisiana.  
Normal Working Hours - (318) 640-6055  
After Hours, Weekends, Holidays - (318) 640-2250



## Sales Office Locations

### UNITED STATES

Valve Division  
Dresser Equipment Group, Inc..  
La. Highway 3225 at U.S. Hwy. 167 North  
P.O. Box 1430  
Alexandria, Louisiana 71309-1430  
Telephone (\*) 1-318-640-2250  
Fax (\*) 1-318-640-6222

### Northeastern Region

Dresser Valve Division  
Dresser Equipment Group, Inc.  
85 Bodwell Street  
Avon, Massachusetts 02322  
Telephone: (\*) 1-508-586-4600  
Fax: (\*) 1-508-941-5497

### Southern Region

Dresser Valve Division  
Dresser Equipment Group, Inc.  
11100 West Blvd.  
Stafford, Texas 77477-3014  
Telephone (\*) 1-281-568-2211  
Fax (\*) 1-281-568-6731

### CANADA

Dresser Valve Division  
Dresser Canada, Inc.  
5010 North Service Road  
Burlington, Ontario, L7L 5R5 Canada  
Telephone (\*) 1-905-335-3529  
Fax (\*) 1-905-336-7628

Dresser Valve Division  
Dresser Canada, Inc.  
#300, 444-58 Avenue S.E.  
Calgary, Alberta  
T2H 0P4 Canada  
Telephone (\*) 1-403-299-2591  
Fax (\*) 1-403-299-2575

### CHINA

Dresser Valve Division China  
Room 2101, Capital Mansion  
#6 Xinyuan Nan Road  
Chaoyang District  
Beijing, China 100004  
Telephone (\*) 86-10-6465-4515  
Fax (\*) 86-10-6466-0195

### JAPAN

Dresser Japan, Ltd., Dresser Valve Division  
11 F-KY Building, 1-8-11 Kita-Shinagawa  
Shinagawa-Ku, Tokyo 140 Japan  
Telephone (\*) 81-3-5462-8191  
Fax (\*) 81-3-5462-8195

### KOREA

Dresser Korea, Inc., #2107 Kuk Dong Building  
60-1, 3-Ka, Choongmu-ro, Chung-Ku  
Seoul, Korea  
Telephone (\*) 82-2-274-0792  
Fax (\*) 82-2-274-0794

### MEXICO

Masoneilan Internacional S.A. de C.V.  
Av. Henry Ford No. 114  
Apartado Postal 572  
54030 Tlalneantla, Mexico  
Telephone (\*) 52-5-310-9863  
Fax (\*) 52-5-310-5584

### SAUDI ARABIA

Dresser Al Rushaid Valve & Instrument Co., Ltd.  
P.O. Box 10145, Jubail Industrial City 31961  
Kingdom of Saudi Arabia  
Telephone (\*) 966-3-341-0278  
Fax (\*) 966-3-341-7624

### SINGAPORE

Dresser Valve Division Far East  
16, Tuas Ave 8  
Singapore 639231  
Telephone (\*) 65-861-6100  
Fax (\*) 65-861-7172

### SOUTH AFRICA

Dresser Limited, Dresser Valve Division  
P.O. Box 2234, 16 Edendale Road  
Eastleigh, Edenvale 1610  
Transvaal, Republic of South Africa  
Telephone (\*) 27-11-452-1550  
Fax (\*) 27-11-452-2903

### UNITED ARAB EMIRATES

Dresser Valve Division  
Units JA01 & JA02  
P.O. Box 61302, Roundabout 8  
Jebel Ali Free Trade Zone, United Arab Emirates  
Telephone (\*) 971-4-838752  
Fax (\*) 971-4-838038

### UNITED KINGDOM

Dresser U.K. Limited  
Dresser Valve Division  
Gillibrands Estate  
Skelmersdale, Lancashire  
WN8 9TU England  
Telephone (\*) 44-1695-52600  
Telex (851) 627039  
Fax (\*) 44-1695-720175

Dresser Valve Division  
Unit 5, Brook Business Center  
Crowley Mill Road  
Uxbridge, Middlesex  
England UB8 2FX  
Telephone (\*) 44-1895-454900  
Fax (\*) 44-1895-454919

The appropriate International Access Code will need to precede the telephone/ fax number if you are placing a call to a location outside of your country.



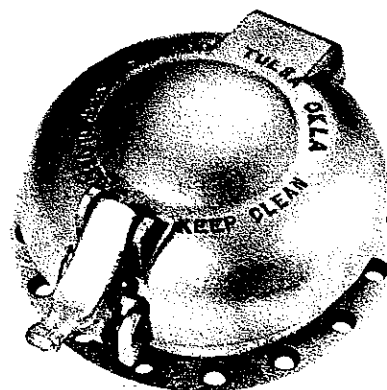
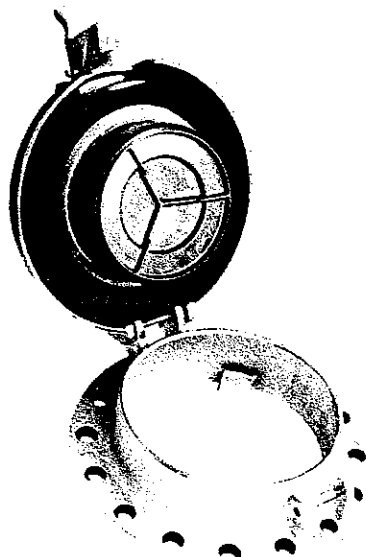
**Dresser Equipment Group, Inc**  
Alexandria, Louisiana 71309-1430 (USA)

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A Halliburton Company

# ENARDO MODEL 660

## THIEF HATCH



*400° F OP. TEMP.*

### SPRING-LOADED

The series 660 spring loaded thief hatch is designed with a round base and cover. It is intended for use on steel and fiberglass tanks which require a vapor tight seal.

**SERIES 660:** Standard 4 oz. pressure setting with 4/10 oz. vacuum relief

**BOLTING PATTERN:** 10-3/8" Circle API, for nominal 8" tank opening

**CONSTRUCTION:** Iron and aluminum castings (non-sparking)

**OPTIONAL EQUIPMENT:**

1. Plastic Trim (PT)
2. Pressure Setting (2, 4, 6, 8, 12, 16 or 24 oz.)
3. Base Gasket
4. Bolt Set
5. Non-Corrosive Coating

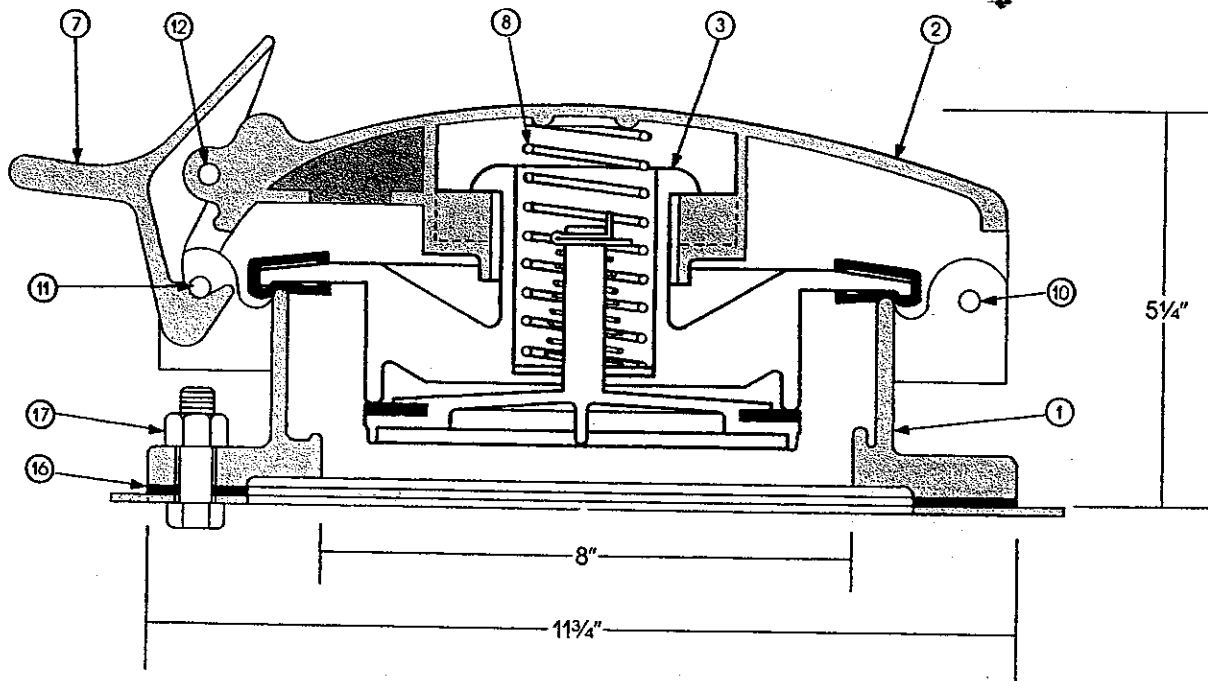
**ORDERING INFORMATION:**

1. Give series number (660 or 660PT)
2. State desired pressure setting
3. Indicate options desired

**SHIPPING WEIGHT:** (approximately)  
25 lbs.

### ENARDO MANUFACTURING CO.

Post Office Box 266  
Tulsa, Oklahoma 74101  
(918) 835-6974  
(800) 322-1155 (Outside Okla.)



**SERIES 660**

Ref.	Part No.	Part Name	Material	Quantity
1	61	Base	Cast Iron	1
2	63	Cover	Cast Aluminum	1
3	72SA1	Center (see Center Assy)	Assembly	1
*3	72SA1-PT	Center (see Center Assy)	Plastic Assembly	1
7	9	Latch	Cast Aluminum	1
8	660-PS-4	4 oz. Pressure Spring	Plt'd. (green coded)	1
+8	660-PS-2	2 oz. Pressure Spring	Plt'd. (black coded)	1
+8	660-PS-8	8 oz. Pressure Spring	Plt'd. (orange coded)	1
+8	660-PS-16	16 oz. Pressure Spring	Plt'd. (blue coded)	1
+8	660-PS-24	24 oz. Pressure Spring	Plt'd. (red coded)	1
10	5-0	Cover Hinge Pin	CRS Plt'd.	1
11	5-F	Latching Pin	CRS Plt'd.	1
12	5-C	Latch Pin	CRS Plt'd.	1
+16	660 BG	Base Gasket	Tank Packing	1
+17	1/2-13x1-1/2	Bolt, Hex	Plt'd.	16
+17	1/2-13	Nut, Hex	Plt'd.	16
19	HCP-148	Hinge Pin Clip	Plt'd.	6

\*Plastic Trim Series

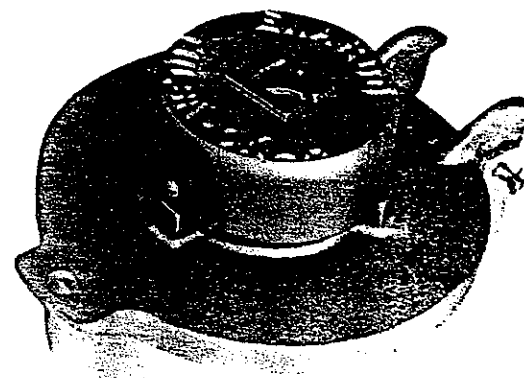
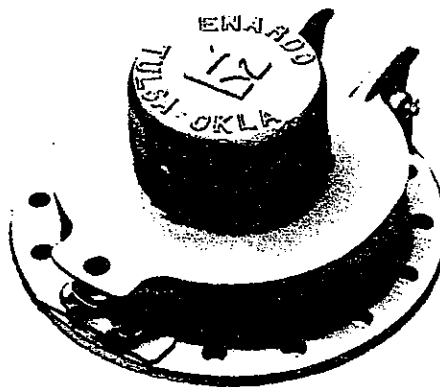
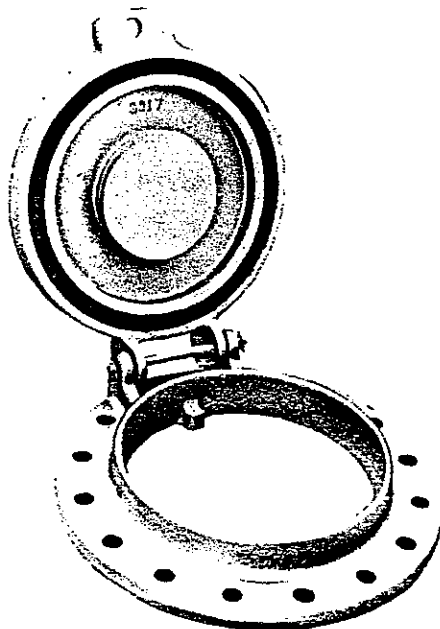
+Furnished upon Request only

NOTE: Inconel Springs will be furnished upon request

# ENARDO MODEL A

PSV-650

## THIEF HATCH



(weld neck base)

### ECONOMICAL PRESSURE—VACUUM VALVE • DEADWEIGHT

The Model A is a deadweight pressure-vacuum relief gauge and thief hatch with a round base. This hatch was specifically designed to meet the demand for an inexpensive valve yet to maintain the ENARDO quality standards. It is designed for use on steel or fiberglass storage tanks.

**MODEL A:** 2 oz. or 4 oz. pressure setting and 4/10 oz. vacuum relief

**BOLTING PATTERN:** 10-3/8" Circle API, for nominal 8" tank opening

**CONSTRUCTION:** Iron and Aluminum castings

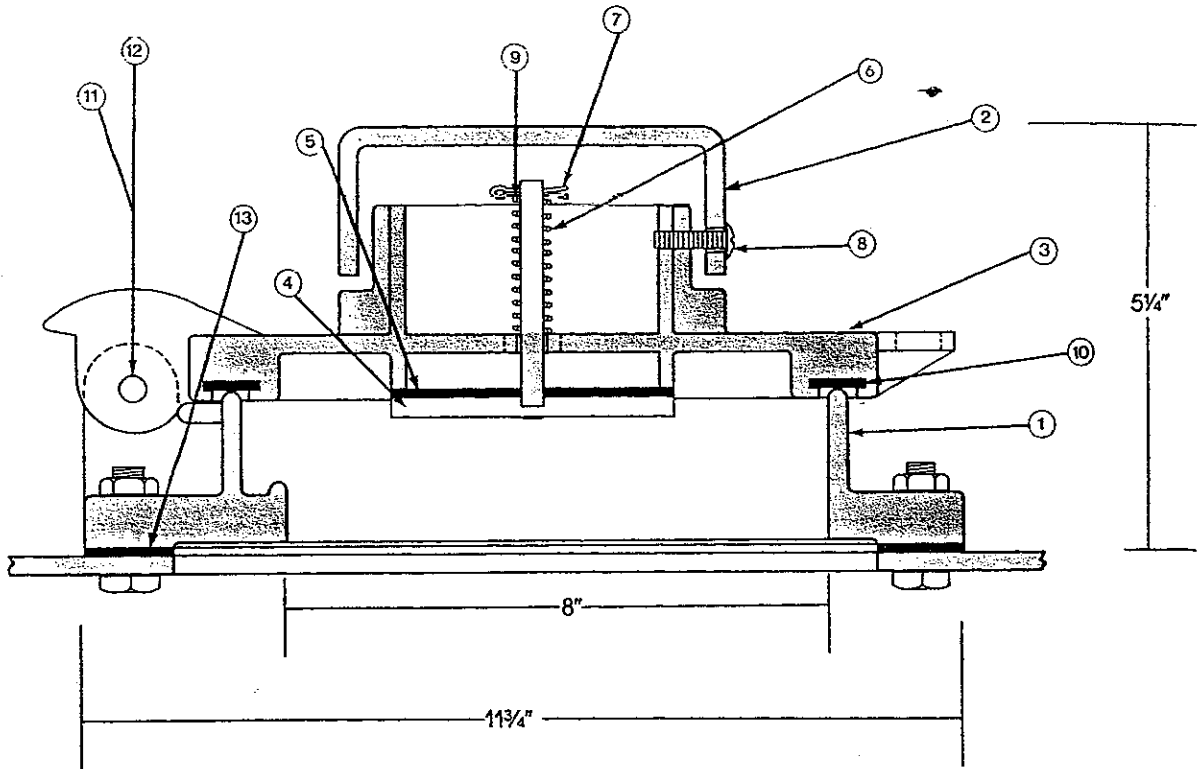
**OPTIONAL EQUIPMENT:**

1. Base Gasket
2. Weld Neck Base
3. Galvanized Coating
4. Epoxy Coating
5. Viton Gaskets
6. Personalized Name

**SHIPPING WEIGHT:** 2 oz. 25 lbs.  
4 oz. 30 lbs.

### ENARDO MANUFACTURING CO.

Post Office Box 266  
Tulsa, Oklahoma 74101  
(918) 835-6974  
(800) 322-1155 (Outside Okla.)



#### MODEL A

Ref.	Part No.	Part Name	Material	Quantity
1	11	Base	Cast Iron	1
2	*WN	Base	Steel	1
*2	A101-2	Cap	Cast Aluminum	1
3	A102	Center	Cast Iron	1
*3	A102-2	Center	Cast Aluminum	1
4	A103	Vacuum Disc	Cast Aluminum	1
5	A104	Vacuum Gasket	Buna N	1
*5	A104V	Vacuum Gasket	Viton	1
6	A105	Vacuum Disc Spring	Stainless Steel	1
7	A106	Coffer Key	Plated	1
8	A107	Cap Set Screw	Plated	1
9	A108	Washer	Plated	1
*10	110-GV	Pressure Gasket	Sponge Viton	1
11	5-K	Hinge Pin	CRS Plated	1
12	HPC-148	Hinge Pin Clip	Plated	2
*13	110-BG	Base Gasket	Tank Packing	1
*14	1/2-13x1 1/2	Bolt, Hex	Pltd.	16
*14	1/2-13	Nut, Hex	Pltd.	16

\*Optional — Furnished upon request only.

# Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PROPAK

P/O# P171531

Date 21/MAR/05

Serial # TN 90060

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 1912GC-3 Cap Style  Screwed  Plain  Packed

Size 1 1/2 48.3mm Province ALTA Spring Number 0A222CR

Set Pressure 8963 KPA CDTP — Spring Range 1266 to 1340

Back Pressure ∅ Temperature 43°C

Capacity 21316 NM3/HR AIR Stamped/Checked By EB

Tag PSV-600-54468/152 Assembled By EB

Service Medium NAT GAS Comments 1299.63

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable.

Conversion of Manufacturers Parts	
Part Description	Reworked Dimensions

Check box if spring washers required machining

<u>EB</u>
Machined by
<u>EB</u>
Checked by

Set/Test Pressure 1<sup>st</sup> 9096 KPag  
2<sup>nd</sup> 9096  
3<sup>rd</sup> 9096

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle H  
Base Assembly H  
Checked by EB

Gauge No. H003AB

Reseat Pressure 8000 KPag

Blowdown 1096 KPag

Simmer Point 8828 KPag

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_  
Lower -6 Notches

Stamping Checked By JH

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.

# Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PROPAK

P/O# P171531

Date 21/MAR/05

Serial # TP07095

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 19096LC-2-MT-LA Cap Style  Screwed  Plain  Packed

Size 3/4 26.7mm Province ACTA Spring Number W1170NC

Set Pressure 1000 KPA CDTP — Spring Range 135 to 146

Back Pressure Ø Temperature 36°C

Capacity 116.40 LPM Stamped/Checked By EB

Tag PSV-601-54468/152 Assembled By EB

Service Medium Glycol Comments \_\_\_\_\_

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable  
1095 KPag

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	

Check box if spring washers required machining

Checked by \_\_\_\_\_

Set/Test Pressure 1<sup>st</sup> 1020 KPag  
2<sup>nd</sup> 1020 KPag  
3<sup>rd</sup> 1020 KPag

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Gauge No. H002C,D

Reseat Pressure 830 KPag

Blowdown 190 KPag

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Simmer Point N/A

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By JH

Lower \_\_\_\_\_ Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.



Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PREPAK

P/O# P171531

Date 21/MAR/05

Serial # TP07100

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 19096LC-2-MT-LA Cap Style  Screwed  Plain  Packed

Size 3/4 26.7mm Province ACTA Spring Number W1170NC

Set Pressure 1000 LPA CDTP — Spring Range 135 to 146

Back Pressure ∅ Temperature 36°C

Capacity 116.40 Lpm Stamped/Checked By EB

Tag PSV-602-54468/52 Assembled By EB

Service Medium Glycol Comments 145 PSI

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable  
1065KPag

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	
<input type="checkbox"/> Check box if spring washers required machining		Checked by

Set/Test Pressure 1<sup>st</sup> 1017 KPag  
2<sup>nd</sup> 1017 KPag  
3<sup>rd</sup> 1017 KPag

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Gauge No. H002CD

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Reseat Pressure 861 KPag

Blowdown 156 KPag

Simmer Point N/A

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By JH

Lower \_\_\_\_\_ Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

This valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.



ENGINEERING AND CONTROLS LTD.

54468-152

FORM.105.REV.9

Sales Order C60000-2

Customer PROPAK

P/O# PI71531

Date 4/MAR/05

Serial # TP08509

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 1905LC Cap Style  Screwed  Plain  Packed

Size 3 88.9mm Province ATA Spring Number 0313CR

Set Pressure 1724 kPa CDTP — Spring Range 248 to 285

Back Pressure 0 Temperature -5°C

Capacity 24245 Nm<sup>3</sup>/HR AIR Stamped/Checked By [Signature]

Tag PSV-610 Assembled By [Signature]

Se Medium HC GAS Comments 249.98

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable

Conversion of Manufacturers Parts					
Part Description	Reworked Dimensions				
<input checked="" type="checkbox"/> Check box if spring washers required machining					
<table border="1"> <tr><td><u>[Signature]</u></td></tr> <tr><td>Machined by</td></tr> <tr><td><u>[Signature]</u></td></tr> <tr><td>Checked by</td></tr> </table>		<u>[Signature]</u>	Machined by	<u>[Signature]</u>	Checked by
<u>[Signature]</u>					
Machined by					
<u>[Signature]</u>					
Checked by					

Set/Test Pressure 1<sup>st</sup> 1737  
2<sup>nd</sup> 1737  
3<sup>rd</sup> 1737

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle #  
Base Assembly #  
Checked by [Signature]

Gauge No. H003AB

Reseat Pressure 1549  
Blowdown 1549  
Simmer Point 188

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By [Signature]

Ring Settings: Upper  

Stamping Checked By [Signature]

Lower 11 Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.



ENGINEERING AND CONTROLS LTD.

Sales Order C60060-3

Customer PROPAK

Consolidated Pressure Safety Valve

P/O# P171531

Test Certificate and Serial Number File

Date 26/APR/05

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Serial # TP12155

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 1905LC Cap Style  Screwed  Plain  Packed

Size 3 88.9mm Province AITA Spring Number 0313CR

Set Pressure 1724 kPa CDTP — Spring Range 248 to 285

Back Pressure Ø Temperature 30°C

Capacity 24245 NMB/HR AIR Stamped/Checked By EB

Tag PSV-615-54468/152 Assembled By EB

Service Medium HCGAs Comments 249.98

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure if applicable

Conversion of Manufacturers Parts	
Part Description	Reworked Dimensions
<input checked="" type="checkbox"/> Check box if spring washers required machining Washers machined by: <u>EB</u>	
Machined by	
Checked by	

Set/Test Pressure 1<sup>st</sup> 1724  
2<sup>nd</sup> 1724  
3<sup>rd</sup> 1724

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle H  
Base Assembly H  
Checked by EB

Gauge No. H003AB

Reseat Pressure 1482

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Blowdown 242

Simmer Point 1718

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By GL

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By GL

Lower 11 Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.

Sales Order C60000-1  
Customer PROPAK  
P/O# P171531  
Date 21/MAR/05  
Serial # TPO5864

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 19567mc-2-FT-SG-GS Cap Style  Screwed  Plain  Packed

Size 2 603mm Province ATA Spring Number W6170IX

Set Pressure 3792 KPA CDTF \_\_\_\_\_ Spring Range 545 to 599

Back Pressure 0 Temperature -13°C

Capacity 9102 NM3/HR AIR Stamped/Checked By EB

Tag PSV-630 - 54468/152 Assembled By EB

Service Medium SOURHEVAPOUR Comments 549.84 PSI

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure if applicable

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	

Check box if spring washers required machining

Checked by \_\_\_\_\_

Set/Test Pressure 1<sup>st</sup> 3848 KPag  
2<sup>nd</sup> 3848 KPag  
3<sup>rd</sup> 3848 KPag

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Gauge No. H003A,B

Reseat Pressure 3538 KPag

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Blowdown 310 KPag

Simmer Point 3807 KPag

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By JH

Lower \_\_\_\_\_ Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.

# Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PREPAK

P/O# P171531

Date 21/MAR/05

Serial # TP07119

Cor. Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 19226 LC-2-MT-GS Cap Style  Screwed  Plain  Packed

Size 1 33.4mm Province ACTA Spring Number W2200 NC

Set Pressure 1724 kPA CDTP — Spring Range 239 to 265

Back Pressure Ø Temperature 93°C

Capacity 1696 NM3/HR AIR Stamped/Checked By EB

Tag PSV-640-54468/152 Assembled By EB

Service Medium HC VAP Comments 249.98

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure if applicable

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	
		Checked by

Check box if spring washers required machining

Set/Test Pressure 1<sup>st</sup> 1765 KPag  
2<sup>nd</sup> 1765  
3<sup>rd</sup> 1765

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Reseat Pressure 1586 KPag

Gauge No. H002C/D

Blowdown 179 KPag

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Simmer Point 1752 KPag

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By JH

Lower \_\_\_\_\_ Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured By Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.

# Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PROPAK

Consolidated Pressure Safety Valve

P/O# P171531

Test Certificate and Serial Number File

Date 21/MAR/05

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Serial # TPO2608

Code Case \_\_\_\_\_ Code Stamp (UV) V NC

Description 19357LC-2-FT-6IS Cap Style  Screwed  Plain  Packed

Size 1 1/2 483mm Province ALTA Spring Number W3220NC

Set Pressure 1724 KPA CDTP — Spring Range 247 to 268

Back Pressure 0 Temperature 66°C

Capacity 2679 Nm3/HR AIR Stamped/Checked By CS

Tag PSV-670-54468/152 Assembled By CS

Service Medium PROP VAP Comments 249.98

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	

Check box if spring washers required machining

Checked by

Set/Test Pressure 1<sup>st</sup> 1731 KPag  
2<sup>nd</sup> 1731  
3<sup>rd</sup> 1731

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Gauge No. H002C,P  
Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Reseat Pressure 1586 KPag

Blowdown 145 KPag

Simmer Point 1717 KPag

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By JH

Ring Settings: Upper \_\_\_\_\_

Stamping Checked By JH

Lower \_\_\_\_\_ Notches

Witnessed By \_\_\_\_\_  
(Customers Inspector)

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured by Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.



ENGINEERING AND CONTROLS LTD.

Sales Order C60000-2

Customer PROPAK

P/O# P171531

Date 4/MAR/05

Serial # TP09810

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp UV V NC

Description 19567LC-2-FT-615 Cap Style  Screwed  Plain  Packed

Size 2 60.3<sup>mm</sup> Province ACTA Spring Number W3250NC

Set Pressure 1724 kPa CDTP — Spring Range 238 to 257

Back Pressure 0 Temperature 43°C

Capacity 4256 NM<sup>3</sup>/HR AIR Stamped/Checked By EB

Tag PSV-681-54468/152 Assembled By EB

Service Medium PROP VAP Comments 249.98

Test Medium  Air  
 Steam  
 Water

Liquid Trim Valves Only.  
Record popping pressure  
if applicable

Conversion of Manufacturers Parts	
Part Description	Reworked Dimensions
<input type="checkbox"/> Check box if spring washers required machining	
Machined by	
Checked by	

Set/Test Pressure 1<sup>st</sup> 1724  
2<sup>nd</sup> 1724  
3<sup>rd</sup> 1724

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Gauge No. H003AB

Reseat Pressure 1572  
Blowdown 152  
Simmer Point 1720

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Tested By AL

Ring Settings: Upper —

Stamping Checked By AL

Lower — Notches

Witnessed By \_\_\_\_\_

(Customers Inspector)

Remarks \_\_\_\_\_

# Barber

ENGINEERING AND CONTROLS LTD.

FORM.105.REV.9

Sales Order C60000-1

Customer PROPAK

P/O# PL71531

Date 21/MAR/05

Serial # TP02607

Consolidated Pressure Safety Valve

Test Certificate and Serial Number File

AS APPROPRIATE, ENSURE ALL UNITS ARE SPECIFIED AS PER CUSTOMERS REQUIREMENTS

Code Case \_\_\_\_\_ Code Stamp UV V NC

Description 19357LC-2-FT-GS

Cap Style  Screwed  Plain  Packed

Size 1.12 483mm Province ATD

Spring Number W3220WC

Set Pressure 1724 KPA CDTP \_\_\_\_\_

Spring Range 247 to 268

Back Pressure Ø Temperature 38°C

Capacity 2679 NM3/HR AIR

Stamped/Checked By EB

Tag PSV-6 90-54468/152

Assembled By EB

Service Medium NAT GAS Comments 249.98 PSI

Test Medium  Air  
 Steam  
 Water

Set/Test Pressure 1<sup>st</sup> 1724 KPag  
2<sup>nd</sup> 1724  
3<sup>rd</sup> 1724

Reseat Pressure 1579 KPag

Blowdown 145 KPag

Simmer Point 1697 KPag

Leakage Rate  Meets API 527 or \_\_\_\_\_ BPM

Ring Settings: Upper \_\_\_\_\_  
Lower \_\_\_\_\_ Notches

Remarks \_\_\_\_\_

The valve furnished on the above order has been inspected and found to be in accordance with specifications, drawings, and requirements of this order. Consolidated Pressure Safety Valves are manufactured by Dresser Flow Control and assembled by Barber Engineering & Controls Ltd.

Liquid Trim Valves Only.  
Record popping pressure if applicable

Manufacturers Hydrostatic  
Test Number \_\_\_\_\_  
Nozzle \_\_\_\_\_  
Base Assembly \_\_\_\_\_  
Checked by \_\_\_\_\_

Conversion of Manufacturers Parts		Machined by
Part Description	Reworked Dimensions	

Check box if spring washers required machining

Checked by \_\_\_\_\_

Gauge No. H002C,D

Back pressure test performed at:  
 30 psig / 205kpag  
 100 psig / 690kpag  
 other \_\_\_\_\_  
 Not applicable

Tested By JH

Stamping Checked By JH

Witnessed By \_\_\_\_\_  
(Customers Inspector)



PT-670

PLEASE SEE DIFFERENTIAL PRESSURE SECTION FOR  
ROSEMOUNT 3051 INFORMATION

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3			PRESSURE INSTRUMENTS				SHEET 1 OF 1	
CUSTOMER : Fort Energy PLANT : 8MM Refrigeration Plant SERVICE : Pressure Transmitter			NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.P
			1	QH	07/25/05	Issued for Purchase	JOB #	054468
							DATE	July 25, 2005
							REQ.	
				BY	CHK'D	APPR.		
1	TAG NO.	PT-670	SERVICE:					
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL _____ BLIND _____ TRANS. <u>X</u> OTHER _____						
3	CASE	MFR STD <u>X</u> _____ NOM SIZE _____ COLOR : MFR STD <u>X</u> _____ OTHER _____						
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER 2" Pipe Mount _____						
5	ENCLOSURE CLASS	GENERAL PURPOSE _____ WEATHER PROOF _____ EXPLOSION PROOF <u>X</u> _____ CLASS 1 Div 2 _____						
6	POWER SUPPLY	FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____						
7	CHART	117 V 60Hz _____ OTHER AC _____ DC <u>X</u> _____ VOLTS 24 _____						
8	CHART DRIVE	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____						
9	SCALES	SPEED _____ POWER _____						
		TYPE _____						
		RANGE 1 _____ 2 _____ 3 _____ 4 _____						
X	10	TRANSMITTER	4 - 20 mA <u>X</u> _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____					
M		OUTPUT	FOR RECEIVER SEE SPEC. SHEET _____					
C	11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____					
O			OTHER _____					
N	12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES _____					
R	13	AUTO - MAN SWITCH	NONE _____ MFR STD _____ OTHER _____					
O	14	SET POINT ADJ.	MANUAL _____ EXTERNAL _____ REMOTE _____ OTHER _____					
L	15	MANUAL REG.	NONE _____ MFR STD _____ OTHER _____					
E	16	OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(ga) _____ 42 - 206 kPa (ga) _____ OTHER _____					
R								
E	17	SERVICE	GAGE PRESS. <u>X</u> _____ VACUUM _____ ABSOLUTE _____ COMPOUND _____					
L	18	ELEMENT TYPE	DIAPHRAGM <u>X</u> _____ HELIX _____ BOURDON _____ BELLOWS _____ OTHER _____					
E	19	MATERIAL	316 SS <u>X</u> _____ BER. COPPER _____ OTHER _____					
M	20	RANGE	FIXED _____ ADJ. RANGE 0-20.7 bar(g) _____ SET AT 0-1750 kPa(g) _____					
E			OVERRANGE PROTECTION TO 110.3 barg _____ BURST PRESSURE: 758 barg _____					
N	21	PROCESS DATA	PRESSURE : NORMAL 100 kPa(g) _____ MAX. 1724 kPa(g) _____ ELEMENT RANGE 0-20.7 bar(g) _____					
T	22	PROCESS CONN.	1/4 INCH NPT _____ 1/2 INCH NPT <u>X</u> _____ OTHER _____					
			LOCATION : BOTTOM <u>X</u> _____ BACK _____ OTHER _____					
	23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____					
	24	FUNCTION	PRESSURE _____ DEVIATION _____ CONTACTS TO _____ ON INC. PRESS _____					
	25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____					
			DIAPH SEAL _____ TYPE _____ DISPH _____ BOT BOWL _____					
			CONN. _____ CAPILLARY : LENGTH _____ MATERIAL _____					
			OTHER 305RC22B11B4 _____					
	26	MANUFACTURER.	<u>ROSEMOUNT</u> _____					
	27	MODEL NO.	<u>3051CG4A22A1AS5C6</u> _____					
	28	P. O. NUMBER	_____					

NOTES:

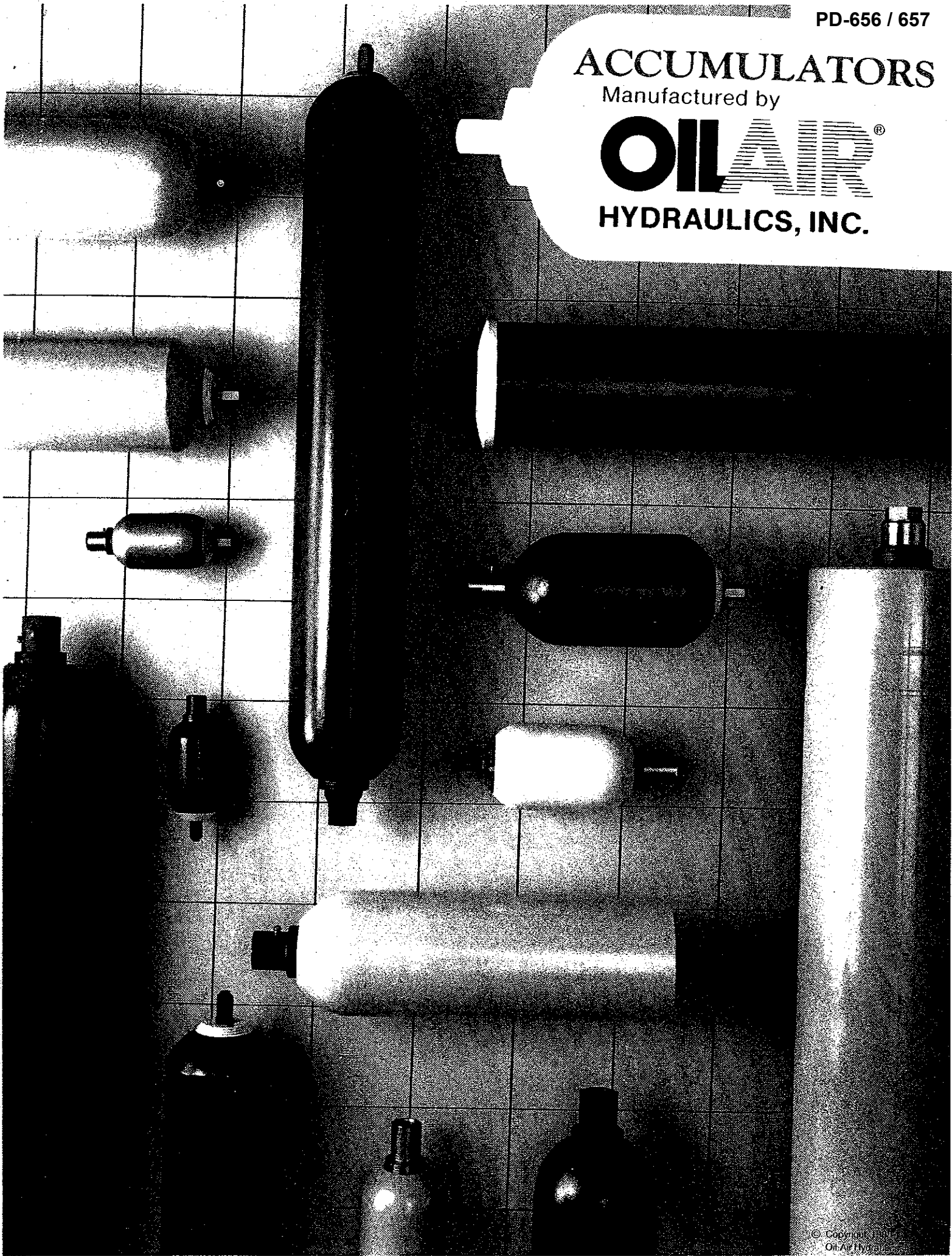
AREA. UNIT # :

# ACCUMULATORS

Manufactured by

# OILAIR<sup>®</sup>

## HYDRAULICS, INC.



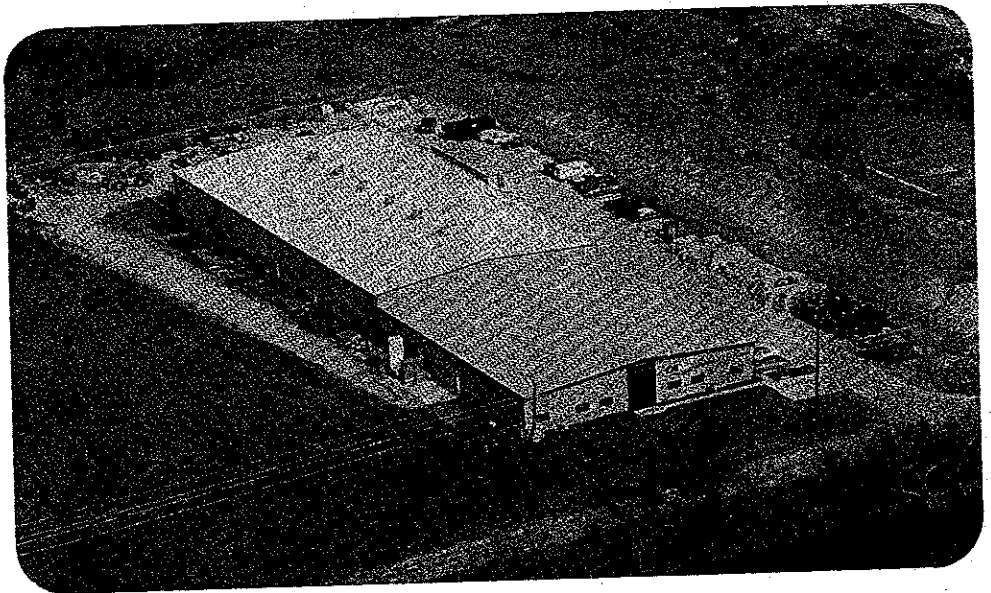
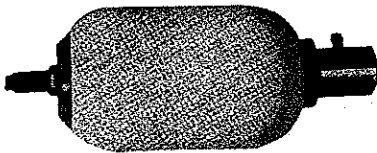
**Oil Air Hydraulics, Inc.** is supplying the Fluid Power Industry with product, reliability, service and design equal to or superior to those of any manufacturer in the industry today.

Oil Air's main 30,000 sq. ft. manufacturing facility is situated on five acres in Brookshire, Texas (just west of Houston, Texas) and supplies a full line of accumulators to the world market. Manufacturing and warehousing facilities are also located in Aberdeen, Scotland, Singapore and Mexico City, Mexico. This product line includes the fully enclosed Bladder Accumulator, the Top Repairable fully enclosed Bladder Accumulator and the Oil Air Float Accumulator, as well as a full range of other type accumulators. These accumulators are available in all the popular sizes and pressures and cover a wide range of applications.

Oil Air products are available through a network of domestic and international distributors who are experienced in the design and application of fluid power systems and are available on call throughout the world to serve your requirements.



**OIL AIR**<sup>®</sup>  
**HYDRAULICS, INC.**



Oil Air Hydraulics, Inc. in Brookshire, Texas

### **Experience.**

Oil Air's management and staff have more experience designing, manufacturing and selling bladder accumulators than other domestic suppliers.

### **Engineering, Design and Quality Assurance.**

All Oil Air products are produced under the strictest controls to ensure reliable, trouble-free service to customers. Beginning with carefully reviewed designs, products are continually reviewed for high performance under Oil Air's agency approved Quality Assurance Program.

The main plant is a National ASME and State Agency approved manufacturer of pressure vessels and is also under constant review by the other agencies.

All standard accumulators are available with most domestic and international code approvals and meet their respective rigid requirements. Most standard accumulators are available with an ASME, USCG, TUV, Lloyds or DNV code stamp. Other codes are also available.

### **SAFETY FEATURES**

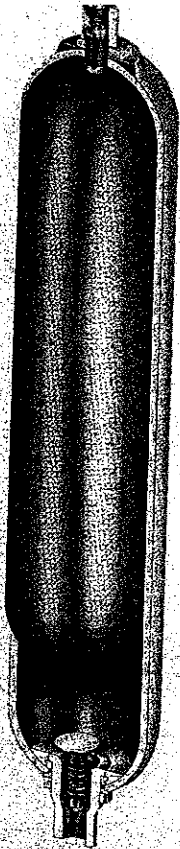
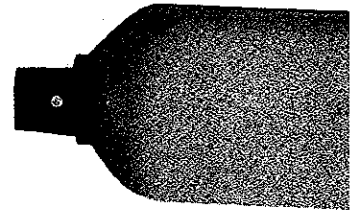
- Safety factor exceeding code requirements.
- Cannot be disassembled when pressurized.
- Pressure relief design feature.
- Factory shipped with Inert Gas (N<sub>2</sub>).
- Complies with all applicable transportation safety codes.

"OIL AIR" is a trademark of Oil Air Hydraulics, Inc.



# STANDARD BLADDER ACCUMULATORS

## THE INDUSTRY STANDARD



Standard Bladder Accumulator

- Accumulators and parts are interchangeable with accumulators produced by other major manufacturers.
- Accumulator cannot be disassembled under pressure.

Major Component	Standard Material	Material Options	Features
Shell	Chrome-Molybdenum Steel, SA372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• Homogenous seamless shell.</li> <li>• Integral pressure relief.</li> <li>• Available with foreign or domestic codes.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• Viton</li> <li>• EPR</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• Design has over 30 years of proven reliability.</li> <li>• See Oil Port options, pages 12-13.</li> </ul>

\*Some material options are at extra cost.

## SPECIFICATIONS (U.S./Metric)

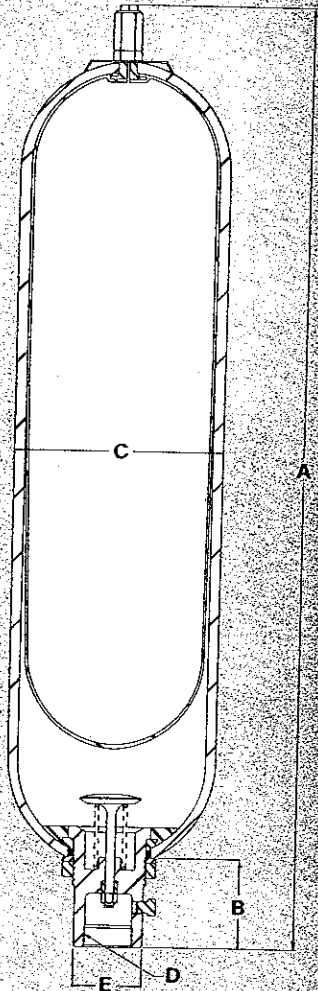
### OIL AIR STANDARD BLADDER ACCUMULATOR—3000 PSI (206.90 bars)

Part No.	Size		Gas Volume		A		B		C		D	E		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	FPT*	In.	cm.	Lbs.	Kg
1qt.-100-1	.25	.946	73	1,196	1 1/2	29.2	2 1/2	5.4	4 1/2	11.4	1"	3	7.6	10	4.5
1-100-1	1	3.78	235	3,851	1 7/8	45.1	3 1/2	8.8	6 1/2	17.1	1 1/4"	3	7.6	34	15
2.5-100-2	2.50	9.46	600	9,834	2 1/8	53.3	3 1/2	8.8	9 1/8	23.0	2"	3	7.6	80	36
5-100-2	5	18.9	1,203	19,717	3 3/8	84.4	3 1/2	8.8	9 1/8	23.0	2"	3	7.6	120	54
10-100-2	10	37.8	2,259	37,025	5 1/4	137	3 1/2	8.8	9 1/8	23.0	2"	3	7.6	220	100
11-100-2	11	41.6	2,535	41,549	5 9/16	151	3 1/2	8.8	9 1/8	23.0	2"	3	7.6	240	109
15-100-2	15	56.7	3,440	56,382	7 1/8	196	3 1/2	8.8	9 1/8	23.0	2"	3	7.6	305	138

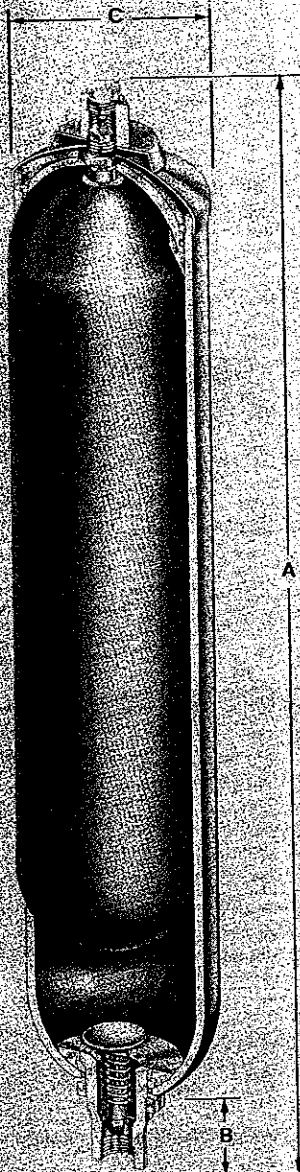
### OIL AIR STANDARD BLADDER ACCUMULATOR—5000 PSI (344.83 bars)

Part No.	Size		Gas Volume		A		B		C		D	E		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	FPT*	In.	cm.	Lbs.	Kg
2.5-5-100-2	2 1/2	9.46	600	9,834	2 1/8	54.6	3 3/4	9.5	9 1/8	24.3	2"	3	7.6	120	54
5-5-100-2	5	18.9	1,203	19,717	3 3/8	85.7	3 3/4	9.5	9 1/8	24.3	2"	3	7.6	220	100
10-5-100-2	10	37.8	2,259	37,025	5 1/4	138	3 3/4	9.5	9 1/8	24.3	2"	3	7.6	335	152
15-5-100-2	15	56.7	3,440	56,382	7 1/8	198	3 3/4	9.5	9 1/8	24.3	2"	3	7.6	485	220

\*See components and options, pages 12-13.

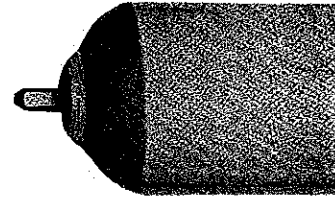


Standard Bladder Accumulator



# OILAIR®

## TOP REPAIRABLE BLADDER ACCUMULATORS



- Large, full inside diameter access.
- Utilizes standard bladder accumulator parts.
- Easily converted to Oil Air Buoyant Float Accumulator.
- Head mechanically locks to prevent disassembly under pressure.
- Volume exceeds that of standard accumulator by an average of 16%.
- Can be serviced with or without removal from manifold or line.

### UNIQUE DESIGN WITH BETTER ACCESSIBILITY FOR SERVICING AND CLEANING

Major Component	Standard Material	Material Options*	Features
Shell	Chrome-Molybdenum Steel, SA372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• Homogenous seamless shell.</li> <li>• Integral pressure relief.</li> <li>• Available with foreign or domestic codes.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• Viton</li> <li>• EPR</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• Design has over 30 years of proven reliability.</li> <li>• See Oil Port options, pages 12-13.</li> </ul>

## SPECIFICATIONS (U.S./Metric)

\*Some material options are at extra cost.

### OIL AIR TOP REPAIRABLE BLADDER ACCUMULATOR—3000 PSI (206.90 bars)

Part No.	Size		Gas Volume		A		B		C		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	Lbs.	Kg
B-5-100-2	5	18.9	1,445	23,683	35 1/2	89.5	3 1/2	8.8	9 1/8	24.6	150	68
B-10-100-2	10	37.8	2,608	42,745	55 1/2	142	3 1/2	8.8	9 1/8	24.6	245	111
B-11-100-2	11	41.6	2,935	48,105	61	156	3 1/2	8.8	9 1/8	24.6	270	122
B-15-100-2	15	56.7	3,985	65,314	80	203	3 1/2	8.8	9 1/8	24.6	355	161

### OIL AIR TOP REPAIRABLE BLADDER ACCUMULATOR—5000 PSI (344.83 bars)

Part No.	Size		Gas Volume		A		B		C		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	Lbs.	Kg
B-5-5-100-2	5	18.9	1,445	23,683	35 1/2	89.5	3 3/4	9.5	10 1/2	26.0	240	109
B-10-5-100-2	10	37.8	2,608	42,745	55 1/2	142	3 3/4	9.5	10 1/2	26.0	400	181
B-15-5-100-2	15	56.7	3,985	65,314	80	203	3 3/4	9.5	10 1/2	26.0	585	265

### MAJOR COMPONENTS AND OPTIONS:

See components and options for standard accumulators (Pages 12-13).

Head and Grommet Assembly for 3000# Assembly—Part No. F-11-203-A

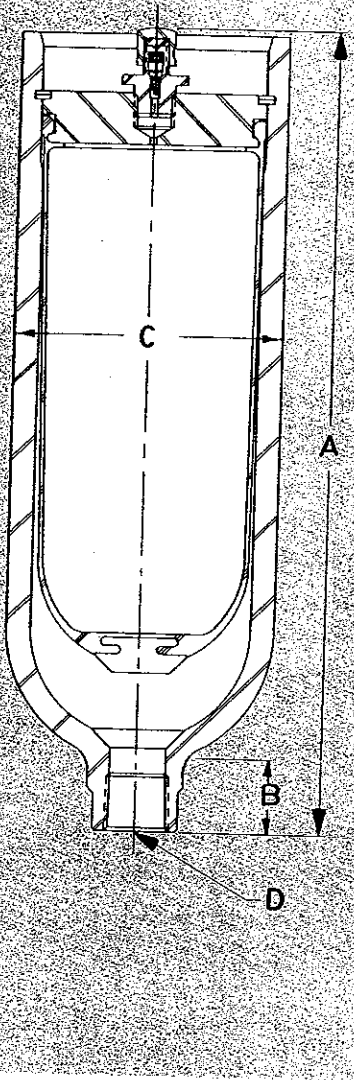
Head and Grommet Assembly for 5000# Assembly—Part No. F-11-5-203-A

Also available in Buoyant Float models



# OILAIR®

## PULSAIDER™ ACCUMULATOR



- Low cost
- Top repairable
- No mechanical moving parts
- Accumulator cannot be disassembled under pressure
- Conforms to existing codes

**UNIQUE DESIGN IS EASILY AND  
INEXPENSIVELY FULLY REPAIRABLE**

Major Component	Standard Material	Material Options*	Features
Shell	Carbon Steel SA-106 GR. B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets or exceeds 4:1 safety requirements</li> <li>• Homogeneous 1 pc seamless shell.</li> <li>• Integral pressure relief.</li> <li>• No welding.</li> </ul>
Bladder	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl**</li> <li>• EPR**</li> <li>• Viton**</li> <li>• Cold weather**</li> </ul>	<ul style="list-style-type: none"> <li>• Open mouth seamless design.</li> <li>• Molded steel button.</li> <li>• Temperature range of Buna: -30° to 180° F.</li> </ul>
Head	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Stainless steel SA 479 Type 304</li> </ul>	<ul style="list-style-type: none"> <li>• Machined forging.</li> <li>• Replaceable standard air valve.</li> </ul>

### SPECIFICATIONS (U.S./Metric)

\*Some material options are at extra cost.  
\*\*Available upon request.

#### OIL AIR PULSAIDER™ TOP-REPAIRABLE ACCUMULATOR—2000 PSI (138 BARS)

Part No.	Size		Gas Volume		A		B		C		D	Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm	In.	cm.	In.	cm.	FPT	Lbs	Kg.
P-15CI-100-1	.06	.23	15	246	8.0	20.32	1.0	2.5	3/4	6.0	1/2"	3.5	1.59
P-30CI-100-1	.13	.49	30	491	8.07	20.50	1.0	2.5	3/4	8.9	1/2"	7.5	3.41
P-60CI-100-1	.26	.98	60	983	10.94	27.78	1.0	2.5	3/4	8.9	1/2"	10.5	4.77
P-150CI-100-1	.65	2.46	150	2458	12.06	30.63	1.25	3.2	3/4	14.2	1"	23.0	10.45
P-230CI-100-1	1.00	3.78	230	3768	14.12	35.87	1.25	3.2	6/16	16.8	1"	42.5	19.32

### COMPONENTS PARTS LIST

Part/Size	15 cu. in.	30 cu. in.	60 cu. in.	150 cu. in.	230 cu. in.
Nominal Size	1/2 pint	1 pint	1 quart	3/4 gallon	1 gallon
Bladder — Buna-N.	P-15CI-300	P-30CI-300	P-60CI-300	P-150CI-300	P-230CI-300
Head	P-15CI-203	P-60CI-203	P-60CI-203	P-150CI-203	P-230CI-203
Ring	P-15CI-205	P-60CI-205	P-60CI-205	P-150CI-205	P-230CI-205
Air Valve	P-301				
Fluid Connection—NPT	1/2" FPT			1" FPT	
Fluid Connection—SAE	3/4"—16 UNF-2B			1 1/16"—12 UNF-2B	

# OILAIR®

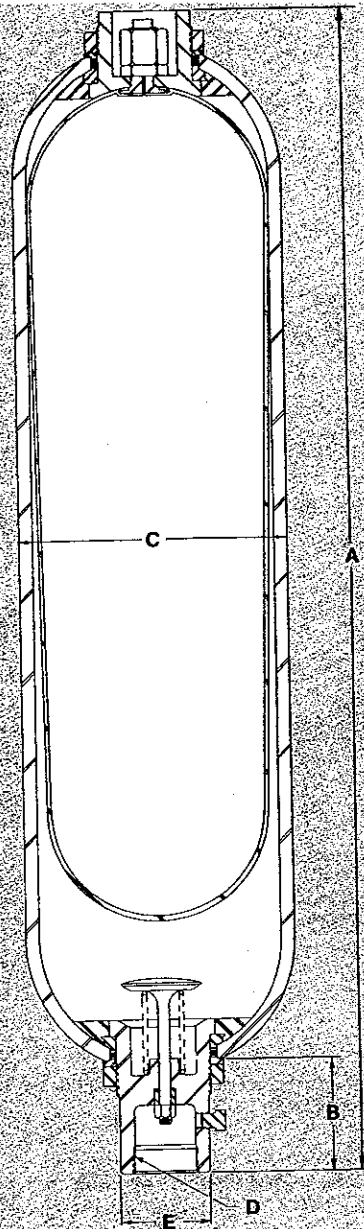
## CONVENTIONAL STYLE TOP REPAIRABLE BLADDER ACCUMULATORS

- Can be serviced from both ends.
- Utilizes many standard bladder accumulator parts.
- Gas-end adapter mechanically locks to prevent disassembly under pressure.
- Can be serviced with or without removal from manifold or line.
- Interchangeable with similar style top repairable accumulators.

**PART FOR PART INTERCHANGEABLE WITH TOP REPAIRABLE ACCUMULATORS SUPPLIED BY OTHER MAJOR MANUFACTURERS**

Major Component	Standard Material	Material Options*	Features
Shell	Chrome-Molybdenum Steel, SA372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>● Electroless-Nickel Plating 1.2 Mil.</li> <li>● Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>● Meets 4:1 safety requirements.</li> <li>● Homogenous seamless shell.</li> <li>● Integral pressure relief.</li> <li>● Available with foreign or domestic codes.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>● Butyl</li> <li>● Viton</li> <li>● EPR</li> <li>● Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>● Fully enclosed bladder.</li> <li>● Molded steel valve stem.</li> <li>● Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>● Electroless-Nickel Plating</li> <li>● SA351, GR. CF8M Stainless</li> </ul>	<ul style="list-style-type: none"> <li>● Design has over 30 years of proven reliability.</li> <li>● See Oil Port options, pages 12-13.</li> </ul>

\*Some material options are at extra cost.



Conventional Style  
Top Repairable Bladder  
Accumulator.  
Also Available in  
High Flow Models

### SPECIFICATIONS (U.S./Metric)

#### OIL AIR CONVENTIONAL STYLE TOP BLADDER ACCUMULATOR—3000 PSI (206.90 bars)

Part No.	Size		Gas Volume		A		B		C		D	E		Weight		Bladder (Buna-N) Part No.
	Gal.	Litre	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm	In.	cm.	In.	cm.	FPT*	In.	cm	Lbs.	K	
T-2.5-100-2	2.50	9.46	600	9,834	2 1/8	53.3	3 1/2	8.8	9 1/16	23.0	2	3	7.6	80	36	T-2.5-300
T-5-100-2	5	18.9	1,203	19,717	3 3/4	84.4	3 1/2	8.8	9 1/16	23.0	2	3	7.6	120	54	T-5-300
T-10-100-2	10	37.8	2,259	37,025	5 1/4	137	3 1/2	8.8	9 1/16	23.0	2	3	7.6	220	100	T-10-300
T-11-100-2	11	41.6	2,535	41,549	5 9/16	151	3 1/2	8.8	9 1/16	23.0	2	3	7.6	240	109	T-11-300
T-15-100-2	15	56.7	3,440	56,382	7 1/8	196	3 1/2	8.8	9 1/16	23.0	2	3	7.6	305	138	T-15-300

### MAJOR COMPONENTS AND OPTIONS:

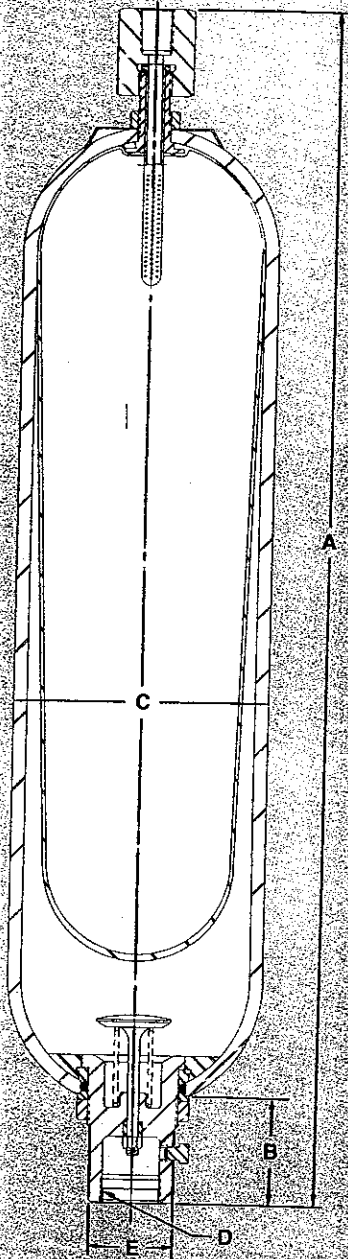
See components and options for standard accumulators (Pages 12-13).  
Gas-End Adapter — Part No. T-11-208



# OILAIR®

## TRANSFER BARRIER ACCUMULATORS

- Accumulators and parts are interchangeable with accumulators produced by other major manufacturers.
- Accumulator cannot be disassembled under pressure.



Transfer Barrier Accumulator

Major Component	Standard Material	Material Options*	Features
Shell	Chrome-Molybdenum Steel SA372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• Homogenous seamless shell.</li> <li>• Integral pressure relief.</li> <li>• Available with foreign or domestic codes.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• Viton</li> <li>• EPR</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• Design has over 30 years of proven reliability.</li> <li>• Available with NPT, SAE &amp; Metric Threads.</li> </ul>
Air Tube Assembly	304 Stainless	None	<ul style="list-style-type: none"> <li>• Available in 4½", 5½", 6½" length.</li> </ul>
Air Valve Adapter	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> </ul>	<ul style="list-style-type: none"> <li>• Available with ¼" to 1¼"</li> <li>• FPT or SAE.</li> </ul>

### SPECIFICATIONS (U.S./Metric)

\*Some material options are at extra cost.

#### OIL AIR TRANSFER BARRIER ACCUMULATOR-3000 PSI (206.90 bars)

Part No.	Size		Gas Volume		A		B		C		D	E		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	FPT*	In.	cm.	Lbs.	Kg
TB-2.5-100-2	2.50	9.46	600	9,834	21½	54.6	3½	8.8	9½	23.0	2"	3	7.6	80	36
TB-5-100-2	5	18.9	1,203	19,717	33¾	85.7	3½	8.8	9½	23.0	2"	3	7.6	120	54
TB-10-100-2	10	37.8	2,259	37,025	54	137.8	3½	8.8	9½	23.0	2"	3	7.6	220	100
TB-11-100-2	11	41.6	2,535	41,549	60	152.4	3½	8.8	9½	23.0	2"	3	7.6	240	109
TB-15-100-2	15	56.7	3,440	56,382	78	198.1	3½	8.8	9½	23.0	2"	3	7.6	305	138

#### OIL AIR TRANSFER BARRIER ACCUMULATOR-5000 PSI (344.83 bars)

Part No.	Size		Gas Volume		A		B		C		D	E		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	FPT*	In.	cm.	Lbs.	Kg
TB-2.5-5-100-2	2½	9.46	600	9,834	22	55.9	3%	9.5	9½	24.3	2"	3	7.6	120	54
TB-5-5-100-2	5	18.9	1,203	19,717	34½	87	3%	9.5	9½	24.3	2"	3	7.6	220	100
TB-10-5-100-2	10	37.8	2,259	37,025	55	139.7	3%	9.5	9½	24.3	2"	3	7.6	335	152
TB-15-5-100-2	15	56.7	3,440	56,382	79	199.7	3%	9.5	9½	24.3	2"	3	7.6	485	220

#### AIR SIDE COMPONENTS

Adapter, Part No. 11-312-TB  
 2½ Gallon Tube, Part No. 11-311-TB-A  
 5, 10 Gallon Tube, Part No. 11-311-TB-B  
 11, 15 Gallon Tube, Part No. 11-311-TB-C  
 O-Ring, Part No. 11-313-TB

#### BLADDERS

2½ Gallon, Part No. TB-2.5-300  
 5 Gallon, Part No. TB-5-300  
 10 Gallon, Part No. TB-10-300  
 11 Gallon, Part No. TB-11-300  
 15 Gallon, Part No. TB-15-300

See components and options for standard accumulators (pages 12-13).

# OILAIR® STANDARD HIGH FLOW BLADDER ACCUMULATORS

- For systems requiring faster response.
- Accumulator and parts are interchangeable with accumulators produced by other major manufacturers.
- Accumulator cannot be disassembled under pressure.

## FOR SYSTEMS SUBJECT TO HIGH CHARGING AND DISCHARGING FLOW RATES

Major Component	Standard Material	Material Options	Features
Shell	Chrome-Molybdenum Steel, SA 372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• Homogenous seamless shell.</li> <li>• Integral pressure relief.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• EPR</li> <li>• Viton</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• Design has proven reliability.</li> <li>• 600 GPM flow rate.</li> </ul>

\*Some material options are at extra cost.

## SPECIFICATIONS (U.S./Metric)

### OIL AIR HIGH FLOW BLADDER ACCUMULATORS—3000 PSI (206.90 bars)

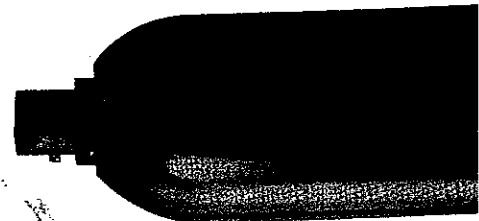
Part No.	Size		Gas Volume		A		B		C		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	In.	cm.	Lbs.	Kg
H-2.5-100	2.5	9.46	600	9,834	2.25	57.1	5%	13.6	9 1/16	23.0	80	36
H-5-100	5	18.9	1,203	19,717	3.43	88.3	5%	13.6	9 1/16	23.0	120	54
H-10-100	10	37.8	2,259	37,025	5.52	141.0	5%	13.6	9 1/16	23.0	220	100
H-11-100	11	41.6	2,535	41,549	61.0	155.0	5%	13.6	9 1/16	23.0	240	109
H-15-100	15	56.7	3,440	56,382	79.0	200.6	5%	13.6	9 1/16	23.0	305	138

## MAJOR COMPONENTS AND OPTIONS:

**Bladders**—See standard accumulator options (Pages 12-13).

**Oil Port**—Part No. H-11-400-2 (4"-8 MPT), Part No. H-11-400-3 (4 1/2"-8 UN) (SAE), Part No. H-11-400-4 (Metric)

**Water Service**—Available with electroless nickel plating (Add -WS) and Stainless (Add -SS) components.



# OILAIR®

## TOP REPAIRABLE HIGH FLOW BLADDER ACCUMULATORS

- Head mechanically locks to prevent disassembly under pressure.
- Volume exceeds that of standard accumulator by an average of 16%.
- For systems subject to high charging and discharging flow rates and faster response.
- Large, full inside diameter access.
- Can be serviced with or without removal from manifold or line.

### UNIQUE DESIGN WITH BETTER ACCESSIBILITY FOR SERVICING AND CLEANING

Major Component	Standard Material	Material Options*	Features
Shell	Chrome-Molybdenum Steel, SA 372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• Homogenous seamless shell.</li> <li>• Integral pressure relief.</li> <li>• Full I.D. open mouth for better accessibility.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• EPR</li> <li>• Viton</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna: -45° to 180° F.</li> </ul>
Oil Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• Design has proven reliability.</li> <li>• 600 GPM flow rate.</li> </ul>

## SPECIFICATIONS (U.S./Metric)

\*Some material options are at extra cost.

### OIL AIR TOP REPAIRABLE HIGH FLOW BLADDER ACCUMULATOR—3000 PSI (206.90 bars)

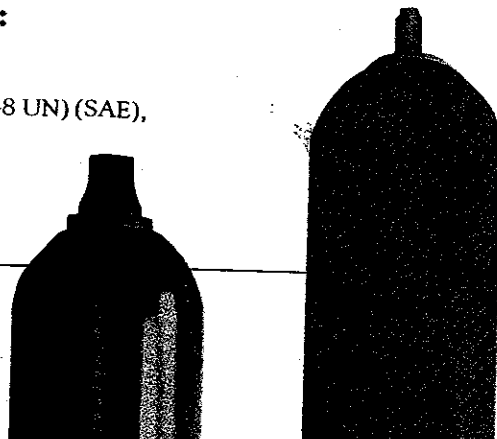
Part No.	Size		Gas Volume		A		B		C		Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm	In.	cm.	In.	cm.	Lbs.	Kg
HT-5-100	5	18.9	1,445	23,683	36 3/4	93.3	5.0	12.7	9 1/2	24.6	150	68
HT-10-100	10	37.8	2,608	42,745	57 1/4	145.4	5.0	12.7	9 1/2	24.6	245	111
HT-11-100	11	41.6	2,935	48,105	63 1/2	160.0	5.0	12.7	9 1/2	24.6	270	122
HT-15-100	15	56.7	3,985	65,314	81 1/2	207.0	5.0	12.7	9 1/2	24.6	355	161

## MAJOR COMPONENTS AND OPTIONS:

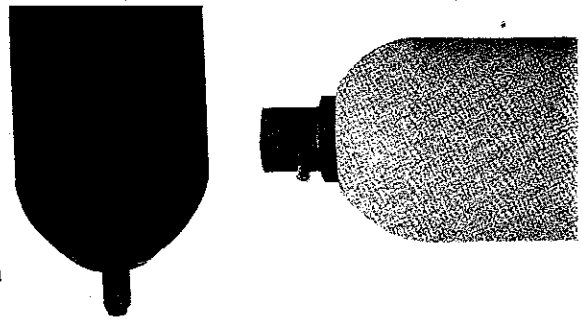
**Bladders**—See standard accumulator options on pages 12-13.

**Oil Port**—Part No. H-11-400-2 (4"-8 MPT), Part No. H-11-400-3 (4 1/2"-8 UN) (SAE), Part No. H-11-400-4 (Metric)

**Water Service**—Available with electroless nickel plating (Add -WS) and Stainless (Add -SS) components.



# OILAIR<sup>®</sup> SURGE ARRESTORS<sup>™</sup>



- Accumulator and parts are interchangeable with accumulators produced by other major manufacturers.
- Cannot be disassembled under pressure.
- Can be used as low pressure accumulator.

## DESIGNED TO CONTROL SURGE AND WATER HAMMER

Major Component	Standard Material	Material Options*	Features
Shell	Alloy Steel	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating 1.2 Mil.</li> <li>• Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>• Meets 4:1 safety requirements.</li> <li>• 25, 40, 80, 100, 120 Gallon sizes are top repairable.</li> </ul>
Bladder Assembly	Buna-Nitrile	<ul style="list-style-type: none"> <li>• Butyl</li> <li>• EPR</li> <li>• Viton</li> <li>• Cold Weather</li> </ul>	<ul style="list-style-type: none"> <li>• Fully enclosed bladder.</li> <li>• Molded steel valve stem.</li> <li>• Temperature range of Buna-N: -45° to 180° F.</li> </ul>
Port Assembly	ANSI Specifications	<ul style="list-style-type: none"> <li>• Electroless-Nickel Plating</li> <li>• SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>• See specification C below.</li> </ul>

\*Some material options are at extra cost.

## SPECIFICATIONS (U.S./Metric)

### OIL AIR SURGE ARRESTOR—275 PSI (18.9 bars)—OIL OR WATER SERVICE

Part No.	Size		Gas Volume		A		B		C	Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	ANSI Flange	Lbs.	Kg
S-2.5-100	2.5	9.46	580	9,506	16 1/4	42.8	8 1/4	20.9	3" 2150#	30	13.6
S-5-100	5	18.9	1,164	19,078	28 1/4	73.3	8 1/4	20.9	3" 2150#	42	19.1
S-10-100	10	37.8	2,310	37,861	50	128.5	8 1/4	20.9	3" 2150#	68	30.8

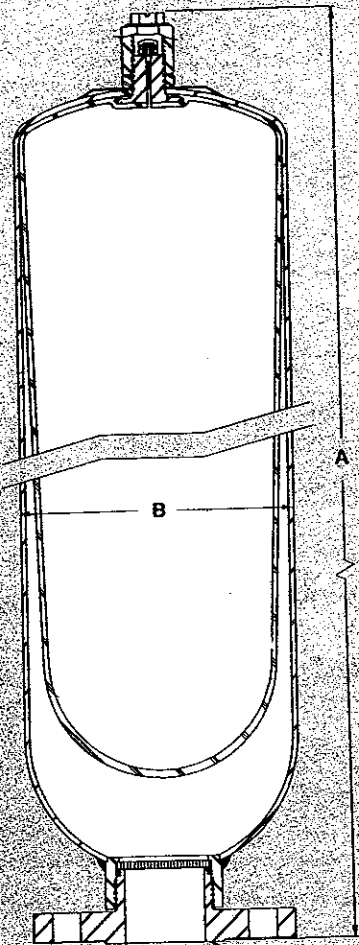
### OIL AIR SURGE ARRESTOR—500 PSI (34.5 bars)—OIL OR WATER SERVICE (SPECIAL ORDER ITEM)

Part No.	Size		Gas Volume		A		B		C	Weight	
	Gal.	Litres	In. <sup>3</sup>	cm <sup>3</sup>	In.	cm.	In.	cm.	ANSI Flange	Lbs.	Kg
S-25-5-100	25	94.6	5,780	94,734	35 1/4	90.3	22	55.8	4" 300#	310	140
S-40-5-100	40	151.4	9,240	151,444	43 1/4	110.0	22	55.8	4" 300#	368	167
S-80-5-100	80	302.8	18,480	302,887	64 1/4	163.2	22	55.8	4" 300#	650	294
S-100-5-100	100	378.5	23,100	378,609	84 1/4	215.4	22	55.8	4" 300#	875	397
S-120-5-100	120	454.2	27,720	454,331	101 1/4	257.3	22	55.8	4" 300#	1,000	453

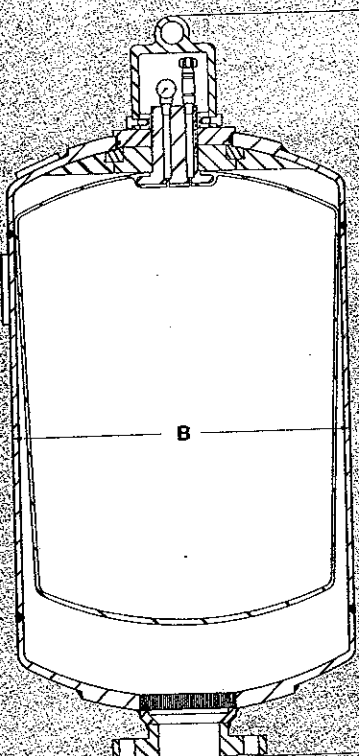
## MAJOR COMPONENTS AND OPTIONS PARTS LIST

Component/Size	Size & Part No.					
	All 275 PSI	25 Gallon	40 Gallon	80 Gallon	100 Gallon	120 Gallon
Bladder Assembly-Buna*	See 3000# Standard Accumulator Bladders on Pages 12-13	S-25-5-300	S-40-5-300	S-80-5-300	S-100-5-300	S-120-5-300
Bladder Assembly-Butyl		S-25-5-300-B	S-40-5-300-B	S-80-5-300-B	S-100-5-300-B	S-120-5-300
Bladder Assembly-EPR		S-25-5-300-E	S-40-5-300-E	S-80-5-300-E	S-100-5-300-E	S-120-5-300
Bladder Assembly-Viton		S-25-5-300-V	S-40-5-300-V	S-80-5-300-V	S-100-5-300-V	S-120-5-300
Port Assy. (flange)	S-2.5-417-A	S-25-5-417-A				

\*Standard



275 PSI Surge Arrestor



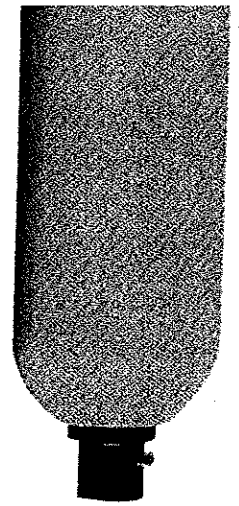
500 PSI Surge Arrestor

# OILAIR®



## GAS BOTTLES

- Gas bottle cannot be disassembled under pressure.
- Variety of air valve adapters available.
- Variety of Ports available.



### DESIGNED TO EXTEND THE OPERATING RANGE OF ACCUMULATOR SYSTEMS.

Major Component	Standard Material	Material Options*	Features
Shell	Chrome-Molybdenum Steel, SA 372 TYPE V, GR. II, CL.B	<ul style="list-style-type: none"> <li>● Electroless-Nickel Plating 1.2 Mil.</li> <li>● Phenolic Resin Coating</li> </ul>	<ul style="list-style-type: none"> <li>● Meets 4:1 safety requirements.</li> <li>● Homogenous seamless shell.</li> <li>● Integral pressure relief.</li> <li>● Available with foreign or domestic codes.</li> </ul>
Port Assembly	AISI 4130	<ul style="list-style-type: none"> <li>● Electroless-Nickel Plating</li> <li>● SA351, GR. CF8M, Stainless</li> </ul>	<ul style="list-style-type: none"> <li>● Design has over 30 years of proven reliability.</li> </ul>

\*Some material options are at extra cost.

### SPECIFICATIONS (U.S./Metric)

#### OIL AIR GAS BOTTLES—3000 PSI (206.90 bars)

Part No.	Size		Gas Volume		A		B		C		D	Weight	
	Gal.	Litres	in. <sup>3</sup>	cm <sup>3</sup>	in.	cm.	in.	cm.	in.	cm.		FPT*	Lbs.
GB-1 qt.-100-1	.25	.946	73	1,196	1 1/4	29.8	2 1/2	5.4	4 1/2	11.4	1"	10	4.5
GB-1-100-1	1	3.70	235	3,851	1 7/8	43.1	3.5	8.8	6 1/4	17.1	1 1/4"	34	15
GB-2.5-100-1	2 1/2	9.46	600	9,834	2 1/8	53.3	3.5	8.8	9 1/16	23.0	1 1/4"	60	36
GB-5-100-1	5	18.9	1,203	19,717	3 3/8	84.4	3.5	8.8	9 1/16	23.0	1 1/4"	120	54
GB-10-100-1	10	37.8	2,259	37,025	5 1/4	137.0	3.5	8.8	9 1/16	23.0	1 1/4"	220	100
GB-11-100-1	11	41.6	2,535	41,549	5 9/16	151.0	3.5	8.8	9 1/16	23.0	1 1/4"	240	109
GB-15-100-1	15	56.7	3,440	56,382	7 1/4	196.0	3.5	8.8	9 1/16	23.0	1 1/4"	305	138

#### OIL AIR GAS BOTTLES—5000 PSI (344.83 bars)

Part No.	Size		Gas Volume		A		B		C		D	Weight	
	Gal.	Litres	in. <sup>3</sup>	cm <sup>3</sup>	in.	cm.	in.	cm.	in.	cm.		FPT*	Lbs.
GB-2.5-5-100-2	2 1/2	9.46	600	9,834	2 1/8	53.0	3 3/4	9.5	9 1/16	24.3	2"	120	54
GB-5-5-100-2	5	18.9	1,203	19,717	3 3/8	85.7	3 3/4	9.5	9 1/16	24.3	2"	220	100
GB-10-5-100-2	10	37.8	2,259	37,025	5 1/4	138.0	3 3/4	9.5	9 1/16	24.3	2"	335	152
GB-15-5-100-2	15	56.7	3,440	56,382	7 1/8	198.0	3 3/4	9.5	9 1/16	24.3	2"	485	220

### MAJOR COMPONENTS AND OPTIONS:

\*Ports—See standard accumulator Oil Port options on pages 12-13.  
(Other options available)

Plug Body for 3000# units 1-15 Gallon Part No. GB-11-302  
 Plug Body for 3000# units 1 Quart Part No. GB-1 qt.-302  
 Plug Body for 5000# units 2 1/2-15 Gallon Part No. GB-11-5-302  
 (Other options available)

Water Service—See notes for standard accumulator on pages 12-13.



# OILAIR®

## MAJOR COMPONENTS FOR BLADDER ACCUMULATORS

### OPTIONS FOR 3,000 PSI ACCUMULATORS

#### STANDARD ACCUMULATORS\*

Size	Size & Part No.						
	1 Quart	1 Gallon	2½ Gallon	5 Gallon	10 Gallon	11 Gallon	15 Gallon
Complete Assembly — NPT Port	1-QI-100-1	1-100-1	2.5-100-2	5-100-2	10-100-2	11-100-2	15-100-2
Complete Assembly — SAE Port	1-QI-100-3	1-100-3	2.5-100-3	5-100-3	10-100-3	11-100-3	15-100-3
Complete Assembly — Water Service	1-QI-100-1-WS	1-100-1-WS	2.5-100-2-WS	5-100-2-WS	10-100-2-WS	11-100-2-WS	15-100-2-WS
Complete Assembly — Butyl	1-QI-100-1-B	1-100-1-B	2.5-100-2-B	5-100-2-B	10-100-2-B	11-100-2-B	15-100-2-B
Complete Assembly — EPR	1-QI-100-1-E	1-100-1-E	2.5-100-2-E	5-100-2-E	10-100-2-E	11-100-2-E	15-100-2-E
Complete Assembly — Viton	1-QI-100-1-V	1-100-1-V	2.5-100-2-V	5-100-2-V	10-100-2-V	11-100-2-V	15-100-2-V
Complete Assembly — Cold Weather	1-QI-100-1-CW	1-100-1-CW	2.5-100-2-CW	5-100-2-CW	10-100-2-CW	11-100-2-CW	15-100-2-CW
Complete Assembly — Split Flange	N/A	1-100-SPF	2.5-100-SPF	5-100-SPF	10-100-SPF	11-100-SPF	15-100-SPF

#### BLADDERS\*

Size	Size & Part No.						
	1 Quart	1 Gallon	2½ Gallon	5 Gallon	10 Gallon	11 Gallon	15 Gallon
Buna-N Bladder Assembly	1-QI-300	1-300	2.5-300	5-300	10-300	11-300	15-300
Butyl Bladder Assembly	1-QI-300-B	1-300-B	2.5-300-B	5-300-B	10-300-B	11-300-B	15-300-B
EPR Bladder Assembly	1-QI-300-E	1-300-E	2.5-300-E	5-300-E	10-300-E	11-300-E	15-300-E
Viton Bladder Assembly	1-QI-300-V	1-300-V	2.5-300-V	5-300-V	10-300-V	11-300-V	15-300-V
Cold Weather Bladder Assembly	1-QI-300-CW	1-300-CW	2.5-300-CW	5-300-CW	10-300-CW	11-300-CW	15-300-CW

#### OIL PORT ASSEMBLIES\*

Size	Size & Part No.						
	1 Quart	1 Gallon	2½ Gallon	5 Gallon	10 Gallon	11 Gallon	15 Gallon
Oil Port Assembly — NPT	1-QI-400-1	1-400-1	11-400-2	11-400-2	11-400-2	11-400-2	11-400-2
Oil Port Assembly — SAE	1-QI-400-3	1-400-3	11-400-3	11-400-3	11-400-3	11-400-3	11-400-3
Oil Port Assembly — Metric	1-QI-400-4	1-400-4	11-400-4	11-400-4	11-400-4	11-400-4	11-400-4
Oil Port Assembly — 1¼" NPT			11-400-1	11-400-1	11-400-1	11-400-1	11-400-1
Oil Port Assembly — Split Flange		1-400-SPF	11-400-SPF	11-400-SPF	11-400-SPF	11-400-SPF	11-400-SPF
Oil Port Assembly — NPT Water Service	1-QI-400-1-WS	1-400-1-WS	11-400-2-WS	11-400-2-WS	11-400-2-WS	11-400-2-WS	11-400-2-WS

Oil Port Specifications (Internal Threads)	1 Quart Accumulators	1 Gallon Accumulators	2½ to 15 Gallon Accumulators
	-1 1"-11½ NPT**	-1 1¼"-11½ NPT**	-1 1¼"-11½ NPT
	-3 1½-12 SAE	-3 1½-12 SAE	-2 2"-11½ NPT**
	-4 M28 x 1.5 Metric	-4 M40 x 1.5 Metric	-3 1½"-12 SAE
	—	—	-4 M50 x 1.5 Metric
N/A	-SPF 1¼" I.D.	-SPF 1½" to 2" I.D.	

\*Other styles and combinations available. Some options are at extra cost.

\*\*Standard



# MAJOR COMPONENTS AND SPECIFICATIONS FOR BLADDER ACCUMULATORS (CONT'D)

## OPTIONS FOR 5,000 PSI ACCUMULATORS

### STANDARD ACCUMULATORS\*

Assemblies/Size	Size & Part No.			
	2½ Gallon	5 Gallon	10 Gallon	15 Gallon
Complete Assembly 2" NPT Port	2.5-5-100-2	5-5-100-2	10-5-100-2	15-5-100-2
Complete Assembly 1½" SAE Port	2.5-5-100-3	5-5-100-3	10-5-100-3	15-5-100-3
Complete Assembly— Water Service	2.5-5-100-2-WS	5-5-100-2-WS	10-5-100-2-WS	15-5-100-2-WS

### BLADDERS\*

Assemblies/Size	Size & Part No.			
	2½ Gallon	5 Gallon	10 Gallon	15 Gallon
Buna-N Bladder Assembly	2.5-5-300	5-5-300	10-5-300	15-5-300
Butyl Bladder Assembly	2.5-5-300-B	5-5-300-B	10-5-300-B	15-5-300-B
EPR Bladder Assembly	2.5-5-300-E	5-5-300-E	10-5-300-E	15-5-300-E
Viton Bladder Assembly	2.5-5-300-V	5-5-300-V	10-5-300-V	15-5-300-V
Cold Weather Bladder Assembly	2.5-5-300-CW	5-5-300-CW	10-5-300-CW	15-5-300-CW

### OIL PORT ASSEMBLIES\*

Specifications	Part No.
Oil Port Assy.—2"x11½" NPT**	11-5-400-2
Oil Port Assy.—1½"x12 SAE	11-5-400-3
Oil Port Assy.—M50x1.5 Metric	11-5-400-4
Oil Port Assy.—Split Flange	11-5-400-4-SPF

### BLADDER VALVE STEM—3000/5000 PSI

Part No.	Specifications
XX-300-X Standard 3000#	1pc, O.D. Thread: ¾"-14 UNF-2A. Nipple: .305-32 UNEF • Valve Core
2pc 3000# XX-3-300-X	2pc, Valve stem: O.D. Thread: ¾"-14 UNF-2A Adapter: O.D. Thread: ½"-20 UNF-2A. Nipple: .305-32 UNEF • Valve Core and mechanical lock
2pc 5000# XX-5-300-X	2pc, Valve stem: O.D. Thread: ¾"-14 UNF-2A Adapter: O.D. Thread: ½"-20 UNF-2A. Nipple: .305-32 UNEF • Mechanical lock

### TEMP. RANGE OF BLADDER COMPOUNDS (Fahrenheit)

Range	Buna-Nitrile	Butyl	Ethylene Propylene	Viton	Cold Weather
High	180°	200°	280°	450°	170°
Low	-45°	-50°	-65°	-10°	-65°

\*Other styles and combinations available. Some options are at extra cost.

\*\*Standard

### Rubber Compounds

Buna-Nitrile—Standard

Butyl, add B following assembly part number.

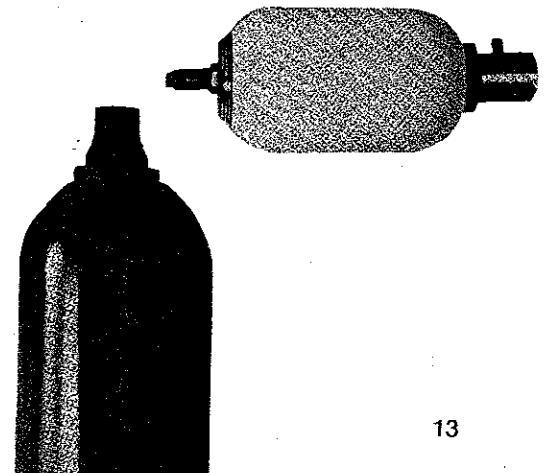
Viton, add V following assembly part number.

Ethylene Propylene (EPR), add E following assembly part number.

Cold Weather, add CW following assembly part number.

### Water Service

Accumulator assemblies are available with electroless nickel plating. Add WS following part number. Oil port assemblies are available in electroless nickel and/or stainless steel. For stainless steel, add SS following part number. Call factory for availability.

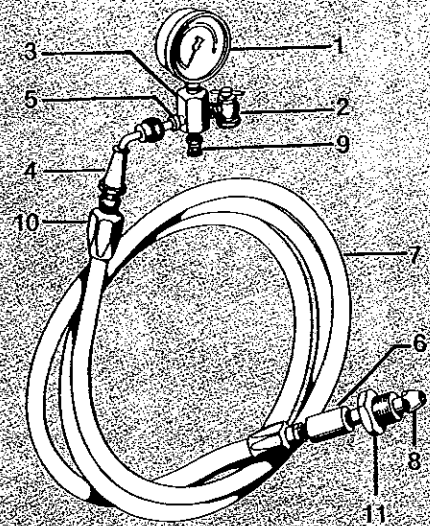


# OILAIR® ACCESSORIES

## CHARGING AND GAUGING ASSEMBLY

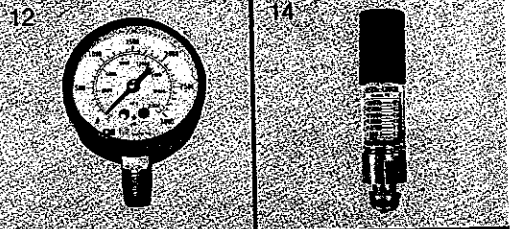
Part Number	Description
CG-3000 CG-5000	Charging and Gauging Assembly consists of 10' charging hose with standard right-hand thread nitrogen fittings, adapter incorporating gas valve, bleeder valve and gas chuck and gauge.
CG-3014 CG-5014	Head Assembly consisting of adapter incorporating gas valve, bleeder valve and gas chuck (less gauge).
CG-3013 CG-5013	Gauging and Head Assembly consisting of head assembly plus gauge.

## CHARGING & GAUGING ASSEMBLY



## CHARGING AND GAUGING PARTS LIST

Description	Part No.	Description	Part No.
1-Gauge 3000#	CG-3001	8-Gland	CG-3008
2-Air Chuck	CG-3002	9-Bleeder Valve	CG-3009
3-Adaptor	CG-3003	10-Hose end Fitting	CG-3010
4-Swivel Connection	CG-3004	11-Nut	CG-3011
5-Tank Valve	CG-3005	12-Gauge 5000#	CG-5001
6-Coupler	CG-3006	13-Valve extension	T-CG-3015
7-Hose	CG-3007	14-Vista Gauge	CG-3101

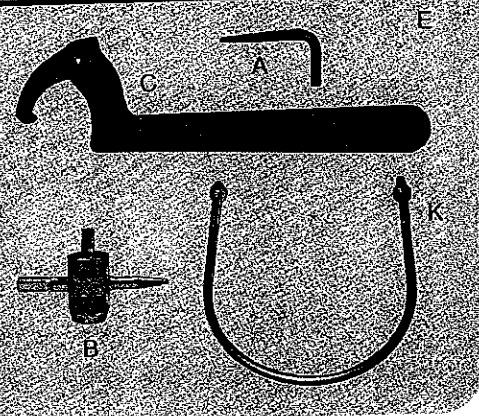


## ACCUMULATOR REPAIR TOOLS

**Bladder Pull Rods** — (Bladder Type Accumulator) Pull rods are available in different lengths for different size accumulators. The pull rods attach to the gas valve of the bladder for ease of assembly into shell during reassembly. Items E, F, G, H.

**Core Tool** — The core tool is used to remove and reinstall the valve core. It is also used to ream valve seat and repair threads. Item B.

**Spanner Wrench** — Fits all standard size bladder accumulators. Used to remove hydraulic poppet assembly from accumulator shell. Item C.



## REPAIR KITS

Description	Part No.	Description	Part No.
2½-15 Gallon Oil Port Assembly Repair Kit (O-Ring, Metal Back-Up, Rubber Back-Up, Anti-Extrusion Ring)	R-101	Air Valve Repair Kit (5 valve cores 1 EZ out Tool, 1 Valve Repair Tool)	R-300
1 Quart Oil Port Assembly Repair Kit	R-102	3000 PSI Head Assembly Repair Kit (Grommet, O-Ring, Adhesive)	R-104
1 Gallon Oil Port Assembly Repair Kit	R-103	5000 PSI Head Assembly Repair Kit (Grommet, O-Ring, Adhesive)	R-105

## TOOLS AND SUPPLIES

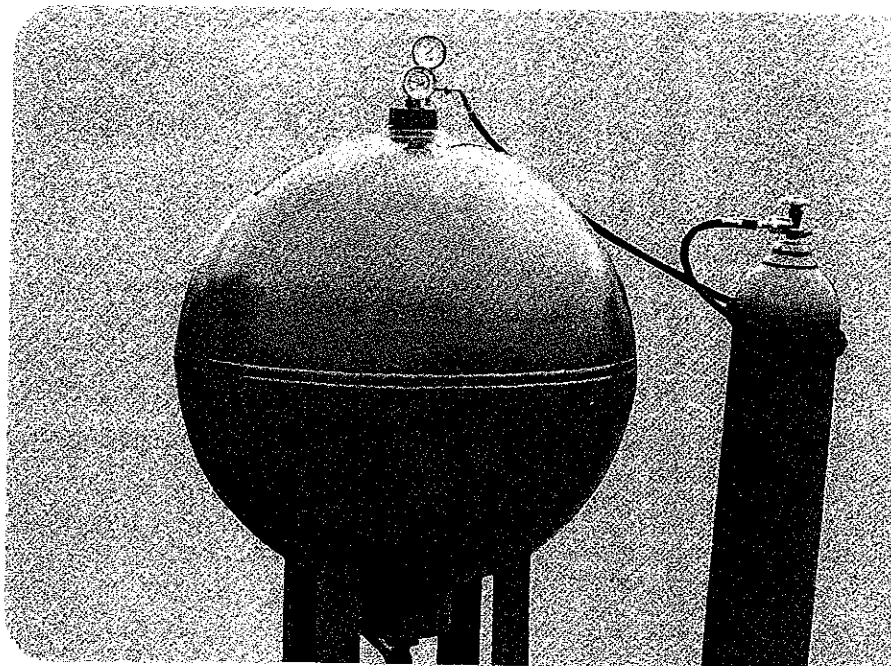
Description	Part No.
A-EZ Out Tool	R-301
B-Valve Core Tool	11-501
C-Spanner Wrench (Standard)	11-502
D-Spanner Wrench (20-80 Gal.)	35-502
E-Bladder Puller (1 Qt.-2½ Gal.)	11-503-1
F-Bladder Puller (5 Gal.)	11-503-2
G-Bladder Puller (10-11 Gal.)	11-503-3
H-Bladder Puller (15 Gal.)	11-503-4
I-Head Puller (Manual)	11-504
J-Head Puller (Hydraulic)	11-504-H
K-Mounting Clamps (2½-15 Gal.)	11-530



# OILAIR® HIGH PRESSURE, LARGE CAPACITY ACCUMULATORS

## 80-GALLON SPHERICAL ACCUMULATOR

Repairable design features a one piece cast shell and uses a non-destructible float system. For high volume, low cycle applications, the cost per gallon is extremely low. Available for 3000 PSI applications. Ideal for leakage compensation and as Nitrogen Back-Up Bottle.



## 25 TO 45-GALLON CYLINDRICAL FLOAT ACCUMULATOR

This high pressure accumulator uses the Oil Air float. It is for use in high pressure, low cycle applications and is ideal for emergency power and pressure compensation applications.

### HOW TO ORDER: SELECT THE FEATURES DESIRED AND PLACE IN PROPER SEQUENCE

Type	Size	Pressure	Designation	Oil Port	Bladder Compound	Service
------	------	----------	-------------	----------	------------------	---------

EXAMPLE: →

**B** **5** **5** **100** **2** **V** **WS**

Description	Symbol
<b>TYPE</b>	
Standard	Blank
Top Repairable	B*
Float	F*
High Flow	H**
High Flow Top Repairable	HT**
Gas Bottle	GB**
Surge Arrestor	S
Conventional Top Repairable	T**
Transfer Barrier	TB**
Pulsaider	P
<b>SIZE</b>	
1 Quart	1 Qt.
1 Gal.	1
2.5 Gal.	2.5
5 Gal.	5
10 Gal.	10

Description	Symbol
<b>SIZE (CONT'D)</b>	
11 Gal.	11
15 Gal.	15
For Pulsaider:	
15 cu. in.	15 ci
1 pint	30 ci
1 Quart	60 ci
150 cu. in.	150 ci
1 gal.	230 ci
<b>PRESSURE</b>	
3000 PSI	Blank
3000 PSI (2pc stem)	3
5000 PSI	5
Surge Arrestors:	
275 PSI	Blank
500 PSI	5
For Pulsaider:	
2000 psi	Blank

Description	Symbol
<b>DESIGNATION</b>	
Accumulators	100
Shells	200
Bladders	300
Oil Ports	400
Accessories	500
<b>OIL PORT</b>	
NPT 1", 1 1/4"	1
NPT 2"	2
SAE	3
Metric	4
Float Special	5
Split Flange	SPF
Special	SPC
Standard for that type	Blank

Description	Symbol
<b>SERVICE</b>	
Oil	Blank
Water Service	WS
Special	SPC
<b>BLADDER COMPOUND</b>	
Buna Nitrile	Blank
Butyl	B
Ethylene Propylene	E
Viton	V
Cold Weather	CW

\* Available in 5, 10, 11 & 15 gallon sizes only.  
 \*\* Available in sizes 2 1/2, 5, 10, 11 & 15 gallon sizes only.

# OILAIR®

HYDRAULICS, INC.

## SOLVING FLUID CONTROL PROBLEMS IS OUR BUSINESS

There are countless fluid power systems in virtually every industry that have a need for accumulators.

### Principle Applications

- **ENERGY CONSERVATION**—Reduces the need for large pumping capacity.
- **EMERGENCY HYDRAULIC POWER**—Power storage for hydraulic fail-safe systems.
- **LEAKAGE COMPENSATION**—Reduces the need for excessive pump operation.
- **THERMAL EXPANSION GUARD**—Compensates for the change in fluid volume caused by temperature variations.
- **HYDRAULIC LINE SHOCK ABSORBERS**—Prevents damage to circuit components and piping.
- **PRESSURIZED GAS BOTTLE**—Extends the efficiency of accumulator systems.
- **PRESSURE HOLDING**—Reduces power requirements, pump wear, operating time and overheating.
- **PRESSURIZED LUBRICANT DISPENSERS**—An inexpensive safeguard for lubrication of bearings.
- **TRANSFER BARRIER**—Separates distinct fluid mediums.
- **OTHER CUSTOMIZED APPLICATIONS**—Oil Air will provide the necessary engineering assistance and support required for customers with special applications.

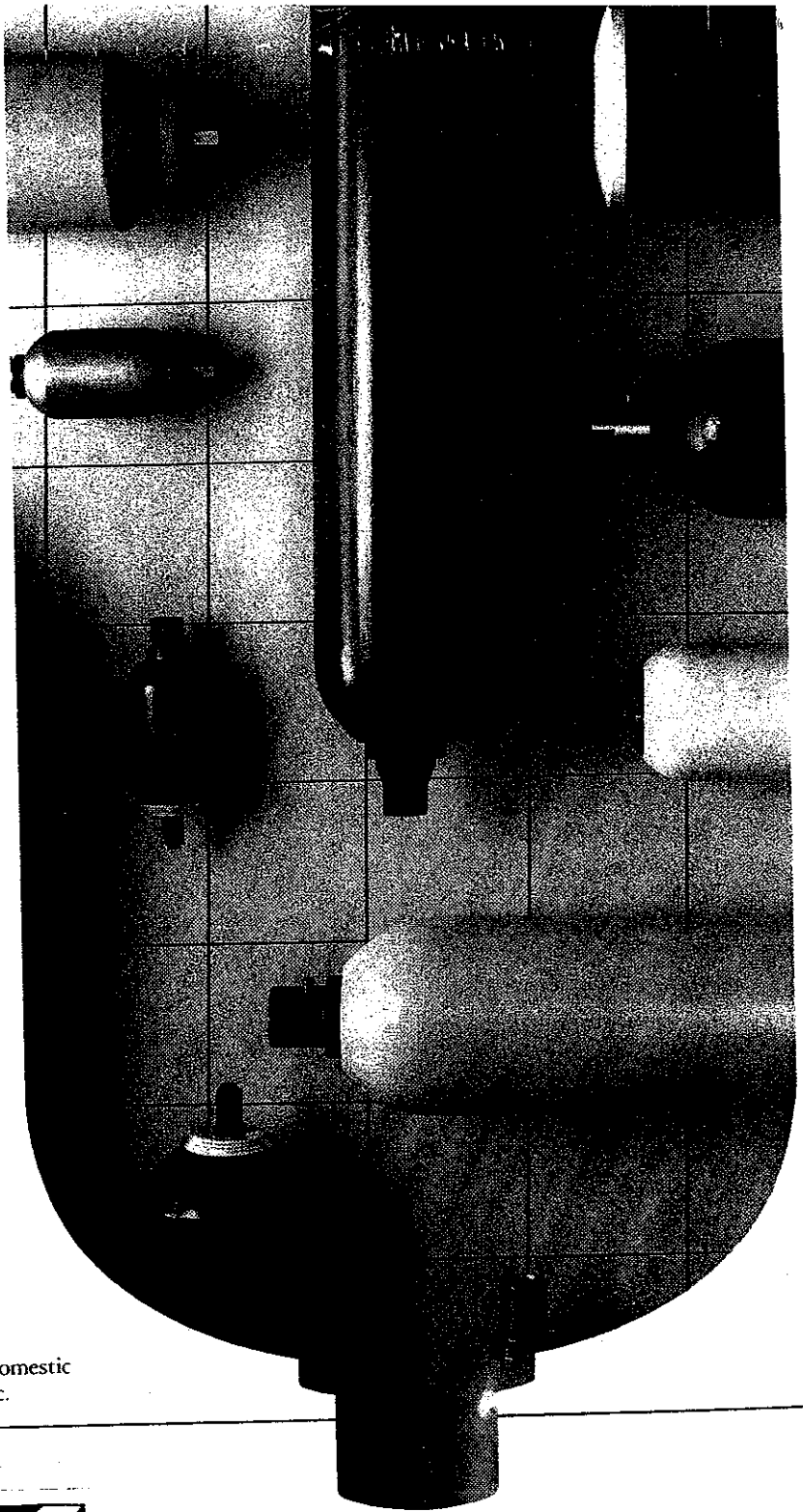
### TO PLACE AN ORDER

Oil Air products are available worldwide through the domestic and international distributors of Oil Air Hydraulics, Inc.

YOUR LOCAL DISTRIBUTOR IS:

**Rucker Fluid Power**

Unit #8, 711 48th Avenue, S.E.  
Calgary, Alberta T2G 4X2  
PHONE 243-4533 FAX (403) 243-8830  
OUT OF TOWN  
**1-800-661-1624**



For more information,  
please call, write, fax  
or telex us:

**OILAIR®**  
HYDRAULICS, INC.

35002 Cooper Road • Brookshire, Texas 77423  
Ph: 713-934-6001 • Ph: 713-934-8566 • Telex: 446749 • Fax: 713-391-7440

Printed in the United States of A

# INSTALLATION AND MAINTENANCE INSTRUCTIONS

3 way solenoid operated valves normally closed, normally open and universal operation

# ASCO

Bulletin

8320

Form no. V32001

### DESCRIPTION

Bulletin 8320 valves are 3 way solenoid operated valves with all connections located in the body. Valves are brass or stainless steel with 1/8 or 1/4 inch NPT process connections.

Standard valves have an epoxy encapsulated solenoid coil for Type 1,2,3,3S, and 4 combination general purpose and watertight installations. Valves with "EP" prefixes in the catalogue number have encapsulated solenoids suitable for Type 3,3S,4,6, and 7(A,B,C,&D) explosion proof Class I, Group A,B,C,&D and Type 9(E,F,&G)-Dust-Ignition Proof Class II Groups E,F,&G.

### OPERATION

**Normally Closed:** Applies pressure when solenoid is energized; exhausts pressure when solenoid is de-energized. When the solenoid is energized flow is from connection "2" to connection "1". Connection "3" is closed. When solenoid is de-energized flow is from connection "1" to connection "3". Connection "2" is closed.

**Normally Open:** Applies pressure when solenoid is de-energized; exhausts pressure when solenoid is energized. When the solenoid is energized flow is from connection "1" to connection "2". Connection "3" is closed. When solenoid is de-energized flow is from connection "3" to connection "1". Connection "2" is closed.

**Universal:** For normally closed or normally open operation, selection or diversion of pressure can be applied to connection "1", "2" or "3".

**NOTE:** To change from normally closed to normally open or universal operation, consult factory.

### Positioning

This valve is designed to perform properly when mounted in any position. For optimum performance and life, the solenoid should be mounted vertical and upright.

### Mounting

Valves may be pipe mounted, direct mounted with self tapping screws in the case of forged brass bodies, or mounted with optional factory supplied mounting brackets.

### Piping

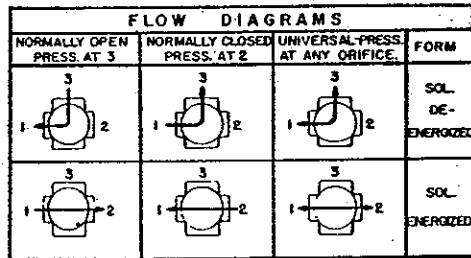
Connect pipe or tubing to valve according to markings on the valve body. Refer to flow diagrams above. Apply pipe compound or teflon tape sparingly to male pipe threads only. When tightening connections do not use the valve body or solenoid as a lever. Locate wrenches as close as possible to the connection point.

**IMPORTANT:** For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on service conditions.

### Wiring

Wiring must comply with local and national codes. Solenoids are provided with 1/2" conduit hubs or other optional connection methods as illustrated in Fig.2,3. The solenoid may be rotated to facilitate electrical connection.

**NOTE:** Alternating current and direct current solenoids are built differently. To convert one to the other it is necessary to change the complete solenoid assembly including core tube, bonnet, and core assembly.



### MAINTENANCE

**NOTE:** It is not necessary to remove the valve from the pipeline for repairs.

**WARNING:** Turn off electrical power supply and de-pressurize valve before making repairs.

### Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the fluid and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise, or leakage will indicate that cleaning is required. Clean valve strainer or filter when cleaning the valve.

### Preventive Maintenance

1. Keep the fluid flowing through the valve as free from dirt and foreign material as possible.
2. While in service, the valve should be operated at least once a month to insure proper opening and closing.
3. Depending on the fluid and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace worn or damaged parts with an ASCO rebuild Kit.

### Causes of Improper Operation

1. Faulty Control Circuits: Check the electrical system by energizing the solenoid. A metallic "click" signifies that the solenoid is operating. Absence of the "click" indicates loss of power supply. Check for loose or blown fuses, open circuited or grounded coil, broken lead wires or splice connections.
2. Burned-Out Coil: Check for open-circuited coil. Replace coils as necessary. Check supply voltage: it must be the same as specified on coil.
3. Low voltage: Check voltage across the coil lead. Voltage must be at least 85% of coil rating.
4. Incorrect Pressure: Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. Excessive Leakage: Disassemble valve and clean all parts. Replace worn or damaged parts with an ASCO Rebuild Kit.

### TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. Check catalogue number prefixes and watt ratings to determine maximum temperatures.

TEMPERATURE LIMITATIONS 8320g, CATA. 32C				
WATT RATING	CATALOGUE PREFIX	MAX. AMBIENT TEMP. F.	MAX. FLUID TEMP. F.	
			1/8 NPT	1/4 NPT
10.1 & 17.1	NONE, FB, KF, KP, SC, SD, SF, SP	125	180	200
10.1 & 17.1	HB, HT, KB, KH, SS, ST, SU	140	180	200
11.6 & 22.6	NONE, KB, KF, KP, SC, SD, SF, SP	104	120	150
11.6 & 22.6	HP, HT, KB, KH, SS, ST, SU, SV	104	120	150

\* MINIMUM AMBIENT TEMPERATURE - 40 F.

### INSTALLATION

Check nameplate for correct catalogue number, pressure, fluid and electrical service.

**ASCOELECTRIC limited**

P.O. Box 160, Brantford, Ontario N3T 5M8

(519)758-2700 fax (519)758-5540



Printed in Canada

### COIL REPLACEMENT (REF. FIG. 1)

Turn off electrical power, disconnect coil lead wires and proceed as follows:

1. Remove red cap, and nameplate.
2. Slip coil off solenoid base sub-assembly.
3. Reassemble in reverse order of disassembly.

### VALVE DISASSEMBLY AND REASSEMBLY (REF. FIG. 1)

Turn off electrical power supply and de-pressure valve.

1. Remove retaining cap and slip entire solenoid off solenoid base sub-assembly.
2. Unscrew bonnet or solenoid base sub-assembly. Remove core assembly, core spring and body gasket.
3. Remove end cap, body gasket, disc spring, disc holder, disc or disc holder assembly.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded view provided.

**ORDERING INFORMATION FOR SPARE PARTS KITS**  
When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage.

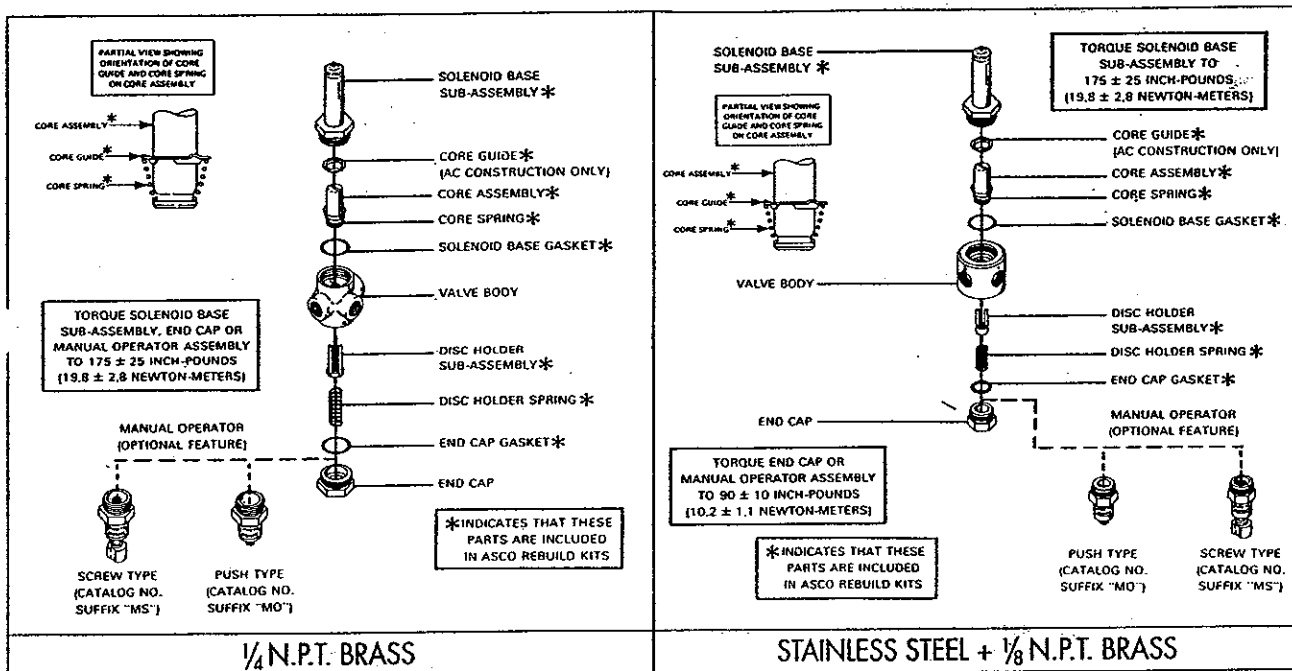


Fig. 5 Series 8320G Valves

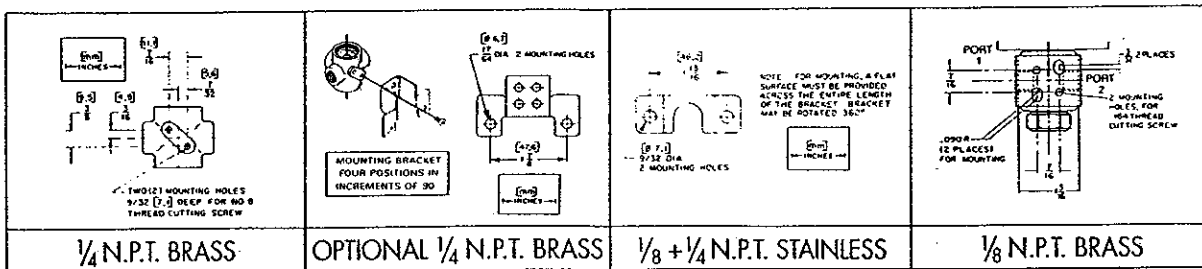


Fig. 6 Mounting

GB

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## GENERAL INSTALLATION AND MAINTENANCE INSTRUCTIONS

Note: These General Installation and Maintenance Instructions must be read in conjunction with the Instruction Sheet for the specific product.

### INSTALLATION

ASCO/JOUCOMATIC components are intended to be used only within the technical characteristics as specified on the nameplate. Changes to the equipment are only allowed after consulting the manufacturer or its representative. Before installation depressurize the piping system and clean internally. The equipment may be mounted in any position if not otherwise indicated on the product by means of an arrow. The flow direction and pipe connection of valves are indicated on the body.

The pipe connections have to be in accordance with the size indicated on the nameplate and fitted accordingly.

#### Caution:

- Reducing the connections may cause improper operation or malfunctioning.
- For the protection of the equipment install a strainer or filter suitable for the service involved in the inlet side as close to the product as possible.
- If tape, paste, spray or a similar lubricant is used when tightening, avoid particles entering the system.
- Use proper tools and locate wrenches as close as possible to the connection point.
- To avoid damage to the equipment, DO NOT OVERTIGHTEN pipe connections.
- Do not use valve or solenoid as a lever.
- The pipe connections should not apply any force, torque or strain to the product.

### ELECTRICAL CONNECTION

In case of electrical connections, they are only to be made by trained personnel and have to be in accordance with the local regulations and standards.

#### Caution:

- Turn off electrical power supply and de-energize the electrical circuit and voltage carrying parts before starting work.
- All electrical screw terminals must be properly tightened according to the standards before putting into service.
- Dependent upon the voltage electrical components must be provided with an earth connection and satisfy local regulations and standards.

The equipment can have one of the following electrical terminals:

- Scade plug connections according to ISO-4400 or 3 x DIN-46244 (when correctly installed this connection provides IP-65 protection).
- Embedded screw terminals in metal enclosure with "Pg" cable gland.
- Scade terminals (AMP type).
- Flying leads or cables.

### PUTTING INTO SERVICE

Before pressurizing the system, first carry-out an electrical test. In case of solenoid valves, energize the coil a few times and notice a metal click signifying the solenoid operation.

### SERVICE

Most of the solenoid valves are equipped with coils for continuous duty service. To prevent the possibility of personal or property damage do not touch the solenoid which can become hot under normal operation conditions.

### SOUND EMISSION

The emission of sound depends on the application, medium and nature of the equipment used. The exact determination of the sound level can only be carried out by the user having the valve installed in his system.

### MAINTENANCE

Maintenance of ASCO/JOUCOMATIC products is dependent on service conditions. Periodic cleaning is recommended, the timing of which will depend on the media and service conditions. During servicing, components should be examined for excessive wear. A complete set of internal parts is available as a spare parts or rebuild kit. If a problem occurs during installation/maintenance or in case of doubt please contact ASCO/JOUCOMATIC or authorized representatives.

A separate Declaration of Incorporation relating to EEC-Directive 89/392/EEC Annex II B is available on request. Please provide product identification number and serial numbers of products concerned.

The product complies with the essential requirements of the EMC Directive 89/336/EEC and amendments and the Low Voltage directives 73/23/EEC and 93/68/EEC. A separate Declaration of Conformity is available on request. Please provide product identification number and serial numbers of the products concerned.

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## INSTRUCTIONS GÉNÉRALES D'INSTALLATION ET D'ENTRETIEN

Nota : Ces instructions générales d'installation et d'entretien complètent la notice spécifique du produit.

### MONTAGE

Les composants ASCO/JOUCOMATIC sont conçus pour les domaines de fonctionnement indiqués sur la plaque signalétique ou la documentation. Aucune modification ne peut être réalisée sur le matériel sans l'accord préalable du fabricant ou de son représentant. Avant de procéder au montage, dépressuriser les canalisations et effectuer un nettoyage interne. À moins qu'une flèche ou la notice n'indique un sens de montage spécifique de la tête magnétique, le produit peut être monté dans n'importe quelle position. Le sens de circulation du fluide est indiqué par repères sur le corps et dans la documentation.

La dimension des tuyauteries doit correspondre au raccordement indiqué sur le corps, l'étiquette ou la notice.

#### Attention :

- Une restriction des tuyauteries peut entraîner des dysfonctionnements.
- Afin de protéger le matériel, installer une crépine ou un filtre adéquat en amont, aussi près que possible du produit.
- En cas d'utilisation de nuban, pâte, aérosol ou autre lubrifiant lors du serrage, veiller à ce qu'aucun corps étranger ne pénètre dans le circuit.
- Utiliser un outillage approprié et placer les clés aussi près que possible du point de raccordement.
- Afin d'éviter toute détérioration, NE PAS TROP SERRER les raccords des tuyauteries.
- Ne pas se servir de la vanne ou de la tête magnétique comme d'un levier.
- Les tubes de raccordement ne doivent exercer aucun effort, couple ou contrainte sur le produit.

### RACCORDEMENT ÉLECTRIQUE

Le raccordement électrique doit être réalisé par un personnel qualifié et selon les normes et règlements locaux.

#### Attention :

- Avant toute intervention, couper l'alimentation électrique pour mettre hors tension les composants.
- Toutes les bornes à vis doivent être serrées correctement avant la mise en service.
- Selon la tension, les composants électriques doivent être mis à la terre conformément aux normes et règlements locaux.

Selon les cas, le raccordement électrique s'effectue par :

- Connecteur débranchable ISO4430 ou 3 x DIN46244 avec degré de protection IP65 lorsque le raccordement est correctement effectué.
- Bornes à vis solitaires du boîtier, sous boîtier métallique avec presse-étoupe "Pg".
- Cosses (type AMP).
- Fils ou câbles solitaires de la borne.

### MISE EN SERVICE

Avant de mettre le circuit sous pression, effectuer un essai électrique. Dans le cas d'une électrovanne, mettre la bobine sous tension plusieurs fois et écouter la "clic" métallique qui signale le fonctionnement de la tête magnétique.

### FONCTIONNEMENT

La plupart des électrovannes comportent des bobinages prévus pour mise sous tension permanente. Pour éviter toute brûlure, ne pas toucher la tête magnétique qui, en fonctionnement normal et en permanence sous tension, peut atteindre une température élevée.

### BRUIT DE FONCTIONNEMENT

Le bruit de fonctionnement varie selon l'utilisation, le fluide et le type de matériel employé. L'utilisateur ne pourra déterminer avec précision le niveau sonore émis qu'après avoir monté le composant sur l'installation.

### ENTRETIEN

L'entretien nécessaire aux produits ASCO/JOUCOMATIC varie avec leurs conditions d'utilisation. Il est souhaitable de procéder à un nettoyage périodique dont l'intervalle varie suivant la nature du fluide, les conditions de fonctionnement et le milieu ambiant. Lors de l'intervention, les composants doivent être examinés pour détecter toute usure excessive. Un ensemble de pièces internes est proposé en pièces de rechange pour procéder à la réparation. En cas de problème lors du montage/entretien ou en cas de doute, veuillez contacter ASCO/JOUCOMATIC ou ses représentants officiels.

Conformément à la directive CEE 85/392/CEE Annexe II B, une Déclaration d'incorporation peut être fournie sur demande. Veuillez nous indiquer le numéro d'accusé de réception (AR) et les références ou codes des produits concernés.

Ce produit est conforme aux prescriptions les plus importantes de la directive CEM 89/336/CEE et amendements et aux directives basse tension 73/23/CEE et 94/56/CEE. Une déclaration de conformité peut être fournie sur simple demande. Veuillez nous indiquer le numéro d'accusé de réception (AR) ainsi que les numéros de série des produits concernés.

DE

CE

## ALLGEMEINE BETRIEBSANLEITUNG

ACHTUNG: Diese Allgemeine Betriebsanleitung gilt in Zusammenhang mit der jeweiligen Betriebsanleitung für die speziellen Produkte.

### EINBAU

Die ASCO/JOUCOMATIC-Komponenten dürfen nur innerhalb der auf den Typenschildern angegebenen Daten eingesetzt werden. Veränderungen an den Produkten sind nur nach Rücksprache mit ASCO/JOUCOMATIC zulässig. Vor dem Einbau der Ventile muß das Rohrleitungssystem drucklos geschaltet und innen gereinigt werden. Die Einbaulage der Produkte ist generell beliebig. Ausnahme: Die mit einem Pfeil gekennzeichneten Produkte müssen entsprechend der Pfeilrichtung montiert werden. Die Durchflußrichtung und der Eingang von Ventilen sind gekennzeichnet.

Die Rohranschlüsse sollten entsprechend den Größenangaben auf den Typenschildern mit handelsüblichen Verschraubungen durchgeführt werden. Dabei ist folgendes zu beachten:

- Eine Reduzierung der Anschlüsse kann zu Leistungs- und Funktionsminderungen führen.
- Zum Schutz der Ventile sollten Schmutzfänger oder Filter so dicht wie möglich in den Ventileingang integriert werden.
- Bei Abdichtung am Gewinde ist darauf zu achten, daß kein Dichtungsmaterial in die Rohrleitung oder das Ventil gelangt.
- Zur Montage darf nur geeignetes Werkzeug verwendet werden.
- Konische Verschraubungen sind sorgfältig anzuziehen. Es ist darauf zu achten, daß beim Anziehen das Gehäuse nicht beschädigt wird.
- Spule und Führungsrohr von Ventilen dürfen nicht als Gegenhalter benutzt werden.
- Die Rohrleitungsanschlüsse sollen fluchten und dürfen keine Spannungen auf das Ventil übertragen.

### ELEKTRISCHER ANSCHLUß

Der elektrische Anschluß ist von Fachpersonal entsprechend der geltenden VDE- und CEE-Richtlinien auszuführen. Es ist besonders auf folgendes zu achten:

- Vor Beginn der Arbeiten ist sicherzustellen, daß alle elektrische Leitungen und Netzteile spannungslos geschaltet sind.
- Alle Anschlußklemmen sind nach Beendigung der Arbeiten vorschriftsmäßig entsprechend den geltenden Regeln anzuziehen.
- Je nach Spannungsbereich muß das Ventil nach den geltenden Regeln einen Schutzleiteranschluß erhalten.

Der Magnetantrieb kann je nach Bauart folgende Anschlüsse haben:

- Anschluß für Gerätesteckdose nach DIN 43650 Form AISO 4400 oder 3x DIN 46244 (durch ordnungsgemäße Montage der Gerätesteckdose wird Schutzklasse IP 65 erreicht).
- Anschlüsse innerhalb eines Blechgehäuses mittels Schraubklemmen. Kabeleinführung ins Gehäuse mit PG-Verschraubung.
- Offene Spulen mit Flachsteckern (AMP-Fahrer) oder mit eingegossenen Kabelenden.

### INBETRIEBNAHME

Vor Druckbeaufschlagung des Produktes sollte eine elektrische Funktionsprüfung erfolgen:

Bei Ventilen Spannung an der Magnetspule mehrmals ein- und ausschalten. Es muß ein Klicken zu hören sein.

### BETRIEB

Die meisten Ventile sind mit Spulen für Dauerbetrieb ausgerüstet. Zur Vermeidung von Personen- und Sachschäden sollte jede Berührung mit dem Ventil vermieden werden, da die Magnetspule bei längerem Betrieb sehr heiß werden kann.

### GERÄUSCHEMISSION

Diese hängt sehr stark von Anwendungsart, den Betriebszeiten und dem Medium, mit denen das Produkt beaufschlagt wird, ab. Eine Aussage über die Geräuschemission des Produktes muß deshalb von demjenigen getroffen werden, der das Produkt innerhalb einer Maschine in Betrieb nimmt.

### WARTUNG

Die Wartung hängt von den Einsatzbedingungen ab. In entsprechenden Zeitabständen muß das Produkt geöffnet und gereinigt werden. Für die Überholung der ASCO/JOUCOMATIC-Produkte können Ersatzteile geliefert werden. Treten Schwierigkeiten bei Einbau, Betrieb oder Wartung auf, sowie bei Unklarheiten, ist mit ASCO/JOUCOMATIC Rücksprache zu halten.

(ASCO/JOUCOMATIC Produkte sind entsprechend der EG-Funktionslinie 89/392/EWG gefertigt.)

Eine separate Herstellererklärung im Sinne der Richtlinie 85/392/EWG Anhang II B ist auf Anfrage erhältlich. Geben Sie bitte für die Produkte die Nummer der Auftragsbestätigung und die Seriennummer an.

Dieses Produkt entspricht den grundlegenden Bestimmungen der EMV-Richtlinie 89/336/EWG, einsch. Nachträge, sowie den Niederspannungsrichtlinien 73/23/EWG u. 93/68/EWG. Bitte geben Sie die Auftragsbestätigungsnummer und die Seriennummern der betreffenden Produkte an.



# ASCO Valves

ASCOELECTRIC limited BRANTFORD, ONTARIO

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ES

**INSTRUCCIONES GENERALES DE INSTALACION Y MANTENIMIENTO**

**Note:** Estas instrucciones Generales de Instalación y Mantenimiento deben considerarse en conjunción con la Hoja de Instrucciones de cada producto.

**INSTALACION**

Los componentes ASCO/JOUCOMATIC sólo deben utilizarse dentro de las especificaciones técnicas que se especifican en su placa de características o catálogo. Los cambios en el equipo sólo estarán permitidos después de consultar al fabricante o a su representante. Antes de la instalación despresurice el sistema de tuberías y limpie internamente.

El equipo puede utilizarse en cualquier posición si no estuviera indicado lo contrario sobre el mismo mediante una flecha o en el catálogo.

En el cuerpo o en el catálogo se indican el sentido del fluido y la conexión de las válvulas a la tubería.

Las conexiones a la tubería deben corresponder al tamaño indicado en la placa de características la etiqueta o el catálogo y ajustarse adecuadamente.

**Precaución:**

- La reducción de las conexiones puede causar operaciones incorrectas o defectos de funcionamiento.
- Para la protección del equipo se debe instalar, en la parte de la entrada y tan cerca como sea posible del producto, un filtro adecuado.
- Si se utilizara cinta, pasta, spray u otros lubricantes en el ajuste, se debe evitar que entren particulares en el producto.
- Se debe utilizar las herramientas adecuadas y colocar flanges inglesas lo mas cerca posible del punto de conexión.
- Para evitar daños al equipo, NO FORZAR las conexiones a la tubería.
- No utilizar la válvula o el solenoide como palanca.
- Las conexiones a la tubería no producirán ninguna fuerza, por o tensión sobre el producto.

**CONEXION ELECTRICA**

Las conexiones eléctricas serán realizadas por personal cualificado y deberán adaptarse a las normas y regulaciones locales.

**Precaución:**

- Antes de comenzar el trabajo, desconecte el suministro de energía eléctrica y desenergice el circuito eléctrico y los elementos portadores de tensión.
- Todos los terminales eléctricos deben estar apretados adecuadamente según normas antes de su puesta en servicio.
- Según el voltaje, los componentes eléctricos deben disponer de una conexión a tierra y satisfacer las normas y regulaciones locales.

El equipo puede tener uno de los siguientes terminales eléctricos:

- Conexiones desenchufables según ISO 4400 o 3 x DIN-46244 (cuando se instala correctamente esta conexión proporciona una protección IP-65).

- Terminales de tornillo con carcasa metálica con entrada de cable de conexión roscada "PG".
- Conector desenchufable (tipo AMP).
- Salida de cables.

**PUESTA EN MARCHA**

Se debe efectuar una prueba eléctrica antes de someter a presión el sistema. En el caso de las válvulas solenoides, se debe energizar varias veces la bobina y comprobar que se produce un sonido metálico que indica el funcionamiento del solenoide.

**SERVICIO**

La mayor parte de las válvulas solenoides se suministran con bobinas para un servicio continuo. Con el fin de evitar la posibilidad de daños personales o materiales no se debe tocar el solenoide, ya que puede haberse calentado en condiciones normales de trabajo.

**EMISION DE RUIDOS**

La emisión de ruidos depende de la aplicación, medio y naturaleza del equipo utilizado. Una determinación exacta del nivel de ruido solamente se puede llevar a cabo por el usuario que disponga la válvula instalada en su sistema.

**MANTENIMIENTO**

El mantenimiento de los productos ASCO/JOUCOMATIC depende de las condiciones de servicio. Se recomienda una limpieza periódica, dependiendo de las condiciones del medio y del servicio. Durante el servicio, los componentes deben ser examinados por si hubieran desgastes excesivos. Se dispone de un juego completo de partes internas como recambio o kit de montaje. Si ocurriera un problema durante la instalación/mantenimiento o en caso de duda contactar con ASCO/JOUCOMATIC o representantes autorizados.

Se dispone, por separado y bajo demanda, de una Declaración de Incorporación conforme a la Directiva CEE 89/392/EEC Anexo II B. Rogamos que nos faciliten los códigos y números de aceptación de pedido correspondientes.

Este producto es conforme a las principales prescripciones de la directiva CEM 89/336/CEE y a las enmiendas y directivas bajas tension 73/23/CEE y 94/68/CEE. Si lo desea, podemos facilitarle una Declaración de Conformidad por separado. Rogamos faciliten el número de confirmación de pedido y los números de serie de los respectivos productos.

IT

**ISTRUZIONI DI INSTALLAZIONE E DI MANUTENZIONE GENERALE**

**Note:** Queste istruzioni devono essere lette in congiunzione con il manuale specifico del prodotto.

**INSTALLAZIONE**

Le elettrovalvole devono essere utilizzate esclusivamente rispettando le caratteristiche tecniche specificate sulla targhetta. Variazioni sulle valvole o sui piloti sono possibili solo dopo aver consultato il costruttore o i suoi rappresentanti. Prima dell'installazione depressurizzare i tubi e pulire internamente.

Le elettrovalvole possono essere montate in tutte le posizioni. Diversamente, una freccia posta sulla valvola indica che deve essere montata in posizione verticale e dritta.

La direzione del flusso è indicata sul corpo della valvola per mezzo di una freccia oppure con l'etichetta "IN", "I", "A", o "P".

I raccordi devono essere conformi alla misura indicata sulla targhetta apposta.

**Attenzione:**

- Ridurre i raccordi può causare operazioni sbalziolate o malfunzionamento.
- Per proteggere il componente installare il più vicino possibile al lato ingresso, un filtro adatto al servizio.
- Se si usano nastro, pasta, spray o lubrificanti simili durante il serraggio, evitare che delle particelle entrino nel corpo della valvola.
- Usare un'attrezzatura appropriata e utilizzare le chiavi solo sul corpo della valvola.
- Per evitare danni al corpo della valvola, NON SERRARE ECCESSIVAMENTE I TUBI.
- Non usare la valvola o il pilota come una leva.
- I raccordi non devono esercitare pressione, torsione o sollecitazione sull'elettrovalvola.

**ALLACCIAMENTO ELETTRICO**

L'allacciamento elettrico deve essere effettuato esclusivamente dal personale specializzato e deve essere conforme alle Norme locali.

**Attenzione:**

- Prima di mettere in funzione togliere l'alimentazione elettrica, disaccettare il circuito elettrico e la parti sotto tensione.
- I morsetti elettrici devono essere correttamente avvitati, secondo le Norme, prima della messa in servizio.
- Le elettrovalvole devono essere provviste di morsetti di terra a seconda della tensione e delle Norme di sicurezza locali.

I piloti possono avere una delle seguenti caratteristiche elettriche:

- Connettore ISO-4400 o 3 x DIN-46244 (se installato correttamente è IP-65).
- Morsetteria racchiusa in custodia metallica. Entrata cavi con pressacavi tipo "PG".
- Bobina con attacchi FASTON (tipo AMP).
- Bobine con fili o cavo.

**MESSA IN FUNZIONE**

Prima di dare pressione alla valvola, eseguire un test elettrico. Eccitare la bobina diverse volte fino a notare uno scatto metallico che dimostra il funzionamento del pilota.

**SERVIZIO**

Molte elettrovalvole sono provviste di bobine per funzionamento continuo. Per prevenire la possibilità di danneggiare cose o persone, non toccare il pilota. La custodia della bobina o del pilota può scaldarsi anche in normali condizioni di funzionamento.

**EMISSIONE SUONI**

L'emissione di suoni dipende dall'applicazione e dal tipo di elettrovalvola. L'utente può stabilire esattamente il livello del suono solo dopo aver installato la valvola sul suo impianto.

**MANUTENZIONE**

Generalmente questi componenti non necessitano spesso di manutenzione. Comunque, in alcuni casi è necessario fare attenzione a depositi o ad eccessiva usura. Questi componenti devono essere puliti periodicamente, il tempo che intercorre tra una pulizia e l'altra varia a seconda delle condizioni di funzionamento. Il ciclo di durata dai componenti dipende dalle condizioni di funzionamento. In caso di usura è disponibile un set completo di parti interne per per la revisione.

Se si incontrano problemi durante l'installazione e la manutenzione o se si hanno dei dubbi, consultare ASCO/JOUCOMATIC o i suoi rappresentanti.

L'utente può richiedere al costruttore una dichiarazione separata riguardante le Direttive EEC 89/392/EEC e 91/368/EEC (vedere allegato II B) fornendo il numero di serie e il riferimento dell'ordine relativo.

Questo prodotto soddisfa i requisiti essenziali della direttiva CEM 89/336/CEE nonché gli emendamenti e le direttive sulla bassa tensione 73/23/CEE e 94/68/CEE. Una Dichiarazione di Conformità separata può essere ottenuta su richiesta. Si prega di fornire il numero della conferma dell'ordinativo ed i numeri di serie dei relativi prodotti.

NL

**ALGEMENE INSTALLATIE- EN ONDERHOUDSINSTRUKTIES**

**N.B.:** Deze algemene instructies t.a.v. installatie en onderhoud moeten in echt worden genomen tezamen met de specifieke voorschriften van het product.

**INSTALLATIE**

ASCO/JOUCOMATIC producten mogen uitsluitend toegepast worden binnen de op de naamplaat aangegeven specificaties. Wijzigingen, zowel elektrisch als mechanisch, zijn alleen toegestaan na overleg met de fabrikant of haar vertegenwoordiger. Voor het inbouwen dient het leidingsstelsel droog en schoon gemaakt te worden en inwendig gereinigd.

De positie van de afsluiter is naar keuze te bepalen, behalve in die gevallen waarbij het tegendeel door pijlen wordt aangegeven. De doorstroombichting wordt bij afsluiters aangegeven op het afsluiterhuis.

De pijp aansluiting moet overeenkomstig de naamplaatgegevens plaatsvinden.

Hierbij moet men letten op:

- Een reductie van de aansluitingen kan tot prestatie- en functie-stoornis leiden.
- Ter bescherming van de interne delen wordt een filter in het leidingsnet aanbevolen.
- Bij het gebruik van draadafdichtingspasta of tape mogen er geen deeltjes in het leidingswerk geraken.
- Men dient uitsluitend geschikt gereedschap voor de montage te gebruiken.
- Bij konische/tape koppelingen moet met een zodanig koppel worden gewerkt dat het product niet wordt beschadigd.
- Het product, de behuizing of de spoel mag niet als hefboom worden gebruikt.
- De pijp aansluitingen mogen geen krachten of momenten op het product overdragen.

**ELEKTRISCHE AANSLUITING**

In geval van elektrische aansluiting dient de door vakkundig personeel te worden uitgevoerd volgens de door de plaatselijke overheid bepaalde richtlijnen.

Men dient in het bijzonder te letten op:

- Voordat men aan het werk begint moeten alle spanningsvoerende delen spanningsloos worden gemaakt.
- Alle aansluitklemmen moeten na het beëindigen van het werk volgens de juiste normen worden aangedraaid.
- Al naar gelang het spanningsbereik, moet het product volgens de geldende normen van een aarding worden voorzien.

Het product kan de volgende aansluitingen hebben:

- Steker aansluiting volgens ISO-4400 of 3x DIN-46244 (bij juiste montage wordt de dichtheidsklasse IP-65 verkregen).
- Aansluiting binnen in het metaal huis d.m.v. schoofaansluiting. De kabeldoorvoer heeft een "PG" aansluiting.
- Spoelen met platte stekker (AMP type).
- Losse of aangegoten kabels

**IN GEBRUIK STELLEN**

Voordat de druk aangesloten wordt dient een elektrische test te worden uitgevoerd. Ingeval van magneetafsluiters, legt men meerdere malen spanning op de spoel aan waarbij een duidelijk "klikken" hoorbaar moet zijn bij juist functioneren.

**GEBRUIK**

De meeste magneetafsluiters zijn uitgevoerd met spoelen voor continu gebruik. Omdat persoonlijke of zakelijke schade kan ontstaan bij aanraking dient men dit te vermijden, daar bij langdurige inschakeling de spoel of het spoelhuis heet kan worden.

**GELUIDSEMISSIE**

Dit hangt sterk af van de toepassing en het gebruikte medium. De bepaling van het geluidsniveau kan pas uitgevoerd worden nadat het ventiel is ingebouwd.

**ONDERHOUD**

Het onderhoud aan de afsluiters is afhankelijk van de bedrijfsomstandigheden.

In bepaalde gevallen moet men bedacht zijn op media welke sterke vervuiling binnen in het product kunnen veroorzaken. Men dient dan regelmatig inspecties uit te voeren door de afsluiter te openen en te reinigen. Indien ongewone slijtage optreedt dan zijn reserve onderdelen sets beschikbaar om een inwendige revisie uit te voeren.

Ingeval problemen of onduidelijkheden tijdens montage, gebruik of onderhoud optreden dan dient men zich tot ASCO of haar vertegenwoordiger te wenden.

Een aparte fabrikanten verklaring van inbouw, in de zin van EU-richtlijn 89/392/EEG aanhangsel IIB kan door de afnemer na opgave van orderbevestigingsnummer en serienummer verkregen worden.

Dit product voldoet aan de essentiële vereisten van de EMC Richtlijn 89/336/EEG en amendementen, net als aan de richtlijnen 73/23/EEG en 93/68/EEG inzake laagspanning. Een afzonderlijke verklaring van overeenstemming is op verzoek verkrijgbaar. Vermeld a.u.b. het nummer van de opdrachtbevestiging en de serienummers van de betreffende producten.

ASCO Valves



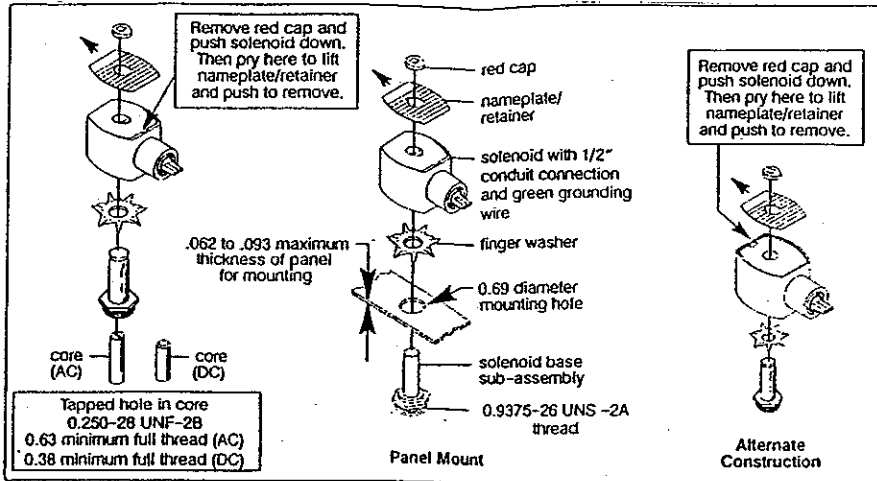


Figure 1. Series 8003G solenoids

**Torque Chart**

Part Name	Torque Value in Inch-Pounds	Torque Value in Newton-Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 - 20	1,7 - 2,3
center screw	5 ± 1	0,6 ± 0,1

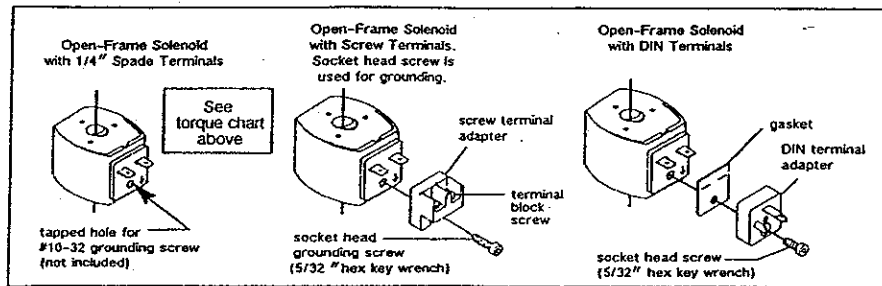


Figure 2. Open-frame solenoids

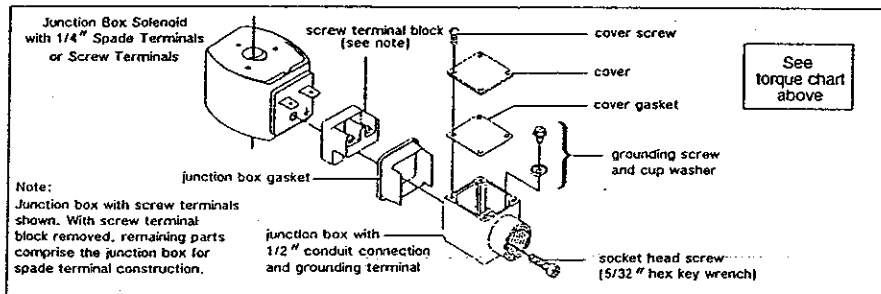


Figure 3. Junction box (optional feature)

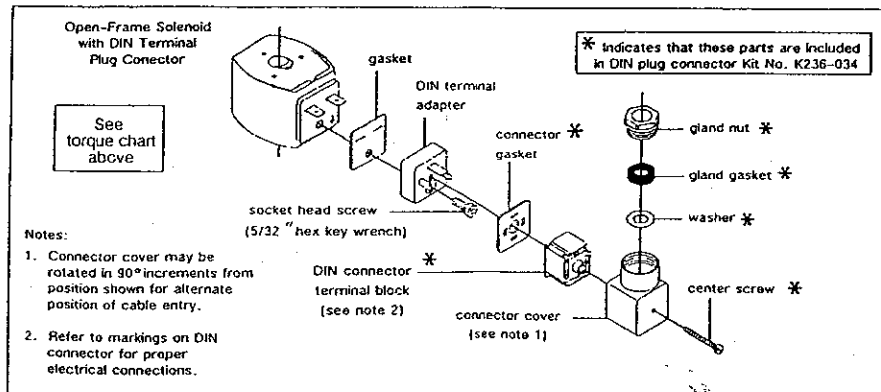


Figure 4. DIN plug connector kit No. K236-034 (optional feature)



# INSTRUCTIONS DE MONTAGE ET D'ENTRETIEN

## DESCRIPTION

Les instructions suivantes sont incluses pour vous donner des informations générales pour l'installation de nos pièces de rechange. Ces instructions sont très générales et couvrent plusieurs types de soupapes, telles que soupapes à commande par solénoïde, à commande par pilote externe, etc.. Pour une information plus exacte au sujet d'une soupape particulière, voir les pages d'instructions qui sont incluses avec la soupape en question.

## FONCTIONNEMENT

Référez au dessin d'assemblage.

## INSTALLATION

Vérifiez la plaque d'identification pour vous assurer que le numéro de catalogue, le voltage, la pression et le service sont tels que requis.

## MISE EN PLACE

Référez aux dessins d'assemblage.

## TUYOTAGE

Couplez les conduits à la soupape selon les indications données sur le châssis de la soupape. Appliquez la pâte pour conduits généreusement sur les pas de vis du conduit mâle seulement: si on l'applique sur le pas de vis de la soupape même, il y a danger que la pâte pénètre dans la soupape et cause des difficultés de fonctionnement.

- important - Pour meilleure opération, il est recommandé qu'un filtre approprié au service soit installé au plus près de la soupape que possible, et que ce filtre soit nettoyé périodiquement.

- avertissement - Évitez de trop serrer les tuyaux. Appliquez les clés le plus près possible du point de raccordement du tuyau et du corps de la soupape. N'utilisez pas la soupape comme levier.

## PRESSION DIFFÉRENTIELLE DE FONCTIONNEMENT (Minimum)

Pour toutes soupapes qui exigent une pression différentielle minimum, il est critique que les lignes de pression et d'échappement ne soient pas réduites. La pression minimum tel qu'indiqué sur la plaque d'identification doit être maintenue.

## CABLAGE

Le câblage doit être conforme aux règlements des Codes Électriques soit Nationaux, soit de l'endroit où l'installation est effectuée.

## ENTRETIEN

- ATTENTION - Débranchez l'alimentation électrique (ou pression auxiliaire) ainsi que la pression avant d'effectuer aucune réparation.

## NETTOYAGE

Un nettoyage périodique de toutes les soupapes et accessoires est recommandé. L'intervalle entre nettoyages variera selon les conditions de service.

## ENTRETIEN PREVENTIF

1. Assurez-vous que la matière circulant dans la soupape est aussi propre que possible.
2. Pendant son service, opérez la soupape au moins une fois par mois pour assurer l'opération normale de la soupape.
3. L'inspection périodique (selon les conditions de service) des parties internes de la soupape est recommandée afin d'observer si il y a endommagement ou usure excessive. Nettoyez la soupape au complet et installez les nouvelles pièces de rechange.

## FONCTIONNEMENT FAUTIF

1. **Defaut du circuit de contrôle:** Vérifiez le système électrique en mettant le solénoïde sous tension. Un dé clic métallique signifie que le solénoïde fonctionne normalement. L'absence d'un dé clic métallique indique une perte d'alimentation du courant. Vérifiez la présence de fusibles fondus, d'une bobine avec un circuit ouvert ou mise à terre, d'un fil ou d'une éprouvette brisée.
2. **Basse tension:** Vérifiez le niveau de tension. La tension doit être au moins à 85% du niveau indiqué sur la plaque d'identification.
3. **Pression inexacte:** Vérifiez que la pression et le service conforme à celle indiquée sur la plaque d'identification de la soupape.
4. **Fuite de pression:** Démontez la soupape et nettoyez toutes les pièces. Installez les pièces de rechange si nécessaire. Vérifiez qu'il n'y a pas d'objets étrangers qui bloquent ou causent la fuite de pression.  
- important - Certaines soupapes, à cause de leurs sièges non-élastiques sont allouées une fuite de pression minime. Consultez le bureau de vente Asco.

## ENSEMBLES DE PIÈCES DE RECHANGE

Pour commander les ensembles de pièces de rechange et les bobines pour les soupapes ASCO, spécifiez le numéro de catalogue, le voltage, la pression et le service en question.  
- a noter - Les pièces indiquées avec (\*) sur le dessin d'assemblage sont incluses dans l'ensemble de pièces de rechange.





# 3 WAY DIRECT ACTING General Service Solenoid Valves

Brass or Stainless Steel Bodies • 1/8" and 1/4" N.P.T.

**Specifications**

**Solenoid Enclosures:** Valves listed in this series have Red-Hat II molded epoxy solenoids, are identified by the change letter "G" in their catalog numbers, e.g., 8320G130, and are shown in red.

**Standard Enclosures:**

Red-Hat II — Types 1, 2, 3, 3S, 4 and 4X Combination General Purpose and Watertight.

**Optional Enclosures:**

Red-Hat II — Types 3, 3S, 4, 4X, 6, 6P, 7 and 9 Combination Explosionproof and Watertight.

To order, add prefix "EF" to catalog number.

Additional constructions are available. The Optional Electrical Features Section, page 22, contains descriptions and ordering information for: Open Frame Solenoids • Junction Box Enclosures • Panel Mount Constructions.

**Electrical:** Standard Voltages: 12, 24, 120, 240, 480 volts, AC, 60 Hz (or 110, 220 volts, AC, 50 Hz)  
6. 12. 24. 120. 240 volts. DC  
Other voltages are available when required.

**Coil:** Continuous duty molded Class F.

**Nominal Ambient Temperature Ranges:** AC Construction: 32°F. to 125°F.

DC Construction: 32°F. to 104°F.  
Refer to Engineering Section for details.

**Valve Parts in Contact with Fluid:**

Body — Brass or 303 s.s., as listed

Seals and Discs — Buna "N"

Core Tube — 305 s.s.  
Core and Plugnut — 430F s.s.  
Core Springs — 302 s.s.  
Shading Coil — Copper (brass body); Silver (stainless steel body)  
Disc Holder — Acetal  
Core Guide — Acetal (10.1 and 17.1 watt only)

**Approvals:** CSA certified.  
Refer to Engineering Section for details.

**Ordering Information:**  
*Important:* We must have catalog number, voltage and Hertz, operating pressure and fluid handled. Use strainers with solenoid valves.

**FOR NAMUR INTERFACE CONSULT FACTORY**

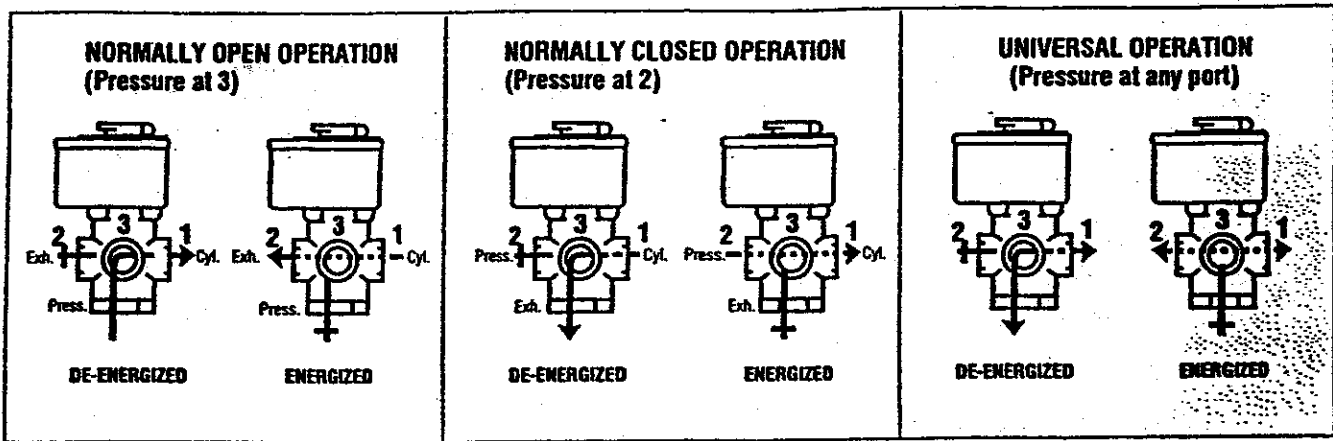
**ELECTRICAL INFORMATION**

Standard Coil and Class of Insulation	Watt Rating and Power Consumption			
	DC Watts	AC		
		Watts	VA Holding	VA Inrush
F	11.6	10.1	25	50
F	22.6	17.1	40	70

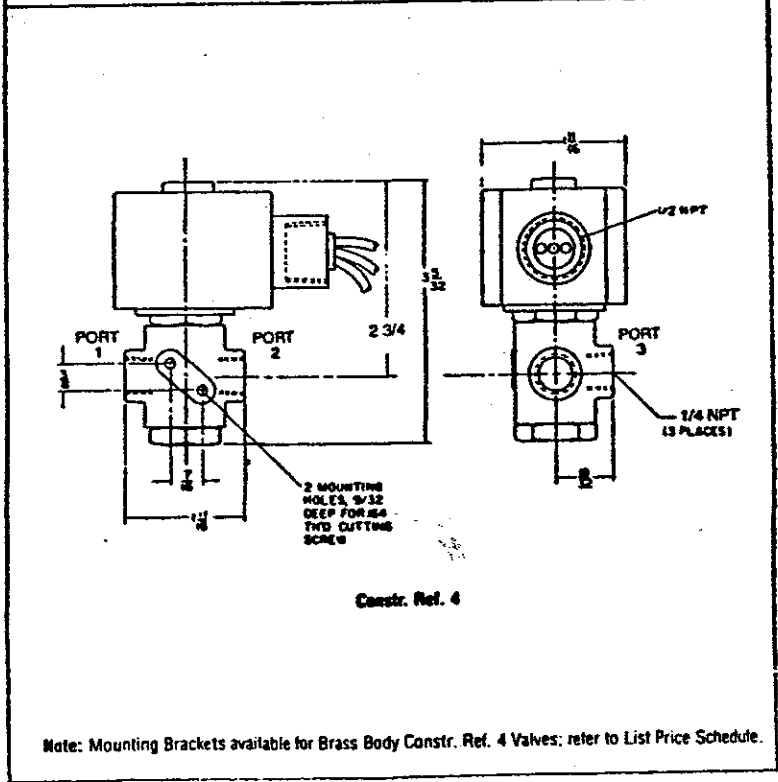
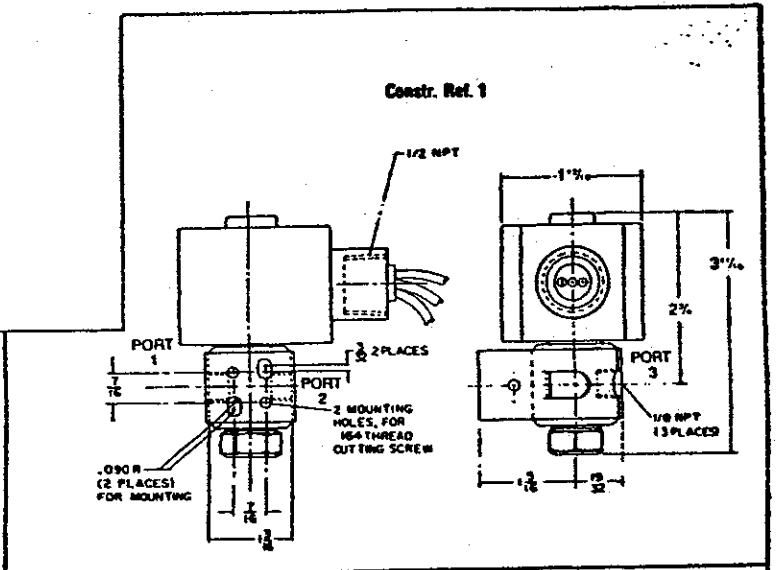
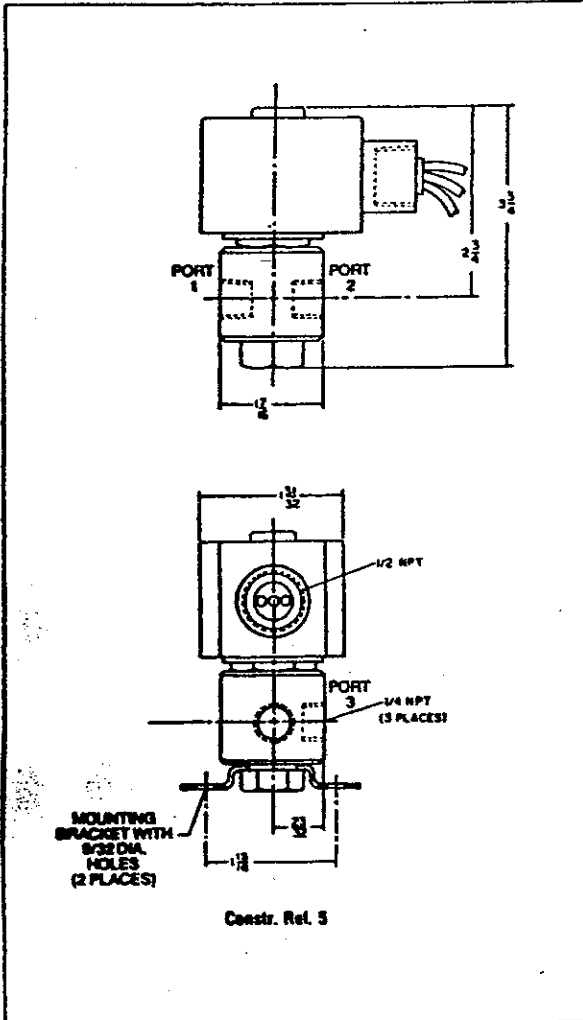
**SPECIFICATIONS**

Pipe Size (In.)	Orifice Size (In.)	Cv Flow Factor	Operating Pressure Differential (psi)								Max. Fluid Temp. °F.		Standard Solenoid Enclosures Red-Hat II-Types 1, 2, 3, 3S, 4 and 4X				Watt Rating/Class of Coil Insulation	
			Max. AC				Max. DC				AC	DC	Brass Body		S. S. Body		AC	DC
			Air-Inert Gas	Water	LI. Oil @ 300 SSU	LI. Oil @ 300 SSU	Air-Inert Gas	Water	LI. Oil @ 300 SSU	LI. Oil @ 300 SSU			Catalog Number	Costr. Ref. No.	Catalog Number	Costr. Ref. No.		
<b>UNIVERSAL OPERATION (Pressure at any port)</b>																		
1/8	1/16	.09	175	175	175	125	125	125	180	120	8320G212	1	8320G221	1	17.1/F	22.6/F		
1/8	3/32	.12	100	100	100	60	60	60	180	120	8320G213	1	8320G222	1	17.1/F	11.6/F		
1/8	1/8	.21	50	50	50	25	25	25	180	120	8320G214	1	8320G223	1	17.1/F	11.6/F		
1/4	1/16	.09	125	130	130	75	75	75	200	150	8320G172	4	—	—	10.1/F	11.6/F		
1/4	1/16	.08	175	175	175	125	125	125	200	150	—	—	8320G230	5	17.1/F	22.6/F		
1/4	3/32	.12	100	100	100	60	60	60	200	150	8320G174	4	8320G200	5	17.1/F	11.6/F		
1/4	1/8	.25	50	50	50	25	25	25	200	150	8320G176	4	8320G201	5	17.1/F	11.6/F		
1/4	1/16	.35	20	20	20	12	12	12	200	150	8320G178	4	—	—	10.1/F	11.6/F		
<b>NORMALLY CLOSED (Closed when de-energized)</b>																		
1/8	1/16	.09	210	225	225	160	160	160	180	120	8320G215	1	8320G224	1	17.1/F	11.6/F		
1/8	3/32	.12	150	150	150	115	115	115	180	120	8320G216	1	8320G225	1	10.1/F	11.6/F		
1/8	1/8	.21	85	85	85	60	60	60	180	120	8320G217	1	8320G226	1	10.1/F	11.6/F		
1/4	1/16	.09	210	225	225	160	160	160	200	150	8320G182	4	8320G231	5	17.1/F	11.6/F		
1/4	3/32	.12	150	150	150	115	115	115	200	150	8320G184	4	8320G202	5	10.1/F	11.6/F		
1/4	1/8	.25	85	85	85	60	60	60	200	150	8320G186	4	8320G203	5	10.1/F	11.6/F		
1/4	1/16	.35	45	45	45	25	25	25	200	150	8320G188	4	—	—	10.1/F	11.6/F		
<b>NORMALLY OPEN (Open when de-energized)</b>																		
1/8	1/16	.09	235	250	250	160	160	160	180	120	8320G218	1	8320G227	1	17.1/F	11.6/F		
1/8	3/32	.12	150	150	150	100	100	100	180	120	8320G219	1	8320G228	1	10.1/F	11.6/F		
1/8	1/8	.21	70	70	70	55	55	55	180	120	8320G220	1	8320G229	1	10.1/F	11.6/F		
1/4	1/16	.09	235	250	250	160	160	160	200	150	8320G180	4	8320G232	5	17.1/F	11.6/F		
1/4	3/32	.12	150	140	140	100	100	100	200	150	8320G182	4	8320G233	5	10.1/F	11.6/F		
1/4	1/8	.25	70	70	70	55	55	55	200	150	8320G184	4	8320G234	5	10.1/F	11.6/F		
1/4	1/16	.35	40	40	40	30	30	30	200	150	8320G186	4	—	—	10.1/F	11.6/F		

8320 SERIES (continued)  
FLOW DIAGRAMS



DIMENSIONS (in inches)



Note: Mounting Brackets available for Brass Body Constr. Ref. 4 Valves; refer to List Price Schedule.

CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : TEMPERATURE INDICATORS	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 5%;">NO</th> <th style="width: 5%;">BY</th> <th style="width: 15%;">DATE</th> <th style="width: 15%;">REVISION</th> </tr> <tr> <td>0</td> <td>RDD</td> <td>03/11/05</td> <td>ISSUE FOR PURCHASE</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	NO	BY	DATE	REVISION	0	RDD	03/11/05	ISSUE FOR PURCHASE									JOB # 054468 DATE 03/11/2005 REQ. BY      CHK'D   APPR.
NO	BY	DATE	REVISION															
0	RDD	03/11/05	ISSUE FOR PURCHASE															

<b>THERMOMETER</b> 1. STEM :            THREADED <u>  X  </u> PLAIN <u>    </u> UNION <u>    </u> MATERIAL                            _____ ELEMENT 2. STEM OR UNION THREAD :                            21 mm <u>  X  </u> 27 mm <u>    </u> 3. STEM DIAMETER : STD <u>  X  </u> 14 mm <u>    </u> 17 mm <u>    </u> 4. CASE MATERIAL : STD <u>  X  </u> OTHER <u>    </u> 5. DIAL SIZE <u>  75  </u> mm COLOR <u>    </u> 6. SCALE LENGTH                                    _____ mm COLOR <u>    </u> 7. FORM : FIG. NO. <u>    2    </u> ADJUSTABLE <u>    </u> 8. EXTERNAL CALIBRATOR                            _____ HERM. SEALED CASE <u>    </u> 9. _____	<b>WELL</b> 10. NONE                            _____ INCLUDED <u>  X  </u> BY OTHERS <u>    </u> 11. MATERIAL :                                    304 SS <u>  X  </u> 316 SS <u>    </u> OTHER <u>    </u> 12. CONSTRUCTION :                                    DRILLED <u>  X  </u> BUILT - UP <u>    </u> OTHER <u>    </u>  <p style="text-align: center;">---- WELL LENGTH MUST SUIT STEM LENGTH ----</p>
--	--

TAG NO.	REV	QTY	RANGE o C	OPERATING TEMP o C	STEM LENGTH m m	WELL CONN. m m	LAG EXT. m m	SERVICE	NOTES	ASSEMBLY & UNIT #
TI-600	0	1	0-100	43	152	27 NPT		E-600 T/S IN		
TI-601	0	1	0-100	37	152	27 NPT		E-600 S/S OUT		
TI-610	0	1	-50-50	-26	229	27 NPT		CHILLER SHELL		
TI-611	0	1	-50-50	0	152	27 NPT		E-600 T/S OUT		
TI-615	0	1	0 - 50	30	102	27 NPT		E-615 S/S OUT		
TI-616	0	1	-50-50	-4	102	27 NPT		E-615 S/S OUT		
TI-620	0	1	-50-50	-23	229	27 NPT		LTS		
TI-630	0	1	0-200	107	229	27 NPT		DEC2 BOTTOMS		
TI-631	0	1	-50-50	-12	102	27 NPT		DEC2 OVHDS		
TI-633	0	1	0-300	232	229	27 NPT		DEC 2 RBLR SH		
TI-635	0	1	0-50	30	102	27 NPT		C3 OUT SUBCLR		
TI-640	0	1	0-100	57	229	27 NPT		GLYCOL FLSH		
TI-650	0	1	0-200	123	229	27 NPT		H-650 REBOILER		
TI-651	0	1	0-150	66	102	27 NPT		H-650 SURGE		
TI-671	0	1	0-150	66	102	27 NPT		K-670 OUT		
TI-680	0	1	0-100	43	229	27 NPT		C3 ACCUMULATOR		

MFR: TREND OR EQUAL

MODEL NUMBER:

P.O. NUMBER:

NOTES:

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3			TEMPERATURE INSTRUMENTS ( FILLED SYSTEM )				SHEET 1 OF 3					
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : TEMPERATURE CONTROLLERS			NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.T				
			0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468				
							DATE	03/11/2005	REQ.			
							BY	CHK'D	APPR.			
1	TAG NO. TIC-630	SERVICE DEETHANIZER										
2	FUNCTIONS	RECORD	_____	INDICATE	X_____	CONTROL	X_____	BLIND	_____	TRANS.	_____	
3	CASE	MFR STD	X_____	NOM SIZE	_____	COLOR : MFR STD	X_____	OTHER	_____			
4	MOUNTING	FLUSH	_____	SURFACE	_____	YOKE	_____	OTHER	_____			
5	ENCLOSURE CLASS	GENERAL PURPOSE	_____	WATERPROOF	X_____	EXPLOSIONPROOF	_____	CLASS	_____			
6	POWER SUPPLY	FOR USE IN INTRINSICALLY SAFE SYSTEM			_____	OTHER	_____					
7	CHART	117 V 60Hz	_____	OTHER AC	_____	DC	_____	VOLTS	_____			
8	CHART DRIVE	STRIP	_____	ROLL	_____	FOLD	_____	CIRCULAR	_____	TIME MARKS	_____	
9	SCALES	SPEED	_____		_____	POWER	_____					
		TYPE	_____		_____		_____					
		RANGE	1	50-200 C	_____	2	_____	3	_____	4	_____	
X	10	TRANSMITTER OUTPUT	4 - 20 mA	_____	10 - 50 mA	_____	21 - 103 kPa(g)	_____	42 - 206 kPa (g)	_____	OTHER	_____
			FOR RECEIVER SEE SPEC. SHEET									
C	11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST									
O			P	_____	PI	X_____	PD	_____	PID	_____	IF	_____
N			DF	_____	IS	_____	DS	_____				
T			OTHER	_____								
R	12	ACTION	ON MEAS. INCREASE OUTPUT :			INCREASES	_____	DECREASES	X_____			
O	13	AUTO - MAN SWITCH	NONE	_____	MFR STD	X_____	OTHER	_____				
L	14	SET POINT ADJ.	MANUAL	X_____	EXTERNAL	_____	REMOTE	_____	OTHER	_____		
L	15	MANUAL REG.	NONE	_____	MFR STD	_____	OTHER	_____				
E	16	OUTPUT	4 - 20 mA	_____	10 - 50 mA	_____	21 - 103 kPa(g)	X_____	42 - 206 kPa (g)	_____	OTHER	_____
R												
17	18	FILL PROCESS DATA	SAMA CLASS	IIIB	_____	COMPENSATION NO	_____					
19	19	RANGE	TEMP: NORMAL	107	° C	MAX. 200	° C	MAX. PRESSURE	3792	kPa (g)		
20	20	BULB	FIXED	X_____	ADJ. RANGE	_____	SET AT	107	° C			
21	21	CAPILLARY	OVERRANGE PROTECTION TO	200C								
22	22	WELL	TYPE	_____	MTL.	_____	EXTENSION:	LENGTH	_____	mm	TYPE	_____
			SIZE: DIAMETER	14.3	mm	LENGTH	_____	mm	INSERTION	_____	mm	
			CONN.	_____	LOCATION	_____	mm	ABOVE	_____		BELOW	_____
			MFR. STD	X_____	LENGTH	4600	mm	MTL.	_____		ARMOR	_____
			MTL.	304SS	INSERTION	267	mm	LAG EXT.	_____	mm	CONN.	27 NPT
			CONST: DRILLED	X_____	BUILT - UP	_____		OTHER	_____			
23	23	ALARM SWITCHES	QUANTITY	_____	FORM	_____	RATING	_____				
24	24	FUNCTION	TEMP	_____	DEVIATION	_____	CONTACTS TO	_____	ON TEMP. INCREASE	_____		
25	25	OPTIONS	FILT - REG.	_____	SUP. GAGE	_____	OUTPUT GAGE	_____	CHARTS	_____		
			OTHER	_____								
26	26	MFR. & MODEL NO.	FISHER									
27	27	MODEL NO.	4196									
28	28	P. O. NUMBER	_____									

NOTES:

AREA. UNIT # :



PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3		TEMPERATURE INSTRUMENTS ( FILLED SYSTEM )				SHEET 3 OF 3		
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : TEMPERATURE CONTROLLERS		NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.T	
		0	RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468	
							DATE	03/11/2005
							REQ.	
					BY	CHK'D	APPR.	
1	TAG NO. TIC-650	EG REGENERATOR						
2	FUNCTIONS	RECORD _____ INDICATE <input checked="" type="checkbox"/> _____ CONTROL <input checked="" type="checkbox"/> _____ BLIND _____ TRANS. _____ OTHER _____						
3	CASE	MFR STD <input checked="" type="checkbox"/> _____ NOM SIZE _____ COLOR : MFR STD <input checked="" type="checkbox"/> _____ OTHER _____						
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER _____						
5	ENCLOSURE CLASS	GENERAL PURPOSE _____ WATERPROOF <input checked="" type="checkbox"/> _____ EXPLOSIONPROOF _____ CLASS _____ FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____						
6	POWER SUPPLY	117 V 60Hz _____ OTHER AC _____ DC _____ VOLTS _____						
7	CHART	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____						
8	CHART DRIVE	SPEED _____ POWER _____						
9	SCALES	TYPE _____ RANGE 1 <u>50-200 C</u> 2 _____ 3 _____ 4 _____						
10	TRANSMITTER OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____ FOR RECEIVER SEE SPEC. SHEET _____						
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI <input checked="" type="checkbox"/> _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____						
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES <input checked="" type="checkbox"/> _____						
13	AUTO - MAN SWITCH	NONE _____ MFR STD <input checked="" type="checkbox"/> _____ OTHER _____						
14	SET POINT ADJ.	MANUAL <input checked="" type="checkbox"/> _____ EXTERNAL _____ REMOTE _____ OTHER _____						
15	MANUAL REG.	NONE _____ MFR STD _____ OTHER _____						
16	OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) <input checked="" type="checkbox"/> _____ 42 - 206 kPa (g) _____ OTHER _____						
17	FILL	SAMA CLASS <u>IIIB</u> _____ COMPENSATION NO _____						
18	PROCESS DATA	TEMP: NORMAL <u>124</u> ° C MAX. <u>200</u> ° C MAX. PRESSURE <u>1034</u> kPa (g)						
19	RANGE	FIXED <input checked="" type="checkbox"/> _____ ADJ. RANGE _____ SET AT <u>124</u> ° C OVERRANGE PROTECTION TO <u>200C</u>						
20	BULB	TYPE _____ MTL. _____ EXTENSION: LENGTH _____ mm TYPE _____ SIZE: DIAMETER <u>14.3</u> mm LENGTH _____ mm INSERTION _____ mm CONN. _____ LOCATION _____ mm ABOVE _____ BELOW _____						
21	CAPILLARY	MFR. STD <input checked="" type="checkbox"/> _____ LENGTH <u>4600</u> mm MTL. _____ ARMOR _____						
22	WELL	MTL. <u>304SS</u> INSERTION <u>267</u> mm LAG EXT. _____ mm CONN. <u>27 NPT</u> CONST: DRILLED <input checked="" type="checkbox"/> _____ BUILT - UP _____ OTHER _____						
23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____						
24	FUNCTION	TEMP _____ DEVIATION _____ CONTACTS TO _____ ON TEMP. INCREASE _____						
25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____ OTHER _____						
26	MFR. & MODEL NO.	<u>FISHER</u>						
27	MODEL NO.	<u>4196</u>						
28	P. O. NUMBER	_____						
NOTES:								
AREA. UNIT # :								

# 4196A, B, C, and S Series

## 4196A, B, C, and S Series Temperature Indicating Controllers

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# 4196A, B, C, and S Series

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# 4196A, B, C, and S Series

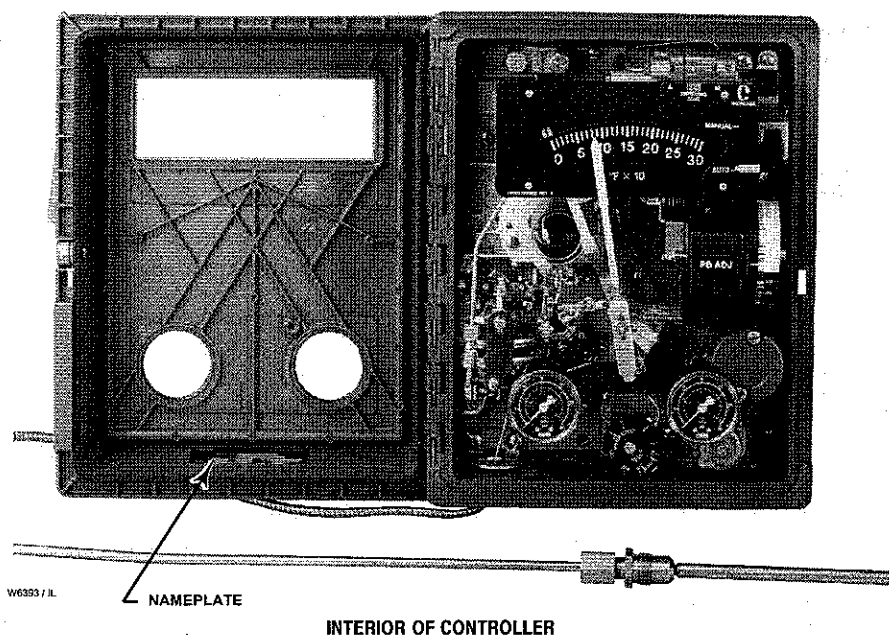


Figure 1-1. 4196 Series Temperature Controllers

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## Section 1 Introduction

### Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information for the 4196A, 4196B, 4196C, and 4196S Series temperature indicating controllers.

Portions of this manual apply only to specific configurations in the 4196 Series controller configurations. These configurations are indicated by letter suffixes in the type number that correspond to the mode and option designated in table 1-2.

The specific controller type number (with letter suffixes) is on the nameplate shown in figure 1-1. Refer to table 1-2 for the definition of each 4196 Series type number.

Only personnel qualified through training or experience should install, operate, and maintain this controller. If there are any questions concerning these instructions, contact your Fisher sales representative or sales office before proceeding.

# 4196A, B, C, and S Series

## Description

The controllers described in this manual provide temperature control with options as shown in table 1-1.

- 4196A Series: Proportional-only control
- 4196B Series: Proportional-plus-reset control
- 4196C Series: Proportional-plus-reset-plus-rate control

- 4196S Series: Differential gap control

These controllers show process temperature and set point on an easy-to-read process scale. The controller output is a pneumatic signal that operates a final control element.

## Specifications

Specifications for the 4196A, B, C, and S Series controllers are listed in table 1-1.

Table 1-1. Specifications

<p><b>Available Configurations</b></p> <p>See table 1-2</p> <p><b>Process Sensor Range (Input Signal<sup>(1)</sup>)</b></p> <p><b>Type:</b> Temperature between -100 and 700°F (-73 and 371°C). See table 1-4 for available ranges</p> <p><b>Minimum Span:</b> 100°F or 60°C</p> <p><b>Maximum Span:</b> 600°F or 300°C</p> <p><b>Output Signal<sup>(1)</sup></b></p> <p><b>Proportional-Only, Proportional-Plus-Reset, or Proportional-Plus-Reset-Plus-Rate Range:</b> 3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.0 bar)</p> <p><b>Differential Gap Range:</b> 0 and 20 psig (0 and 1.4 bar) or 0 and 35 psig (0 and 2.4 bar)</p> <p><b>Action:</b> Field-reversible between direct (increasing sensed temperature increases output pressure) or reverse (increasing sensed temperature decreases output pressure)</p> <p><b>Process Scale</b></p> <p>Standard scale is matched to the range of the sensing element. Optional<sup>(2)</sup> scales available</p> <p><b>Supply and Output Connections</b></p> <p>1/4-inch NPT female</p> <p><b>Supply Pressure Requirements</b></p> <p>See table 1-3</p>	<p><b>Remote Set Point Pressures</b></p> <p>3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.0 bar)</p> <p><b>Maximum Allowable Pressure In Closed Vessel (For Temperature Bulb)<sup>(3)</sup></b></p> <p><b>3/8-inch (9.7 mm) Diameter Temperature Bulb:</b> 1000 psig (69 bar)</p> <p><b>9/16-inch (14.3 mm) Diameter Temperature Bulb:</b> 500 psig (34.5 bar)</p> <p>Also, see tables 2-1 and 2-2 for thermowell maximum process fluid velocities and maximum process pressures.</p> <p><b>Controller Adjustments</b></p> <p><b>Proportional Band<sup>(1)</sup>:</b> 5 to 500% of process scale range</p> <p><b>Reset<sup>(1)</sup>:</b> Adjustable from 0.01 to more than 74 minutes per repeat (from 100 to less than 0.0135 repeats per minute)</p> <p><b>Rate<sup>(1)</sup>:</b> Adjustable from 0 to 20 minutes</p> <p><b>Differential Gap Controller<sup>(1)</sup>:</b> 5 to 100% of process scale range</p> <p><b>Set Point:</b> Adjustable from 0 to 100% of the scale range</p> <p><b>Controller Performance</b></p> <p><b>Repeatability<sup>(1)</sup>:</b> 0.4% of output span</p> <p><b>Dead Band<sup>(1)</sup>:</b> Less than 0.3% of process scale span</p> <p><b>Time Constant of Temperature Bulb:</b> 6 to 12 seconds for a 200°F (93°C) span (bare bulb in agitated liquid)</p>
---	---

(continued)

# 4196A, B, C, and S Series

Table 1-1. Specifications (continued)

<p><b>Steady-State Air Consumption (A, B, and C Series Controllers)<sup>(1, 4)</sup></b></p> <p><b>Without Auto/Manual Station</b>          3 to 15 psig (0.2 to 1.0 Bar) Output: 3.5 scfh (0.1 normal m<sup>3</sup>/h)          6 to 30 psig (0.4 to 2.0 Bar) Output: 5.0 scfh (0.14 normal m<sup>3</sup>/h)</p> <p><b>With Auto/Manual Station (suffix letter E)</b>          3 to 15 psig (0.2 to 1.0 Bar) or 6 to 30 psig (0.4 to 2.0 Bar) Output: 10.0 scfh (0.28 normal m<sup>3</sup>/h)</p> <p><b>Steady-State Air Consumption Differential Gap (S Series Controllers)<sup>(1, 4)</sup></b></p> <p>0 and 20 psig (0 and 1.4 bar) Output: 3.5 scfh (0.1 normal m<sup>3</sup>/h)          0 and 35 psig (0 and 2.4 bar) Output: 5.0 scfh (0.14 normal m<sup>3</sup>/h)</p> <p><b>Delivery Capacity (All 4196 Series)<sup>(4)</sup></b></p> <p>3 to 15 psig (0.2 to 1.0 Bar) Output: 240 scfh (5.9 normal m<sup>3</sup>/h)</p>	<p>6 to 30 psig (0.4 to 2.0 Bar) Output: 350 scfh (10.4 normal m<sup>3</sup>/h)</p> <p><b>Exhaust Capacity (All 4196 Series)<sup>(4)</sup></b></p> <p>3 to 15 psig (0.2 to 1.0 Bar) Output: 186 scfh (4.6 normal m<sup>3</sup>/h)          6 to 30 psig (0.4 to 2.0 Bar) Output: 295 scfh (7.0 normal m<sup>3</sup>/h)</p> <p><b>Operative Ambient Temperature Limits<sup>(1)</sup></b></p> <p>-40 to 160°F (-40 to 70°C)</p> <p><b>Mounting</b></p> <p>Controller can be mounted on actuator, panel, wall, or pipestand.</p> <p><b>Approximate Weight</b></p> <p>10 pounds (4.5 kg)</p>
--	--

1. These terms are defined in ISA Standard S51.1-1979.
2. Consult your Fisher Controls sales office or sales representative for additional information.
3. At 100°F (40°C).
4. Scfh-Standard cubic feet per hour (60°F and 14.7 psia); Normal m<sup>3</sup>/hr-Normal cubic meters per hour (0°C and 1.01325 bar, absolute).

Table 1-2. Available Configurations

Series	TYPE NUMBER <sup>(1)</sup>	MODES				OPTIONS		
		Proportional-Only (One-Mode Controllers)	Proportional-Push-Reset (Two-Mode Controllers)	Proportional-Plus-Reset-Plus-Rate (Three-Mode Controllers)	Differential Gap (Snap-Acting Controllers)	Internal Auto/Manual Station (Suffix Letter E)	Anti-Reset Windup (Suffix Letter F)	Remote Set Point (Suffix Letter M)
4196A	4196A	X	---	---	---	---	---	---
	4196AE	X	---	---	---	X	---	---
	4196AM	X	---	---	---	---	---	X
	4196AME	X	---	---	---	X	---	X
4196B	4196B	---	X	---	---	---	---	---
	4196BE	---	X	---	---	X	---	---
	4196BF	---	X	---	---	---	X	---
	4196BFE	---	X	---	---	X	X	---
	4196BM	---	X	---	---	---	---	X
	4196BME	---	X	---	---	X	---	X
	4196BFM	---	X	---	---	---	X	X
4196BFME	---	X	---	---	X	X	X	
4196C	4196C	---	---	X	---	---	---	---
	4196CE	---	---	X	---	X	---	---
	4196CF	---	---	X	---	---	X	---
	4196CFE	---	---	X	---	X	X	---
	4196CM	---	---	X	---	---	---	X
	4196CME	---	---	X	---	X	---	X
	4196CFM	---	---	X	---	---	X	X
4196CFME	---	---	X	---	X	X	X	
4196S	4196S	---	---	---	X	---	---	---
	4196SE	---	---	---	X	X	---	---
	4196SM	---	---	---	X	---	---	X
	4196SME	---	---	---	X	X	---	X

1. Reverse-acting constructions are designated by the suffix letter R in the type number.

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Table 1-3. Supply Pressure Data

Output Signal Range		Normal Operating Supply Pressure <sup>(1)</sup>	Maximum Pressure To Prevent Internal Part Damage <sup>(2)</sup>
U.S. Units	3 to 15 psig 6 to 30 psig	20 psig 35 psig	40 psig 40 psig
Metric Units	0.2 to 1.0 bar 0.4 to 2.0 bar	1.4 bar 2.4 bar	2.8 bar 2.8 bar

1. If this pressure is exceeded, control may be impaired.  
2. If this pressure is exceeded, damage to the controller may result.

Table 1-4. Available Temperature Ranges of Temperature Bulbs<sup>(1)</sup>

TEMPERATURE SPAN		ELEMENT RANGE	OPERATING RANGE	TEMPERATURE BULB DIAMETER	OVERRANGE LIMITS <sup>(2)</sup>		MAXIMUM TEMPERATURE <sup>(3)</sup>	
°F Minimum	°F Maximum	°F	°F	Inch	°F Minimum	°F Maximum	°F	
U. S. Units	175	200	0 to 200	0 to 300	3/8	-20	300	450
			50 to 250			30	350	
			100 to 300			80	400	
	250	300	0 to 300	-25 to 325	9/16	-30	450	375
			0 to 100	-25 to 200		-10	150	
	100	100	50 to 150	75 to 300	40	200	750	
			100 to 200	-25 to 225	65	250		
			0 to 150	-100 to 275	-15	225		
	125	150	50 to 200	25 to 400	35	275	1000	
			-100 to 200	-100 to 700	-130	350		
	270	300	100 to 400	0 to 450	70	550	1100	
			0 to 400	-100 to 600	-40	600		
425	500	0 to 500	-100 to 700	-50	750			
525	600	0 to 600		-60	900			
°C Minimum	°C Maximum	°C	°C	mm	°C Minimum	°C Maximum	°C	
Metric Units	100	100	0 to 100	-15 to 150	9.5	-10	150	230
			50 to 150			40	200	
			-15 to 85			-25	135	
	150	150	0 to 150	-30 to 160	14.3	-15	225	190
			-20 to 40	-30 to 95		-6	90	
	60	60	0 to 60	38 to 150	54	150	400	
			60 to 120	-75 to 135	-90	150		
			50 to 200	-5 to 200	35	275		
	150	150	0 to 200	-75 to 230	-20	300	535	
			0 to 250	-75 to 315	-25	375		
	235	250	0 to 250		-30	450		
	275	300	0 to 300					

1. Contact your Fisher sales office or sales representative about other spans and ranges.  
2. All temperature bulbs are tested to +50 percent of overrange limits. With travel stops in place, if the overrange limits are exceeded, the controller may require recalibration.  
3. With travel stops in place, temperatures in excess of these values may cause permanent damage to the temperature element.

# 4196A, B, C, and S Series

## Section 2 Installation, Mounting, and Connections

### Controller Mounting Orientation

Mount the controller with the housing vertical, as shown in figure 2-1, so that the vent points down.

### Pipestand Mounting

Refer to figure 2-2. Pipestand mounting parts are provided to mount the controller to a 2-inch (nominal) pipe. Attach a bracket (key 68) to the controller with cap screws (key 66) and lock washers (key 67). Attach two clamps (key 69) to the bracket, and fasten the controller to the pipe.

### Panel Mounting

Using the dimensions shown in figure 2-3, cut a hole in the panel surface. Slide the controller into the hole and attach the bracket (key 68) to the rear of the controller using three cap screws (key 66) and washers (key 67). Tighten the screws (key 70) to seat the case snugly and evenly against the panel surface.

### Wall Mounting

Using the dimensions in figure 2-4. Drill holes in the wall to align with the four holes in the bracket (key 68). If the tubing is to run through the wall, drill a hole in the wall large enough to accept the tubing.

Mount the controller to the bracket using three cap screws (key 66) and lock washers (key 67). Attach the bracket to the wall, using suitable screws or bolts.

### Actuator Mounting

Refer to figure 2-1. A controller specified for mounting on a control valve actuator is mounted at the factory. If the controller is ordered separately for installation on a control valve actuator, mount the unit as described in this section. Mounting parts vary for different actuator types.

Attach the mounting bracket to the actuator yoke with cap screws, lock washers, and spacer spools. Attach the controller to the bracket with cap screws, lock washers, and spacer spools. On some designs, the mounting bracket is attached to the actuator casing rather than to the yoke.

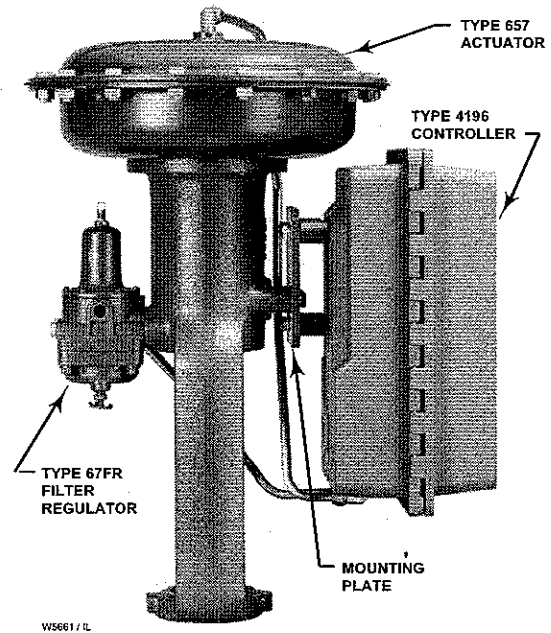


Figure 2-1. Typical Actuator Mounting

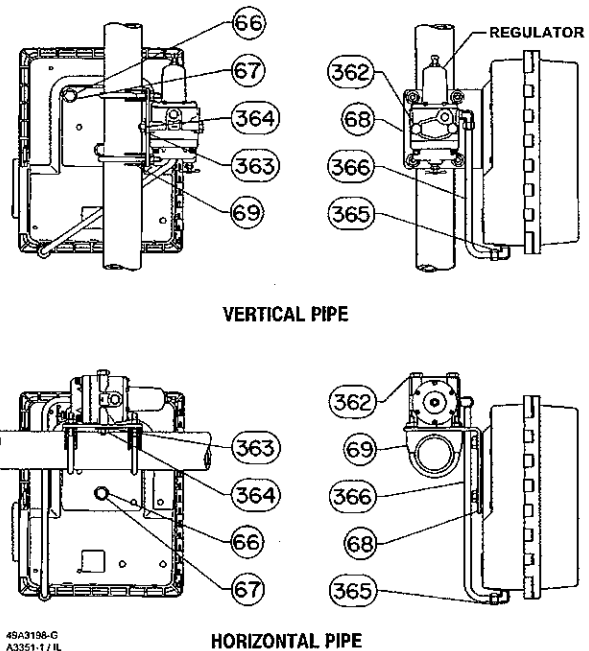


Figure 2-2. Pipestand Mounting

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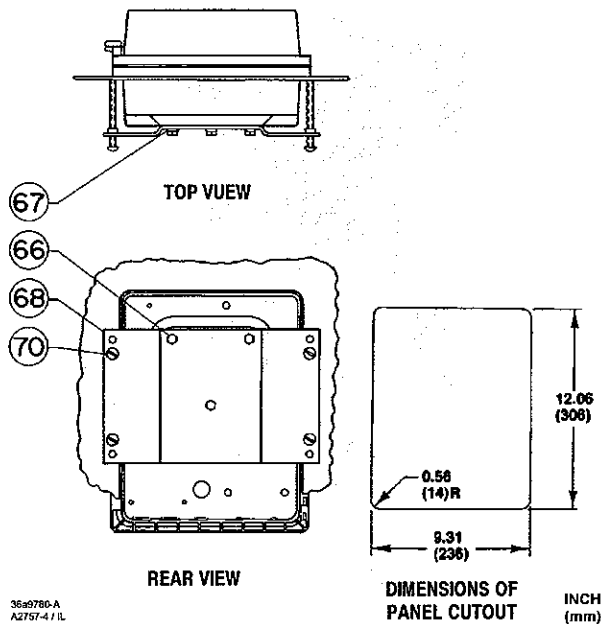
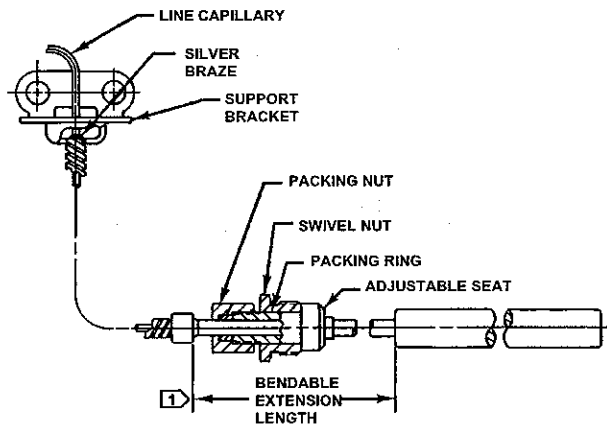


Figure 2-3. Panel Mounting



NOTE:  
1 MINIMUM BEND RADI 1-1/4  
A5434 / IL

Figure 2-5 Temperature Element Assembly, Adjustable Union

## Temperature Sensing Bulb, Bushings, and Thermowells

### **WARNING**

Failure of the thermowell may result in personal injury or equipment damage due to escaping process fluid. To avoid such injury or damage, be sure the process fluid velocity and pressure are within the thermowell limits in tables 2-1 and 2-2.

Process temperature is sensed by a temperature element consisting of a bulb immersed in the process fluid, a bendable extension, and an armored capillary tube (see figure 2-5). When the temperature bulb is to be placed within a closed vessel, bushings are available to attach the bulb to the vessel. The bushing (dimensions are shown in figure 2-6) penetrates the vessel and the temperature element is attached to the bushing with a threaded connection.

If the process pressure exceeds the limitations of the temperature bulb, or if the process fluid is corrosive, a thermowell (dimensions are shown in figure 2-6) is recommended which penetrates the vessel and isolates the temperature bulb from the process fluid. Table 2-1 lists process fluid velocities for thermowells. Table 2-2 lists maximum process pressures for thermowells.

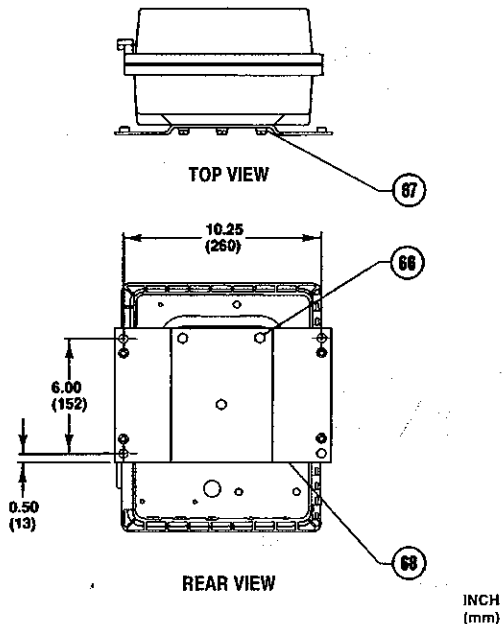


Figure 2-4. Wall Mounting

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BUSHING							
TEMPERATURE BULB DIA.		DIMENSION					
		A <sup>(1)</sup>		B		C	
Inch	mm			Inch	mm	Inch	mm
3/8	10	1/2-14 NPSM		0.44	11	0.44	11
9/16	14	1-20 UNEF		0.75	19	0.63	16

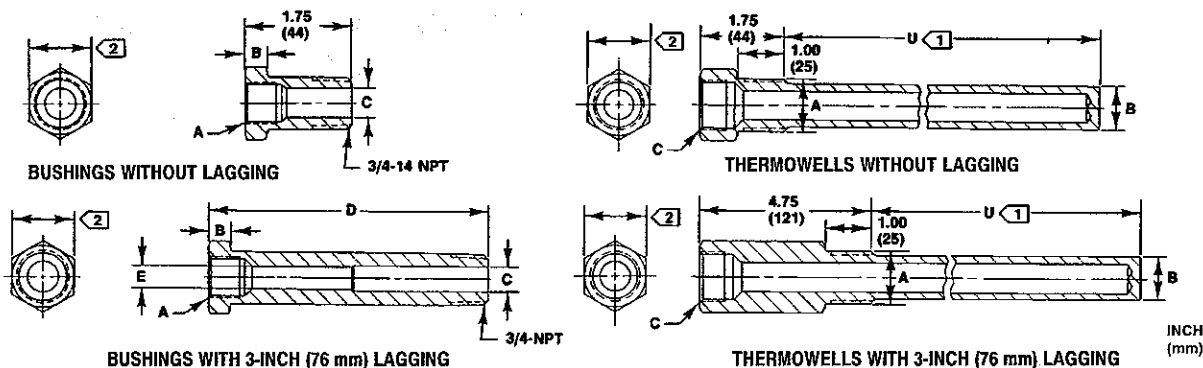
1. Seat area per SAMA Standard RC-17-10-1963.

LAGGED BUSHING											
TEMPERATURE BULB DIA.		DIMENSION									
		A <sup>(1)</sup>		B		C		D		E	
Inch	mm			Inch	mm	Inch	mm	Inch	mm	Inch	mm
3/8	10	1/2-14 NPSM		0.44	11	0.47	12	4.44	113	0.44	11
9/16	14	1-20 UNEF		0.75	19	0.66	17	4.75	121	0.63	16

1. Seat area per SAMA Standard RC-17-10-1963.

THERMOWELL								
TEMPERATURE BULB DIA.		DIMENSION					U (Insertion Length)	
		A <sup>(1)</sup>		B		C		
Inch	mm			Inch	mm		Inch	mm
3/8	10	1/2-14 NPT		0.63	16	1/2-14 NPSM-2B	7.5	191
		3/4-14 NPT		0.77	20		10.5	267
							16	406
9/16	14	3/4-14 NPT		0.88	22	1-20 UNEF-2B	7.5	191
							10.5	267
							16	406
							24	610

1. Seat area per SAMA Standard RC-17-10-1963.



NOTES:  
 1 TOLERANCES FOR THIS DIMENSION ARE AS FOLLOWS:  $\pm 0.06$  INCH (1.5 mm) WHEN LENGTH IS 12 INCHES (305 mm) OR LESS  
 $\pm 0.125$  INCH (3.2 mm) WHEN LENGTH IS GREATER THAN 12 INCHES (305 mm).  
 2 7/8 INCH HEX FOR 3/8-INCH TEMPERATURE BULB; 1-1/8 INCH HEX FOR 9/16-INCH TEMPERATURE BULB

A3240-2/IL

Figure 2-6. Bushing and Thermowell Dimensions

With the controller case mounted so the temperature bulb reaches the process, screw the bulb into the bushing or thermowell. To make installation of the temperature bulb easier, bend the bendable extension. The bendable extension has a minimum bend radii of 1-1/4 inch.

If the temperature bulb is to be installed in a pipe, process velocity is an important consideration. Install a thermowell where the process temperature is to be measured, keeping in mind the velocity limits shown in table 2-1. Tapered thermowells, built to withstand even greater process velocities, are also available. After proper installation of the thermowell, the temperature element is then attached to the thermowell with a threaded connection.

## Pressure Connections

Refer to figure 2-7 for pressure connection locations. All pressure connections are 1/4-inch NPT female.

Use 1/4-inch or 3/8-inch pipe or tubing for supply, output, and remote set point connections.

## Supply Pressure Connection



**WARNING**

Personal injury or property damage may occur from an uncontrolled process if the supply medium is not clean, dry, oil-free, or a non-corrosive gas. Industry instrument air quality standards describe acceptable dirt, oil, and moisture content. Due to the variability in nature of the problems these influences can have on pneumatic equipment, Fisher Controls has no technical basis to recommend the level of filtration equipment required to prevent performance degradation of pneumatic equipment. A filter

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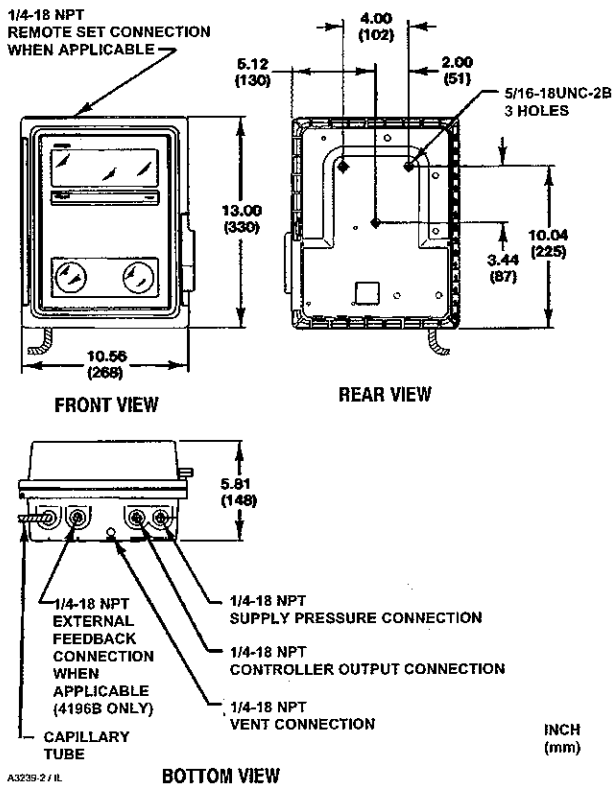


Figure 2-7. Location of Connections

or filter regulator capable of removing particles 40 micron in diameter should suffice for most applications. Use of suitable filtration equipment and the establishment of a maintenance cycle to monitor its operation is recommended.

Supply pressure must be clean, dry air or non-corrosive gas that meets the requirements of ISA Standard S7.3-1975 (R1981). Use a suitable supply pressure regulator to reduce the supply pressure source to the normal operating supply pressure shown in table 1-3. Connect supply pressure to the SUPPLY connection on the bottom of the case, as shown in figure 2-7

## Remote Set Point (suffix letter M) Pressure Connection

If the controller has remote set point (suffix letter M), connect the remote set point pressure to the top of the controller case at the location shown in figure 2-7. Use clean, dry air or a non-corrosive gas. Use a 3 to 15 psig (0.2 to 1.0 bar) remote set point pressure range for a 3 to 15 psig (0.2 to 1.0 bar) controller output pressure range. Use a 6 to 30 psig (0.4 to 2.0 bar)

remote set point pressure range for a 6 to 30 psig (0.4 to 2.0 bar) controller output pressure range. If pressure is supplied to the remote set point connection with a regulator, a small bleed orifice should be placed between the regulator and remote set point connection to prevent pressure variations due to regulator lock-up.

## External Feedback Pressure Connection (4196B Series Controllers Only)

When a secondary controller in an override application has this option, reset windup is minimized in the secondary controller. Connect the external feedback connection, shown in figure 2-7, of the secondary controller to the customer-supplied high or low select relay.

## Vent

### WARNING

If a flammable, toxic, or reactive gas is to be used as the supply pressure medium, personal injury and property damage could result from fire or explosion of accumulated gas or from contact with a toxic or reactive gas. The controller case and cover assembly do not form a gas-tight seal, and when the assembly is enclosed, a remote vent line, adequate ventilation, and necessary safety measures should be used. However, a remote vent pipe alone cannot be relied upon to remove all hazardous gas. Vent line piping should comply with local and regional codes and should be as short as possible with adequate inside diameter and few bends to reduce case pressure buildup.



# 4196A, B, C, and S Series

Table 2-1 Maximum Process Fluid Velocities<sup>(1)</sup> for Thermowells

THERMOWELL SIZE	TEMPERATURE BULB DIAMETER		MATERIAL	INSERTION LENGTH <sup>(2)</sup> , INCH (mm)							
				7.5 (191)		10.5 (267)		16 (406)		24 (610)	
	Inch	mm		Feet/s	m/s	Feet/s	m/s	Feet/s	m/s	Feet/s	m/s
1/2 NPT	3/8	10	Brass	38	11.6	19	5.8	8	2.4	---	---
			Carbon steel	48	14.6	25	7.6	11	3.4	---	---
			304 stainless steel/316 stainless steel	50	15.2	26	7.9	11	3.4	---	---
			Monel	48	14.6	24	7.3	11	3.4	---	---
3/4 NPT	3/8	10	Brass	54	16.5	27	8.2	12	3.7	---	---
			Carbon steel	69	21.0	35	10.7	15	4.6	---	---
			304 stainless steel/316 stainless steel	72	21.9	37	11.3	16	4.9	---	---
			Monel	68	20.7	35	10.7	15	4.6	---	---
3/4 NPT	9/16	14	Carbon steel	97	29.6	49	14.9	21	6.4	10	3.0
			304 stainless steel/316 stainless steel	100	30.5	51	15.5	22	6.7	10	3.0
			Monel	95	28.9	49	14.9	21	6.4	9	2.7

1. For gas, air, or steam. Values may be lower for liquids.  
2. This is the U dimension in figure 2-6.

Table 2-2. Maximum Process Pressures for Thermowells

THERMOWELL SIZE	TEMPERATURE BULB DIAMETER		MATERIAL	TEMPERATURE °F (°C)											
				70 (21)		200 (93)		400 (204)		600 (316)		800 (427)		1000 (538)	
	Inch	mm		Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar	Psig	Bar
1/2 NPT	3/8	10	Brass	2810	193.9	2530	174.6	440	30.4	---	---	---	---	---	---
			Carbon steel	3160	218.0	3040	209.8	2900	200.1	2770	191.1	2110	145.6	920	63.4
			304 SST	4120	284.3	3740	258.1	3400	234.6	3280	226.3	3180	219.4	2750	189.8
			316 SST	4120	284.3	4120	284.3	3850	265.7	3760	259.4	3680	253.9	3080	212.5
			Monel	3820	263.6	3530	243.6	3250	224.3	3210	221.5	3130	215.9	---	---
3/4 NPT	3/8	10	Brass	5000	345.0	4200	289.8	1000	69.0	---	---	---	---	---	
			Carbon steel	5200	358.8	5000	345.0	4800	331.2	4600	317.4	3500	241.5	1500	103.4
			304 SST	7000	483.0	6200	427.8	5600	386.4	5400	372.6	5200	358.8	4500	310.5
			316 SST	7000	483.0	7000	483.0	6400	441.6	6200	427.8	6100	441.6	5100	351.9
			Monel	6500	448.5	6000	414.0	5400	372.6	5300	365.7	5200	358.8	1500	103.4
3/4 NPT	9/16	14	Carbon steel	2310	159.4	2030	140.1	1900	131.1	1820	125.6	1430	98.7	---	---
			304 SST	3470	239.4	3080	212.5	2520	173.9	2430	167.7	1850	127.7	1630	112.5
			316 SST	3470	239.4	3470	239.4	3240	223.6	3150	217.4	3100	213.9	2600	179.4
			Monel	3070	211.8	2510	173.2	2460	169.7	2410	166.3	2150	148.4	---	---

## CAUTION

**When installing a remote vent pipe, take care not to over-tighten the pipe in the vent connection. Excessive torque will damage the threads in the connection.**

If a remote vent is required, the vent line must be as short as possible with a minimum number of bends and elbows. Vent line piping should have a minimum inside diameter of 3/4 inches (19 mm) for runs up to

20 feet (6.1 meters) and a minimum inside diameter of 1 inch (25 mm) for runs from 20 to 100 feet (6.1 to 30.5 meters)

The vent must be protected against the entrance of any foreign material that could plug it; or, if a remote vent is not required, the vent opening in the case, shown in figure 2-7 must be protected against the entrance of any foreign material that could plug it. Check the vent periodically to be certain it is not plugged.

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# 4196A, B, C, and S Series

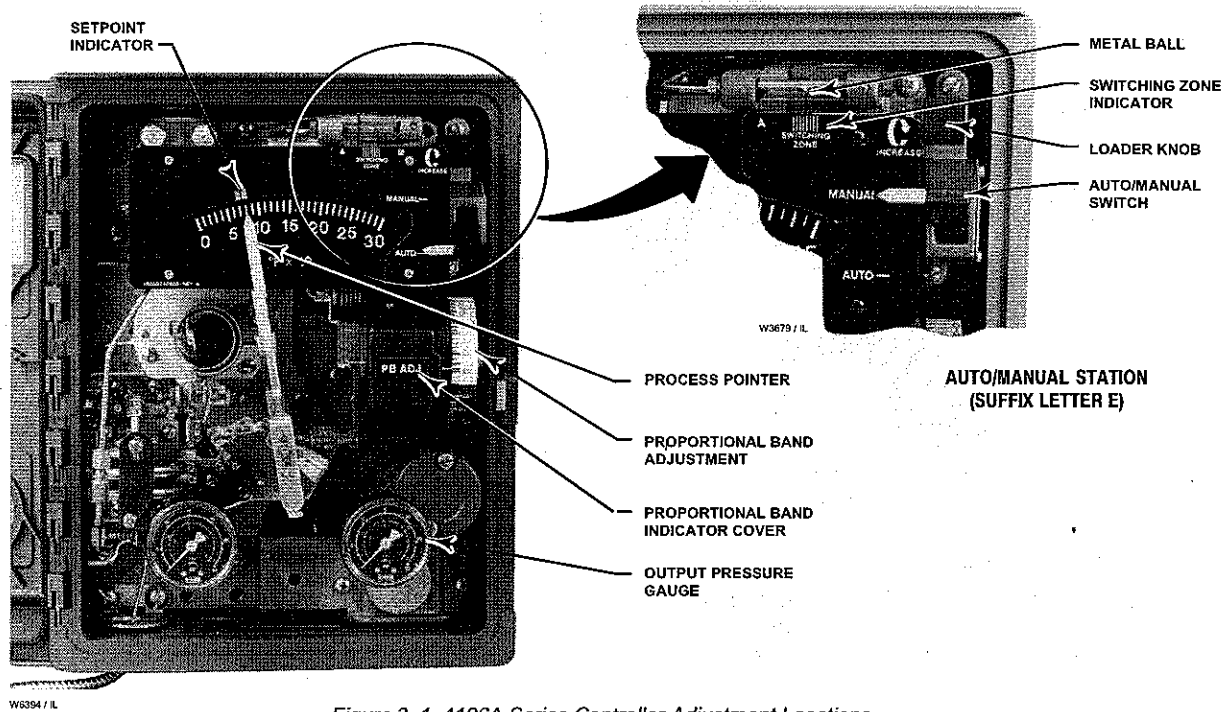


Figure 3-1. 4196A Series Controller Adjustment Locations

## Section 3 4196A Series Proportional-Only Controllers

### Adjustments for 4196A Series Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup and calibration. Adjustment locations are shown in figures 3-1 and 3-3. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 3-4 and 3-5. Unless otherwise noted, key numbers given in this section are found in figure 6-20.

### Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

### Remote Set Point (suffix letter M) Adjustment



**Do not manually move the set point indicator on controllers with remote set point. Manually moving the set point indicator could damage the controller.**

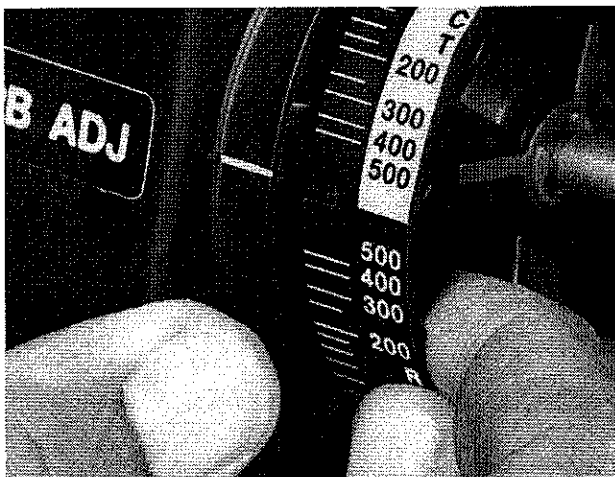
If the controller is equipped with remote set point (suffix letter M), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point and decrease the pressure to decrease the set point.

### Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process temperature required to drive the controller from zero output to full output.

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

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Figure 3-2. Changing Controller Action  
(4196A Series Controllers)

## Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 3-2 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

### For direct control action:

An increasing process temperature increases output pressure.

### For reverse control action:

An increasing process temperature decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

## Switching the Auto/Manual Station (suffix letter E)



**Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.**

Refer to figure 3-1 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point to move the ball into the switching zone. Turn the switch to AUTO, and move the set point to control the output.

When the auto/manual switch is in AUTO, adjusting the loader knob has no effect on the controller output. When the auto/manual switch is in MANUAL, changing the set point has no effect on the controller output.

## Prestartup Checks for 4196A Series Controllers

Refer to figure 3-1 for adjustment locations and refer to figure 6-20 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input temperature or other control signal to the controller.

### Note

**If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks.**

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator, and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.1 bar) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.
5. Adjust the proportional band for 5 percent DIRECT.
6. The process pointer should read ambient temperature  $\pm 1$  percent of span. Be sure that the bulb is exposed to air only and is not resting against the floor, test bench, or other surface.
7. The controller output pressure should be 0 psig.
8. Rotate the proportional band to 5 percent REVERSE.

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9. The controller output should be within 2 psig (0.14 bar) of the supply pressure.

10. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196A Series calibration procedure for recalibration.

## Startup for 4196A Series Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

### Note

**When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary, depending on the actual process being controlled.**

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.
2. For controllers with:

### Manual set point:

Move the set point indicator to the desired set point.

### Remote set point:

- a. See figure 2-7 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.
  - b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.
3. Determine the initial proportional band setting in percent from the following equation:

$$P.B. = \frac{200 \times \text{Allowable Overshoot}}{\text{Temperature Span}}$$

For example:

$$\frac{200 \times 10^\circ\text{F}}{100^\circ\text{F}} = 20\%$$

4. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual control valves in the pipeline, and close the manual bypass valve if one is used.
5. Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until

the system cycles. At this point, double the proportional band setting (proportional band setting  $\times$  2).

6. Check the stability of the recommended proportional band setting by introducing a disturbance and monitoring the process.

## Calibration of 4196A Series Controllers

### General Calibration Instructions

### Note

**If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode prior to performing calibration.**

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are found in figure 6-20.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

### Temperature Baths

Some calibration procedures require that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input span.

The bath should be capable of maintaining a temperature to within  $\pm 0.10$  percent of the input span and should be agitated so that the temperature is consistent throughout.

If available, three baths, preset at 0 percent, 50 percent, and 100 percent of input span, could be used to simplify and speed up the calibration process. Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within  $\pm 0.05$  percent of input span.

### Process Indicator Zero and Span Calibration

Before starting this procedure:

- ° Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- ° Provide a means of measuring the controller output pressure by connecting the controller output to a pres-

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sure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.

## Note

**Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.**

Refer to figure 3-1 and 3-3 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark,  $\pm 2$  percent of span. If the error is greater than  $\pm 2$  percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within  $\pm 1$  percent of the mid-scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. This distributes the error over the entire scale span and brings all points within  $\pm 1$  percent of the process scale span. Tighten the zero adjustment locking screw.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit  $\pm 1$  percent of the scale span.

12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

13. The process pointer should indicate process scale upper limit  $\pm 1$  percent of the process scale span.

14. If the error is greater than  $\pm 1$  percent, repeat steps 3 through 13.

## **Remote Set Point (suffix letter M) Zero and Span Calibration**

Refer to figure 3-1 and 3-3 for adjustment locations. Refer to figures 6-20 and 6-24 for key number locations.

## Note

**Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.**

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply remote set point pressure equal to the mid-range value.
9. Make sure the set point indicator is within  $\pm 1$  percent of the mid-scale mark and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within  $\pm 2$  percent of the mid-scale mark, then proceed with step 10. If the set point indicator is not within  $\pm 2$  percent, proceed to the remote set point calibration procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjust-

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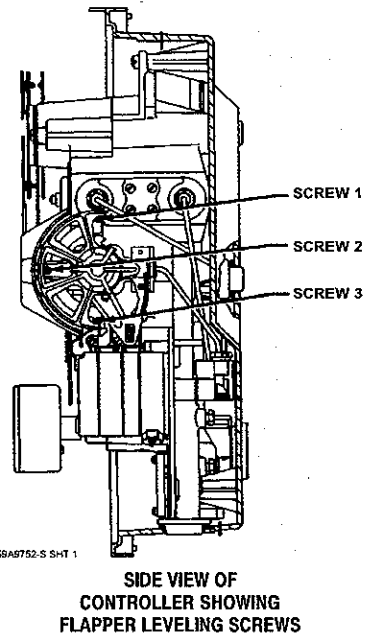
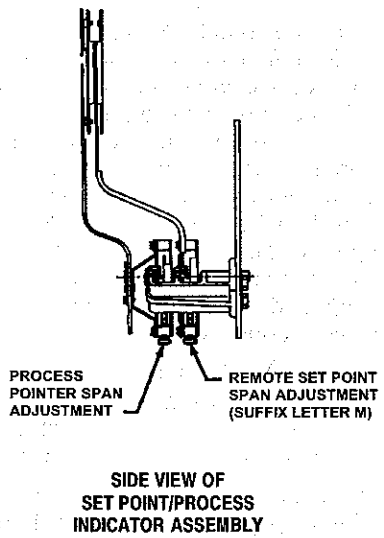
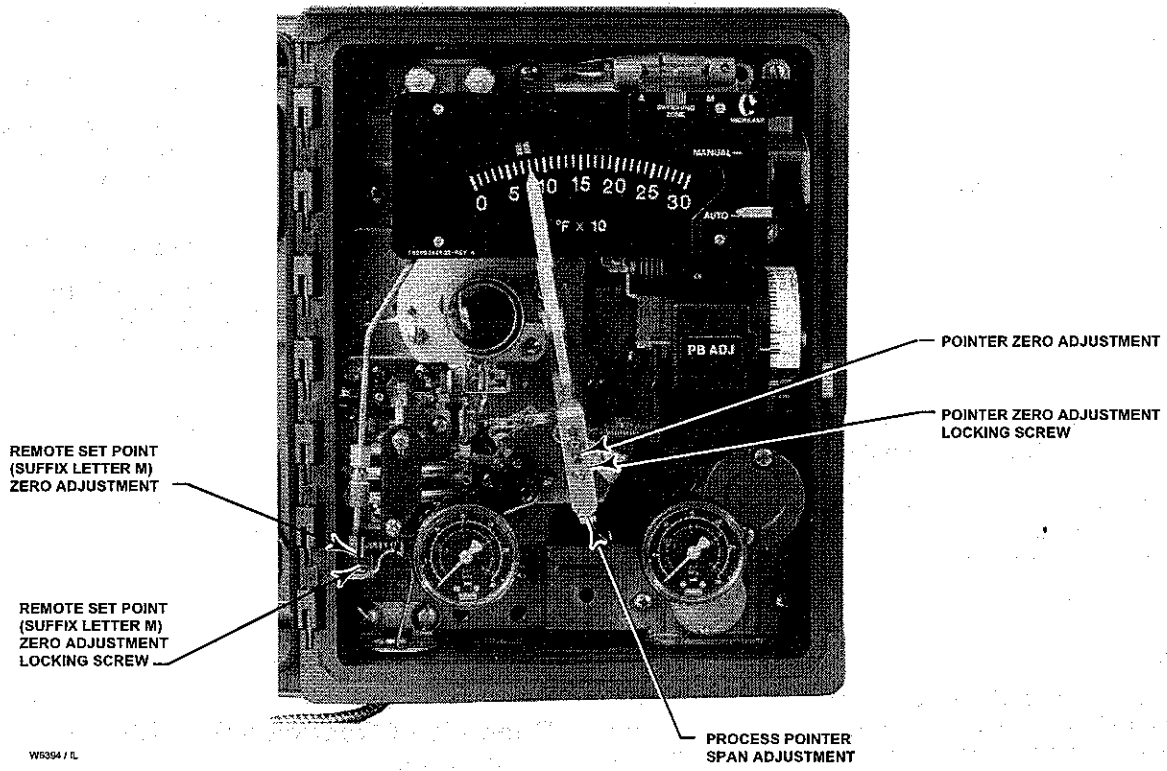


Figure 3-3. 4196A Series Controller Calibration Adjustment Locations

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ment screw to correct for half the error at mid-scale. Tighten the zero adjustment locking screw.

11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within  $\pm 1$  percent.

12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

## Flapper Alignment

### Note

**Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.**

Flapper leveling screw numbers and adjustments are shown in figure 3-3. Key number locations are shown in figure 6-20.

Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3. After performing the flapper alignment procedure, go to the startup procedure.

1. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at mid-scale on the process scale.

2. If a temperature bath is available, adjust the bath for 50 percent of the scale range and place the temperature bulb in the bath. Allow 5 minutes for the controller to stabilize. If a bath is not available, an alternate method is to disconnect link number 1 at the temperature element and tape the process pointer at the mid-scale mark of the process scale. Note the hole from which link number 1 was removed for proper replacement. This method should only be used if a temperature bath is not available to simulate a process temperature at mid-scale value.

3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).

4. Set the proportional band between DIRECT and REVERSE.

5. The controller output should be  $9 \pm 0.10$  psig ( $0.62 \pm 0.007$  bar) for a 3 to 15 psig (0.2 to 1.0 bar) output or  $18 \pm 0.2$  psig ( $1.2 \pm 0.01$  bar) for a 6 to 30 psig (0.4 to

2.0 bar) output. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is within tolerance.

6. Set the proportional band to 30 percent DIRECT.

7. The controller output should be  $9 \pm 0.25$  psig ( $0.62 \pm 0.02$  bar) or  $18 \pm 0.5$  psig ( $1.2 \pm 0.04$  bar). If not, adjust flapper leveling screw 3 (the screw nearest the nozzle).

8. Set the proportional band to 30 percent REVERSE.

9. The controller output should be  $9 \pm 0.25$  psig ( $0.62 \pm 0.02$  bar) or  $18 \pm 0.5$  psig ( $1.2 \pm 0.04$  bar). If not, adjust flapper leveling screw 1 (the screw nearest the nozzle).

10. Repeat steps 4 through 9 until the controller output remains in tolerance without further leveling screw adjustment.

11. If link 1 was disconnected, remove the tape and reconnect link 1 to the temperature element using the hole noted in step 2.

12. Set the proportional band to 400 percent in the desired controller action and replace the proportional band indicator cover.

## Principle of Operation for 4196A Series Controllers

### Overall Operation

Refer to the schematic diagram in figure 3-4.

The input element is connected to the process pointer and to the flapper by connecting links. As the process temperature increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows. The action of the proportional bellows counteracts the flapper movement that resulted from the process temperature change and backs the flapper away from the nozzle until equilibrium is reached.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature except that, when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning



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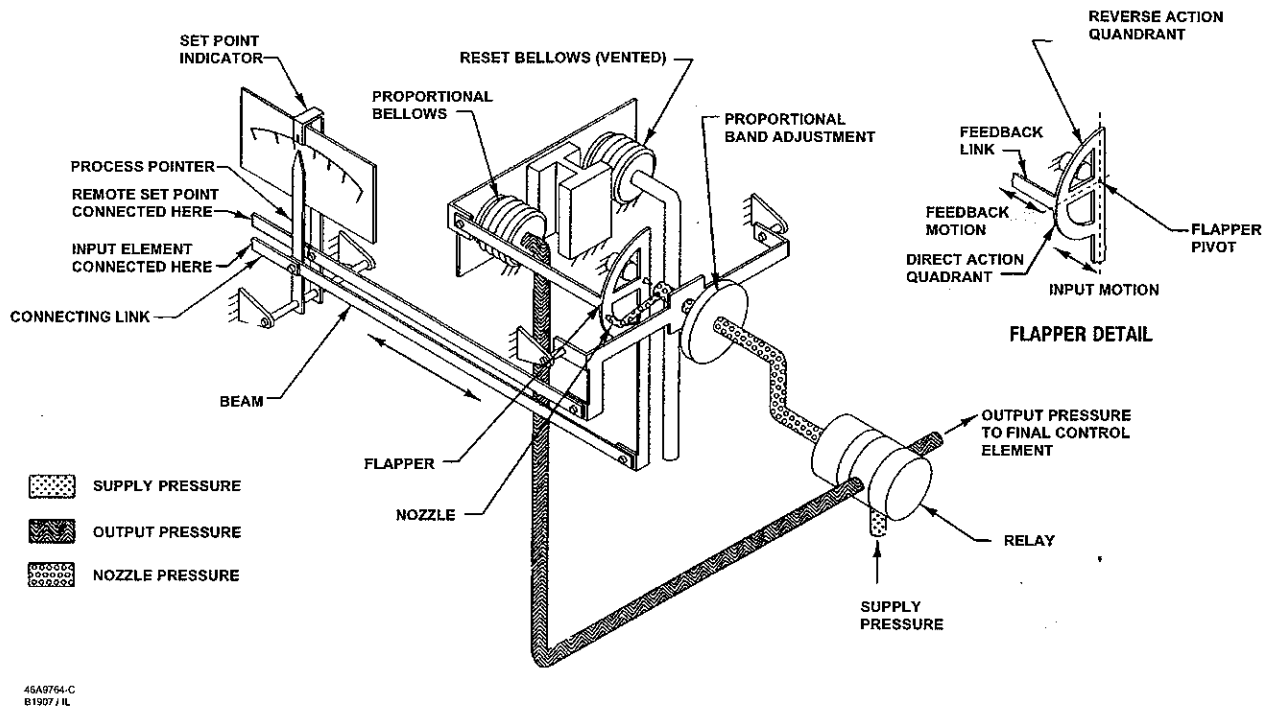


Figure 3-4. 4196A Series Controller Schematic

the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 3-4. With the controller in the reverse-acting mode, an increase in process temperature causes a decrease in output pressure.

### Remote Set Point (suffix letter M) Operation

The capability to adjust the controller set point from a remote location is available with all 4196A Series controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

### Auto/Manual Station (suffix letter E) Operation

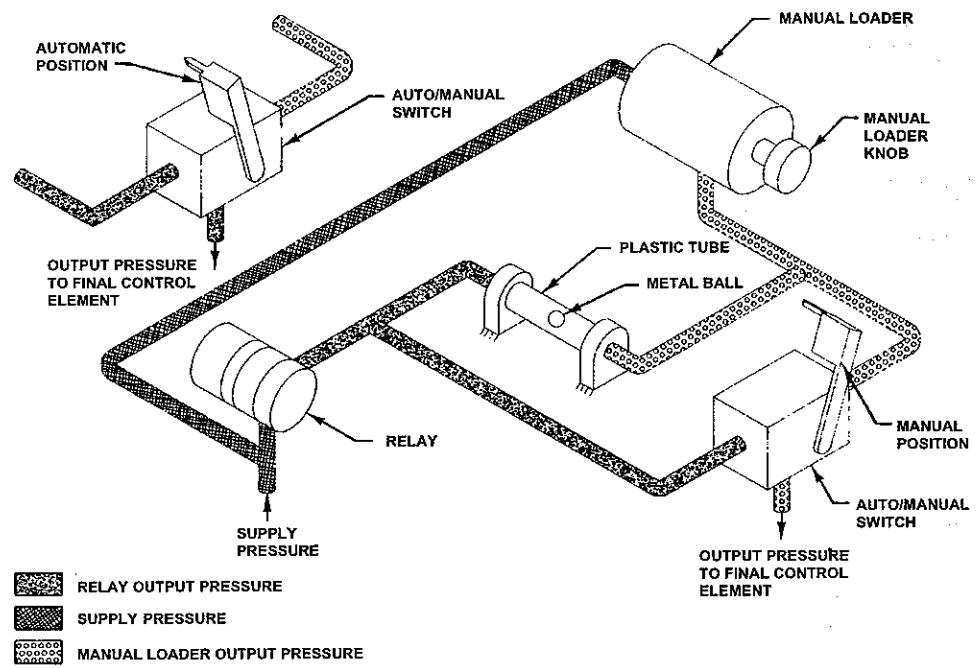
A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 3-5. Supply pressure to the relay is also applied to the

manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the manual loader output is channeled through the auto/manual switch and becomes the controller output. When the auto/manual switch is in the AUTO position, the relay output is channeled through the switch to become the controller output.

Before the auto/manual switch is operated, the relay output must equal the manual loader output to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.

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Figure 3-5. Auto/Manual Station Schematic

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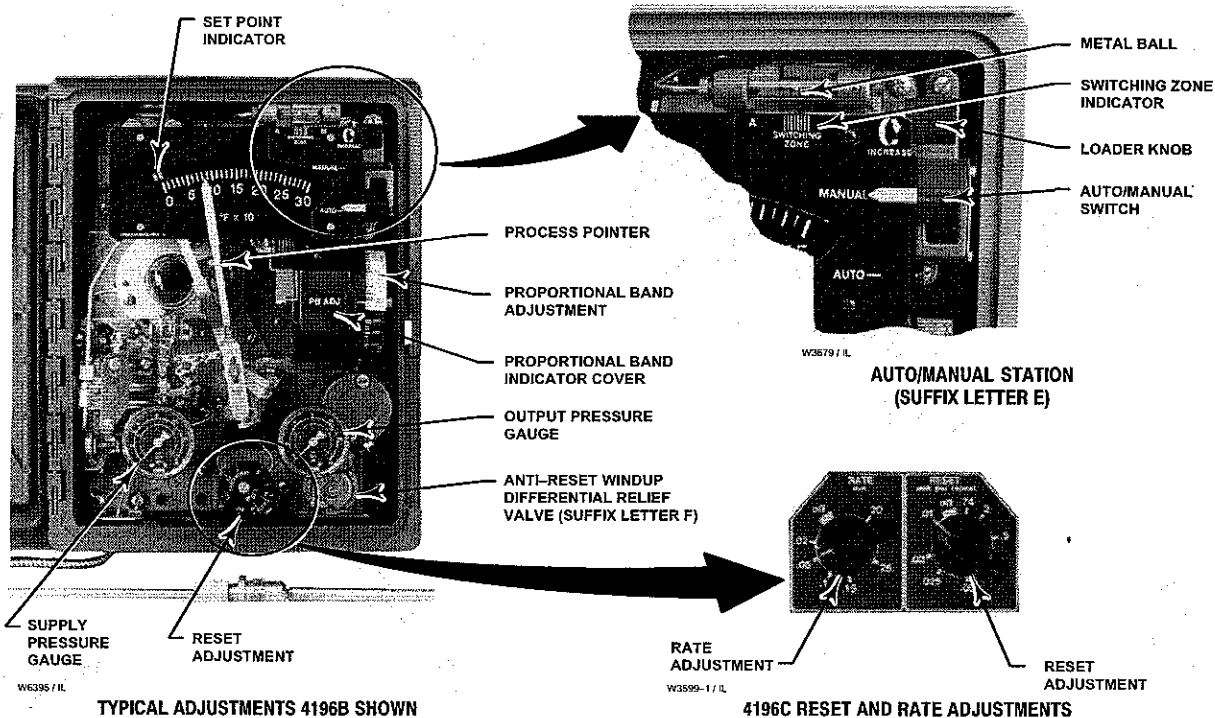


Figure 4-1. 4196B and C Series Controller Adjustment Locations

## Section 4 4196B Series Proportional-Plus-Reset Controllers And 4196C Series Proportional-Plus-Reset-Plus-Rate Controllers

### Adjustments for 4196B and C Series Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup, and calibration. Adjustment locations are shown in figures 4-1 and 4-3. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagrams in figures 4-5 through 4-9. Unless otherwise noted, key numbers refer to figure 6-20.

#### Manual Set Point Adjustment

Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not affect the proportional band setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

#### Remote Set Point (suffix letter M) Adjustment

**CAUTION**

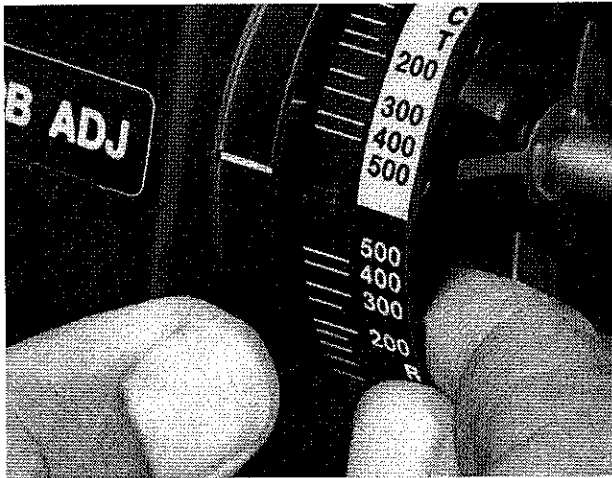
**Do not manually move the set point indicator on controllers with remote set point. Manually moving the set point indicator could damage the controller.**

If the controller is equipped with remote set point (suffix letter M), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point and decrease the pressure to decrease the set point.

#### Proportional Band Adjustment (PB ADJ)

The proportional band determines the output sensitivity of the controller. The proportional band adjustment is marked in percentages of process temperature required to drive the controller from zero output to full output.

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Figure 4-2. Changing Controller Action  
(4196B and C Series Controllers)

To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

## Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 4-2 and rotate the proportional band adjustment to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

### For direct control action:

An increasing process temperature increases output pressure.

### For reverse control action:

An increasing process temperature decreases output pressure.

After changing the action, tighten the two screws on the proportional band indicator cover.

## Reset Adjustment

To adjust reset, open the controller cover, and locate the RESET adjustment. Rotate the adjustment clockwise to decrease the minutes per repeat or counterclockwise to increase the minutes per repeat. Increasing the minutes per repeat provides a slower reset action.

## Rate Adjustment

To adjust rate, open the controller cover and locate the RATE adjustment. Rotate the adjustment clockwise to decrease the minutes (less rate action) or counterclockwise to increase the minutes (more rate action).

## Anti-Reset Windup (suffix letter F) Adjustment

If the arrow on the differential relief valve points toward the bottom of the controller case, as shown in figure 4-1, the relief valve opens with increasing controller output pressure. If the arrow points in the opposite direction, the relief valve opens with decreasing controller output pressure. Differential relief pressure is factory set at 5 psi (0.3 bar). Maximum differential relief pressure is 7 psi (0.5 bar); minimum is 2 psi (0.1 bar).

Turn the adjusting screw counterclockwise to increase differential relief pressure; clockwise to decrease it.

## Switching the Auto/Manual Station (suffix letter E)

### CAUTION

Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.

Refer to figure 4-1 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

When the automatic/manual switch is in AUTO, adjusting the loader knob has no effect on the controller output. When the automatic/manual switch is in MANUAL, changing the set point has no effect on the controller output.

## Prestartup Checks for 4196B and C Series Controllers

Refer to figure 4-1 for adjustment locations and refer to figure 6-20 for key number locations.

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When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input pressure or other control signal to the controller.

## Note

If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks. If the controller has the external feedback option, connect the controller output connection to the external feedback connection (see figure 2-7). Adjust the controller for full output pressure and with the RESET knob adjusted to 0.01 minutes/repeat, verify the tubing connections do not leak. Disconnect after completing the prestartup checks.

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.
2. For a controller with remote set point (suffix letter M), connect regulated pressure of 3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.1 bar) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of the scale span above the process pointer.
5. Set the reset adjustment to 0.01 minutes per repeat.
6. Set the rate adjustment to OFF (4196C Series).
7. Adjust the proportional band for 5 percent DIRECT.
8. The controller output pressure should be 0 psig.
9. Rotate the proportional band to 5 percent REVERSE.
10. The controller output should be within 2 psig (0.14 bar) of the supply pressure.
11. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action. Secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196B and C Series calibration procedure for recalibration.

## Startup for 4196B and C Series Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

## Note

When performing the startup procedures, keep in mind that the initial settings are guidelines. They will vary depending on the actual process being controlled.

1. Be sure the supply pressure regulator is delivering the proper supply pressure to the controller.

2. For controllers with:

### Manual set point:

Move the set point indicator to the desired set point.

### Remote set point:

a. See figure 2-7 for the location of the remote set point connection. Connect an adjustable pressure source to the remote set point connection.

b. Adjust the pressure source until the set point indicator reaches the desired set point. Remember: Increasing the remote set point pressure increases the set point.

3. Set the reset adjustment to 0.5 minutes per repeat. For controllers with rate, set the rate adjustment to OFF.

4. Determine the initial proportional band setting in percent from the following equation:

$$P.B. = \frac{200 \times \text{Allowable Overshoot}}{\text{Temperature Span}}$$

For example:

$$\frac{200 \times 10^{\circ}\text{F}}{100^{\circ}\text{F}} = 20\%$$

5. Turn the proportional band adjustment (PB ADJ) to the percentage calculated from the equation.

6. If the controller is used in conjunction with a control valve, slowly open the upstream and downstream manual control valves in the pipeline, and close the manual bypass valve if one is used.

7. Tune the various controller actions.

**Tuning proportional action:** Create a load upset by momentarily changing the set point. Check for system cycling. If the system does not cycle, lower the proportional band setting (thus raising the gain) and disturb the system again by changing the set point. Continue this procedure until the system cycles. At this point, double the proportional band setting (proportional band setting  $\times 2$ ) and begin tuning the reset.

**Tuning reset action:** Disturb the system. If the system does not cycle, speed up the reset by changing

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the setting to a lower value (faster reset) and disturb the system again. Continue this procedure until the system cycles. When the system cycles, multiply the reset time setting by a factor of three (reset setting  $\times 3$ ) and slow down the reset by changing the reset setting to the higher value. The reset is now tuned.

**Tuning rate action:** For a controller with rate (4196C Series), adjust the rate toward the higher setting until cycling occurs. When the system cycles, divide the rate value by a factor of three (rate setting  $\div 3$ ) and decrease the rate by changing the setting to the lower value. The rate is now tuned

8. Check the stability of the recommended tuning settings by introducing a disturbance and monitoring the process.

9. Once stable control is attained, the process pointer and set point indicator should be in line. If they are aligned, adjust the set point to the desired value. If they are not, readjust the set point to the desired control point, and proceed with step 10.

10. If the process pointer is within 5 percent of the set point indicator, turn the link 3 adjustment (see figure 6-13 for location) until the process pointer aligns with the set point indicator. Turn the link 3 adjustment screw clockwise to increase the process indication or counterclockwise to decrease it. If the process pointer is misaligned with the set point indicator by more than 5 percent of the scale span, perform the calibration procedures for 4196B and C Series controllers.

## Calibration of 4196B and C Series Controllers

### General Calibration Instructions

#### Note

**If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing calibration.**

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers refer to figure 6-20.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

### Temperature Baths

Some calibration procedures require that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input span.

The bath should be capable of maintaining a temperature to within  $\pm 0.10$  percent of the input span and should be agitated so that the temperature is consistent throughout.

If available, three baths, preset at 0 percent, 50 percent, and 100 percent of input span, could be used to simplify and speed up the calibration process. Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within  $\pm 0.05$  percent of input span.

### Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.

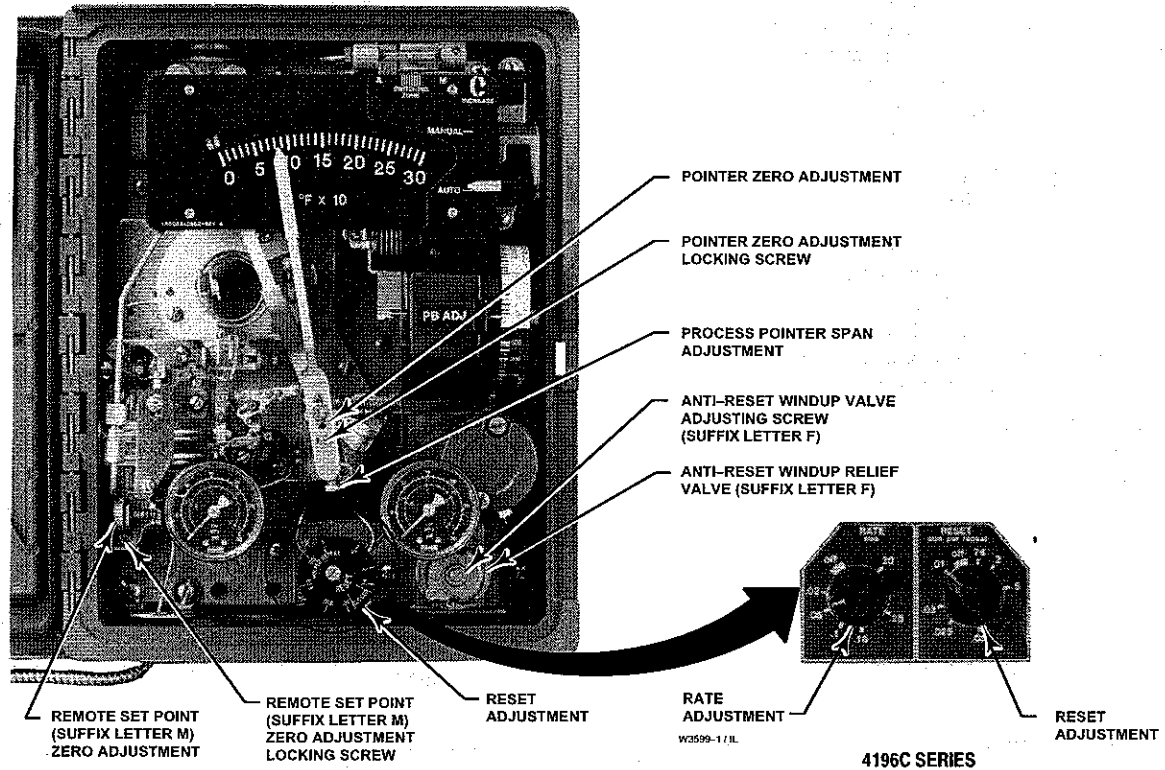
#### Note

**Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.**

Refer to figures 4-1 and 4-3 for adjustment locations.

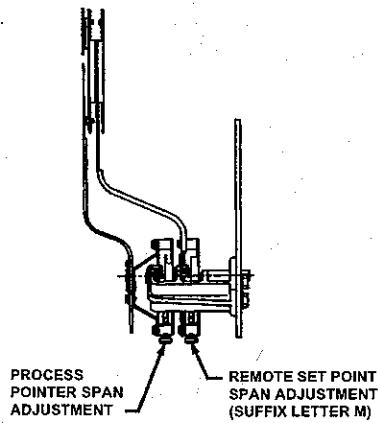
1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

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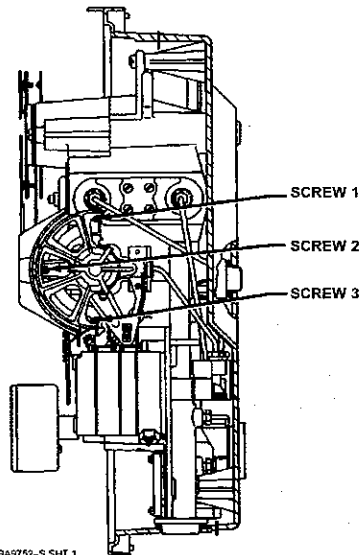
W6395 / IL

FRONT VIEW, 4196B SERIES



SIDE VIEW OF SET POINT/PROCESS INDICATOR ASSEMBLY

39A1126-B  
A6731 / IL



SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS

69A9752-S SH1 1

Figure 4-3. 4196B and C Series Controller Calibration Adjustment Locations

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6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark,  $\pm 2$  percent of span. If the error is greater than  $\pm 2$  percent, refer to the Maintenance section and perform the zero and span adjustment procedure.
9. Adjust the process pointer to within  $\pm 1$  percent of the mid-scale mark by loosening the locking screw and turning the zero adjustment screw. This distributes the error over the entire scale range and brings all points within  $\pm 1$  percent of the process scale span.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit  $\pm 1$  percent of the scale span.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. The process pointer should indicate the process scale upper limit  $\pm 1$  percent of the process scale span.
14. If the error is greater than  $\pm 1$  percent, repeat steps 3 through 13.

## **Remote Set Point (suffix letter M) Zero and Span Calibration**

Refer to figures 4-1 and 4-3 for adjustment locations. Refer to figures 6-21 and 6-24 for key number locations.

### **Note**

**Any adjustment of the remote set point span adjustment screw requires readjustment of the remote set point zero adjustment screw.**

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point

zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.

5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.
7. Repeat steps 3 through 6 until the error is eliminated.
8. Adjust the remote set point pressure to the mid-range value.
9. Make sure the set point indicator is within  $\pm 1$  percent of the mid-scale mark, and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within  $\pm 2$  percent of the mid-scale mark, proceed with step 10. If the set point indicator is not within  $\pm 2$  percent, proceed to the remote set point zero and span adjustment procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within  $\pm 1$  percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section. Otherwise, perform the flapper alignment procedure in this section.

## **Flapper Alignment**

### **Note**

**Perform the process indicator zero and span calibration procedure and, for controllers with remote set point (suffix letter M), the remote set point zero and span calibration procedure before the flapper alignment.**

Flapper leveling screw numbers and adjustments are shown in figure 4-3. Key number locations are shown in figure 6-20.

Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time



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## Note

**4196B and C Series controllers with anti-reset windup (suffix letter F) are supplied with two O-rings (key 52), a valve cover (key 51) and two machine screws (key 53). Use these parts in the next step.**

1. For controllers with anti-reset windup (suffix letter F), record the direction of the arrow on the anti-reset windup relief valve (key 55). Remove the relief valve and install the two O-rings (key 52) and valve cover (key 51) supplied with the controller. Secure the valve cover with the two machine screws (key 53) provided.
2. If the controller has the external feedback option (available with the 4196B Series only), connect the controller output to the external feedback connection. See figure 2-7 for the location of the output and external feedback connections.
3. If necessary, remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Provide regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.
5. For a controller with manual set point, move the set point indicator to the mid-scale mark of the process scale span. For a controller with remote set point (suffix letter M), adjust the remote set point pressure until the set point indicator is at the mid-scale mark of the process scale.
6. Set the reset adjustment to 0.01 minutes per repeat.
7. If the controller has rate (4196C Series), turn the rate adjustment to OFF.
8. If a temperature bath is available, adjust the bath for 50 percent of the scale range and place the temperature bulb in the bath. Allow 5 minutes for the controller to stabilize. If a bath is not available, an alternate method is to disconnect link number 1 at the temperature element and tape the process pointer at the mid-scale mark of the process scale. Note the hole from which link number 1 was removed for proper replacement. This method should only be used if a temperature bath is not available to simulate a process temperature at mid-scale value.

## Note

**Because of the high controller gain, the controller output will not remain stable in steps 9 through 13. The controller output gauge is adequate to monitor the output pressure during this procedure.**

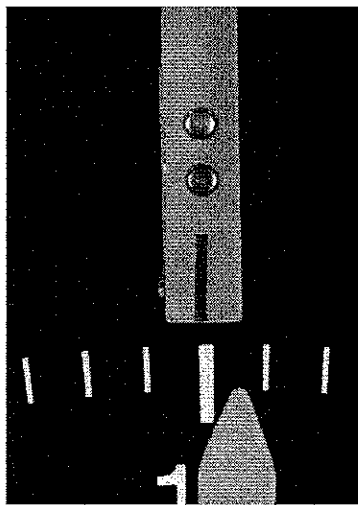
9. Set the proportional band between DIRECT and REVERSE.
10. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 2 (the screw nearest the nozzle) until the output is relatively stable.
11. Set the proportional band to 30 percent DIRECT. The controller output should be relatively stable at any value within the output range. If not, adjust flapper leveling screw 3 (the screw nearest the nozzle) until the output is relatively stable.
12. Set the proportional band to 30 percent REVERSE. The controller output should be relatively stable within the output range. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is relatively stable.
13. Repeat steps 9 through 12 until the controller output remains relatively stable without further flapper leveling screw adjustment.

## Note

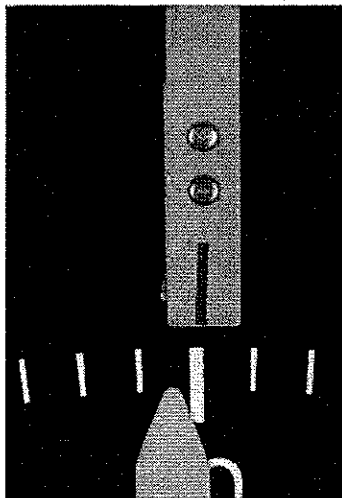
**Steps 14 through 20 check the flapper alignment.**

14. Set the proportional band to 30 percent DIRECT.
15. If link number 1 was previously disconnected, remove the tape and align the process pointer with the right-hand edge of the set point indicator as shown in figure 4-4. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the right-hand edge.  
The controller output should be within 2 psig (0.14 bar) of the supply pressure.
16. If link number 1 was previously disconnected, remove the tape and align the process pointer with the left-hand edge of the set point indicator as shown in figure 4-4. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the left-hand edge.  
The controller output pressure should go to 0 psig.
17. Set the proportional band to 30 percent REVERSE.
18. If link number 1 was previously disconnected, remove the tape and align the process pointer with the right-hand edge of the set point indicator as shown in figure 4-4. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the right-hand edge.  
The controller output pressure should be 0 psig.
19. If link number 1 was previously disconnected, remove the tape and align the process pointer with the

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RIGHT-HAND EDGE



LEFT-HAND EDGE

Figure 4-4. Alignment of the Process Pointer with the Set Point Indicator

left-hand edge of the set point indicator as shown in figure 4-4. If link number 1 was not disconnected and a temperature bath is used, adjust the set point indicator so the process pointer aligns with the left-hand edge.

The controller output should be within 2 psig (0.14 bar) of supply pressure.

20. If the controller does not perform as indicated in steps 14 through 19, the flapper is not correctly

aligned. This may occur because the output was not sufficiently stabilized in steps 9 through 13. Repeat steps 9 through 19.

21. Set the proportional band to 400 percent in the desired controller action. Replace the proportional band indicator cover (key 36) and tighten the two screws (key 6). Reconnect link number 1, if disconnected, to the same hole in the temperature element noted in step 8.

22. For controllers with anti-reset windup (suffix letter F), remove the two machine screws, valve cover and two O-rings installed in step 1 of this procedure. Install the anti-reset windup relief valve (key 55) with the arrow pointing in the direction recorded in step 1.

23. If the controller has the external feedback option (available with the 4196B Series only), remove the connection between the controller output and the external feedback connection.

## ***Anti-Reset Windup Differential Relief Valve (suffix letter F) Calibration***

### **Calibration for the differential relief valve to relieve on rising controller output pressure**

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.

2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4196C Series only) to OFF.

3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark of the process scale.

4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.

5. Refer to figure 4-3 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on rising controller output pressure, install the valve so the arrow on the valve points down. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing down. Tighten the two mounting screws.

6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.

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## Note

**Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.**

7. Increase the process temperature to the controller until the controller output pressure balances at 6 psig (0.4 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output range or 12 psig (0.8 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output range.
8. Turn the reset adjustment to the CLOSED (4196B Series) or OFF (4196C Series) position.
9. Increase the controller output pressure in small steps (approximately 0.5 psig (0.04 bar)) by changing the process temperature or by changing the controller set point. After each change in temperature or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.5 psi (0.04 bar) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp upward to supply pressure with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original controller output pressure in step 7 and the controller output pressure recorded in step 10.
12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 4-3. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 5 psi (0.4 bar) differential pressure.
13. Repeat steps 7 through 12 until the required differential pressure is obtained.

### Calibration for the differential relief valve to relieve on falling controller output pressure

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Do not apply supply pressure at this time.

2. Set the reset adjustment to 0.01 minutes per repeat (wide open) and the rate adjustment (4196C Series) to the OFF position.
3. For a controller with manual set point, move the set point indicator to the mid-scale mark on the process scale. For a controller with remote set point, adjust the remote set point pressure until the set point indicator is at the mid-scale mark on the process scale.
4. Set the proportional band to 100 percent in either the DIRECT or REVERSE action depending on the application requirements.
5. Refer to figure 4-3 for the location of the anti-reset windup differential relief valve. For the differential relief valve to relieve on falling controller output pressure, install the valve so the arrow on the valve points up. To change the direction of the arrow, loosen the two mounting screws, pull the valve out, and reinstall the valve with the arrow pointing up. Tighten the two mounting screws.
6. Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.

## Note

**Because of the high controller gain with the reset adjustment at 0.01 minutes per repeat, the controller output will not balance perfectly in the following step. If the controller output is stable for approximately 5 seconds, it is adequately balanced.**

7. Increase the process temperature to the controller until the controller output pressure balances at 12 psig (0.8 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output range or 24 psig (1.6 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output range.
8. Turn the reset adjustment to the CLOSED (4196B Series) or OFF (4196C Series) position.
9. Decrease the controller output pressure in small steps (approximately 0.5 psig (0.04 bar)) by changing the process temperature or by changing the controller set point. After each change in temperature or set point, the controller output pressure should quickly change and then stabilize at the new value.
10. Continue to change the controller output pressure in 0.5 psi (0.04 bar) steps and check the output pressure after each step to make sure it stabilizes. At some point, the controller output will start to ramp downward to 0 psig with no further change to the controller input or set point. Record the controller output pressure where this ramping action begins because this is the point at which the differential relief valve has relieved.
11. To obtain the differential relief valve differential setting, calculate the difference between the original

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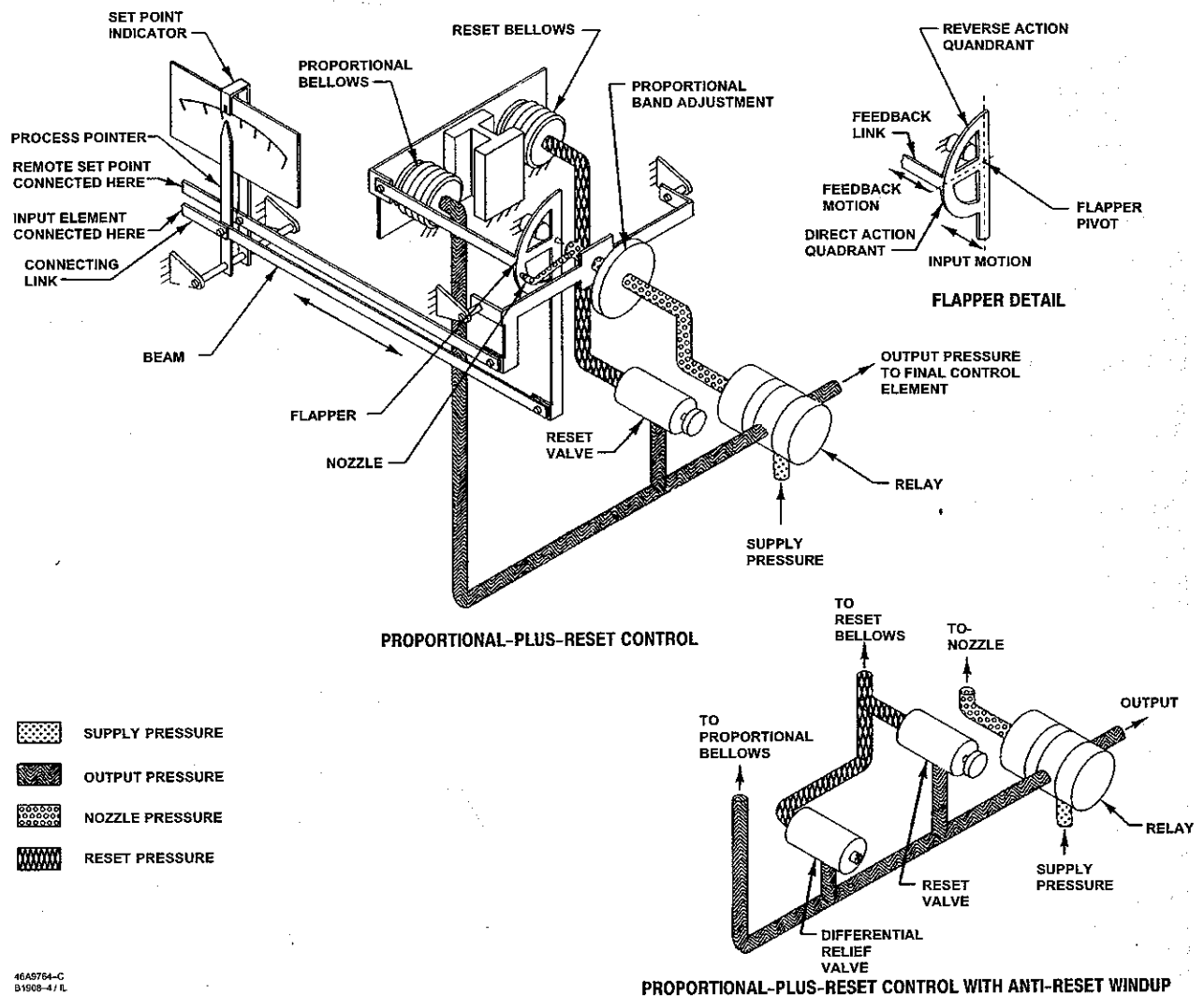


Figure 4-5. 4196B Series Controller Schematic.

controller output pressure in step 7 and the controller output pressure recorded in step 10.

12. If the differential pressure calculated in step 11 is incorrect for the application, adjust the differential pressure by turning the differential relief valve adjustment screw, shown in figure 4-3. Turn the screw clockwise to decrease the differential pressure or counterclockwise to increase the differential pressure. The differential relief valve is set at the factory to relieve at approximately 5 psi (0.4 bar) differential pressure.

13. Repeat steps 7 through 12 until the required differential pressure is obtained.

## Principle of Operation for 4196B and C Series Controllers

### Overall Operation

Refer to the schematic diagram in figure 4-5 for 4196B Series controllers. Refer to the schematic diagram in figure 4-6 for 4196C Series controllers.

The input element connects to the process pointer and to the flapper by connecting links. As the process temperature increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the proportional bellows and to the reset bellows. The action of the proportional bellows quickly

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counteracts the flapper movement that resulted from the process temperature change and backs the flapper away from the nozzle.

Pressure in the reset bellows opposes the action of the proportional bellows and slowly moves the flapper closer to the nozzle. The result of this interaction is that when the process temperature changes, proportional action temporarily reduces the gain of the controller for improved stability. The process temperature then slowly returns to set point, as pressure in both bellows equalizes via the reset action.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature, except that when the set point is changed, the nozzle moves with respect to the flapper.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle to a position on the flapper where less input and more feedback motion occurs, which decreases the gain of the controller. Decreasing (narrowing) the proportional band moves the nozzle toward a position where more input and less feedback motion occurs, which increases the gain. The controller action is changed from direct to reverse by turning the proportional band adjustment to position the nozzle on the flapper quadrant to a point where the direction of the flapper motion versus input motion is reversed as shown in the flapper detail of figure 4-5 or 4-6. With the controller in the reverse-acting mode, an increase in process temperature causes a decrease in output pressure.

A 4196C Series controller also has a rate valve as shown in figure 4-6 and 4-7. This valve is an adjustable restriction that momentarily increases the controller gain to accelerate the corrective action for slow responding systems. A proportional-plus-reset-plus rate controller responds to a change in process temperature as follows:

- First, the rate action delays the proportional action just long enough to allow the controller to respond to the change quickly with high gain, but not long enough for the high gain to cause instability.
- Then, the low gain provided by the proportional action keeps the system stable. Finally, reset action slowly increases the gain and returns the process temperature toward the set point.

## **Anti-Reset Windup (suffix letter F) Operation**

Anti-reset windup is available on all 4196B and C Series controllers and is designated by the letter F in the type number. The differential relief valve operates when the difference between proportional bellows pressure and reset bellows pressure reaches a prede-

termined value. Anti-reset windup reduces overshoot of the process temperature that can result from large or prolonged deviation from set point.

## **Remote Set Point (suffix letter M) Operation**

The capability to adjust the controller set point from a remote location is available with all 4196B and C Series controllers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via connecting linkage. Increasing the control pressure to the capsule increases the set point setting, and decreasing the control pressure reduces the set point setting.

## **Auto/Manual Station (suffix letter E) Operation**

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 4-8. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch. Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the manual loader output is channeled through the auto/manual switch and becomes the controller output. When the auto/manual switch is in the AUTO position, the output of the relay is channeled through the switch to become the controller output.

Before the auto/manual switch is operated, the relay output must equal the manual loader output to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal blocking air flow through the tube.

## **External Feedback Operation**

External feedback is available with all 4196B Series controllers. Controllers with this option have an external connection on the bottom of the controller case as shown in figure 2-7. This connection breaks the positive feedback (reset) loop inside the controller and brings it outside as shown in figure 4-9. The connection allows the positive feedback loops of two controllers (primary and secondary) to be tied together when

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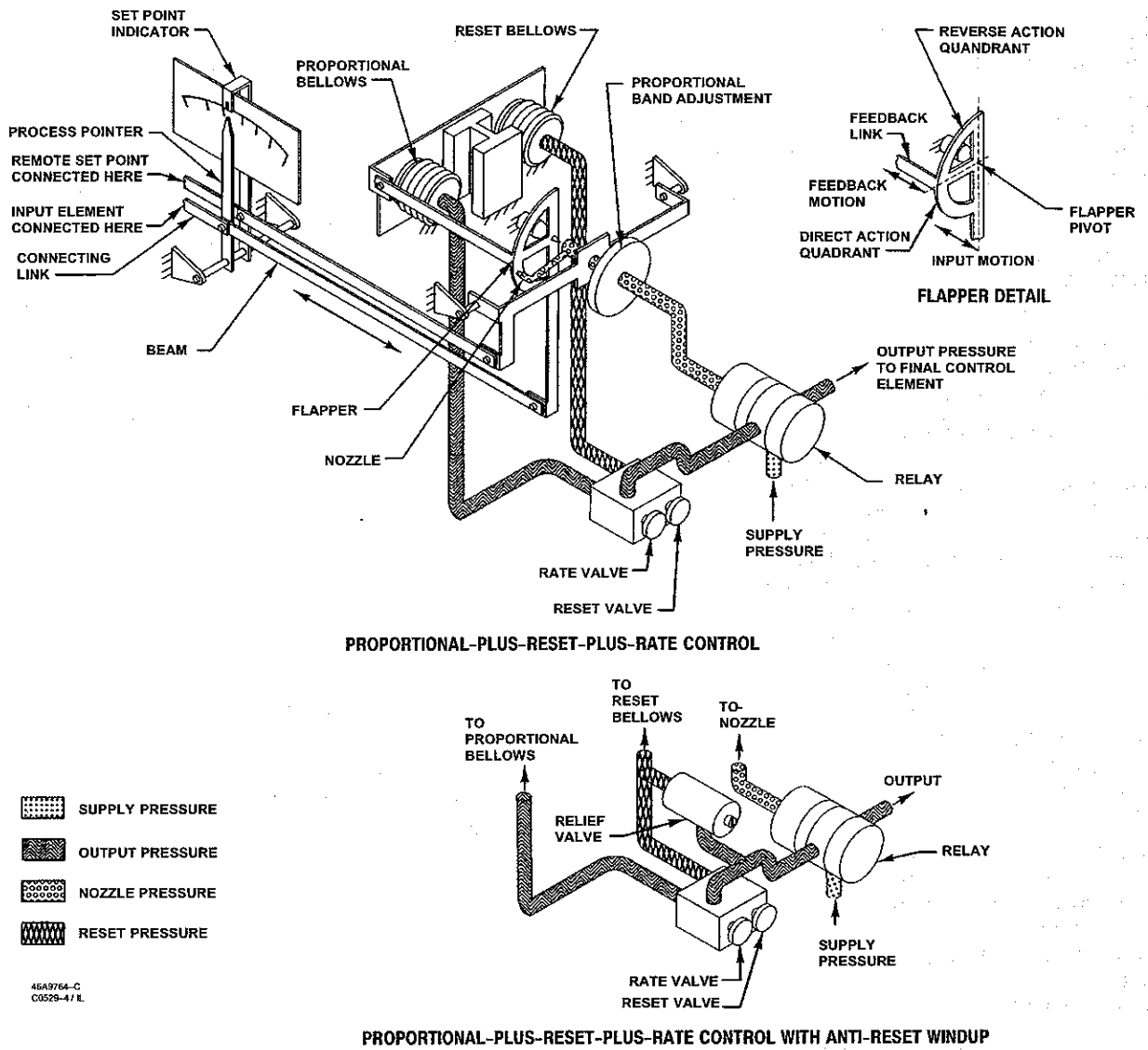


Figure 4-6. 4196C Series Controller Schematic

the controllers are used in an override application. When connected, the secondary controller tracks the primary controller, minimizing reset windup.

# 4196A, B, C, and S Series

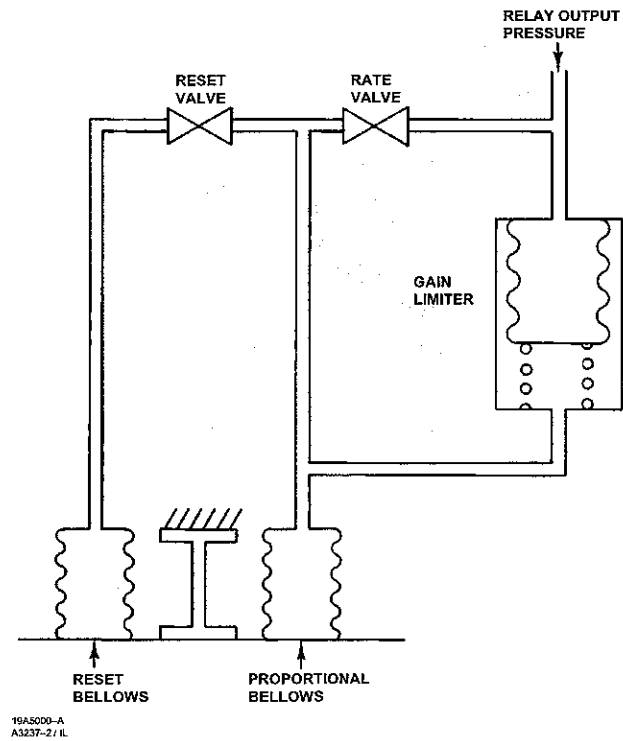


Figure 4-7. Reset-Rate Schematic

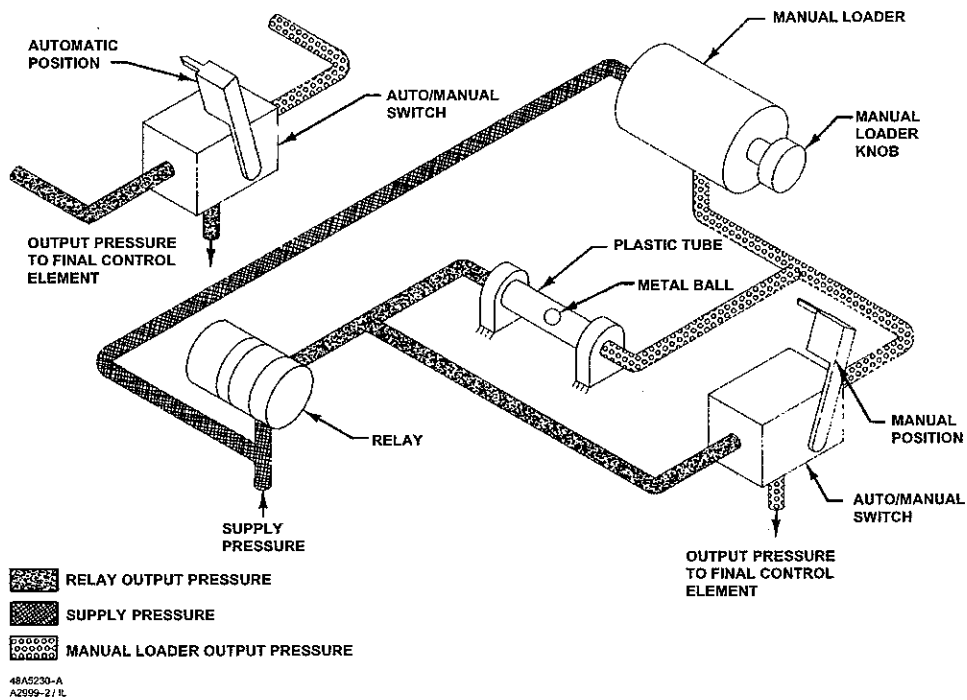


Figure 4-8. Auto/Manual Station Schematic (4196B and C Series)

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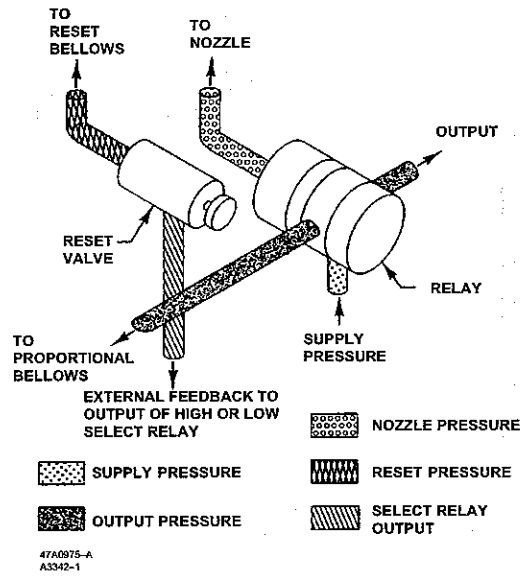


Figure 4-9. Schematic of External Feedback Option



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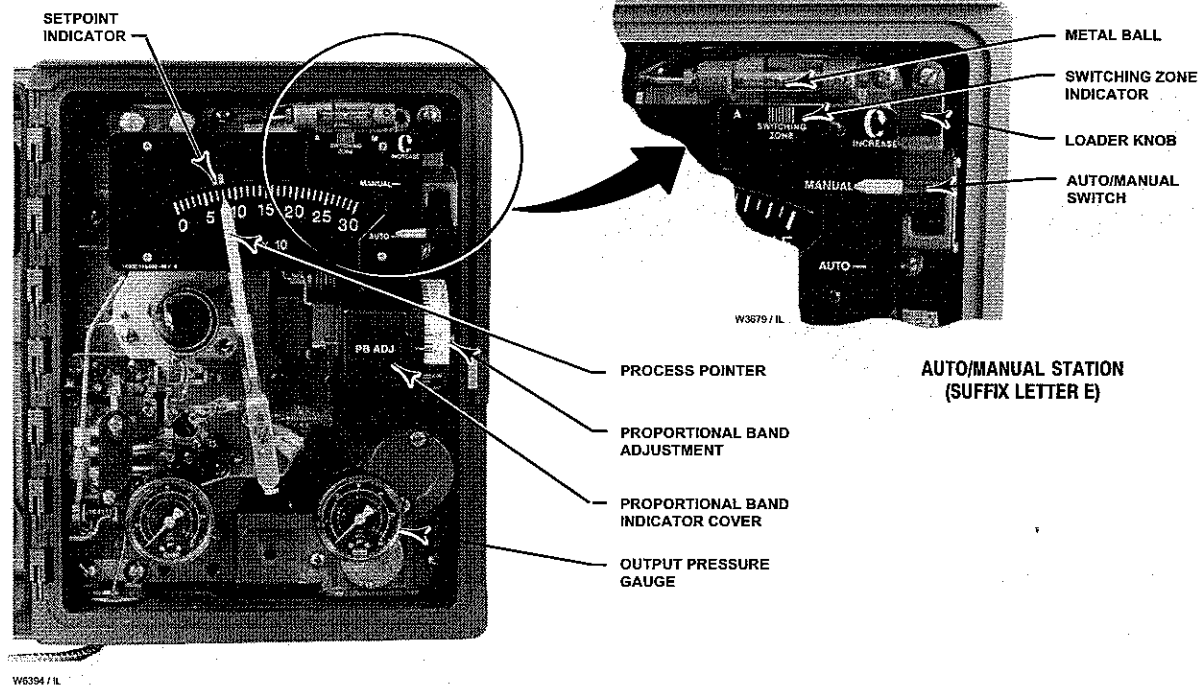


Figure 5-1. 4196S Series Controller Adjustment Locations

## Section 5 4196S Series Differential Gap Controllers

### Adjustments for 4196S Series Controllers

This section includes descriptions of adjustments and procedures for prestartup, startup, and calibration. Adjustment locations are shown in figures 5-1 and 5-3. To better understand the adjustments and overall controller operation, refer to the principle of operation section and to the schematic diagram in figure 5-5. Unless otherwise noted, key numbers given in this section are found in figure 6-20.

### Manual Set Point Adjustment

The set point indicator adjusts the upper or lower switching point, depending on controller action. Adjust the set point by moving the set point indicator until the line on the set point indicator is over the desired value on the process temperature scale. Move the indicator to the right to increase the set point, and to the left to decrease it. Adjusting the set point does not effect the differential gap setting.

If the controller is equipped with the optional internal or external set point adjustment, turn the adjustment knob clockwise to increase the process set point, and counterclockwise to decrease the process set point.

### Remote Set Point (suffix letter M) Adjustment



**Do not manually move the set point indicator on controllers with remote set point. Moving the set point indicator could damage the controller.**

If the controller is equipped with remote set point (suffix letter M), vary the remote set point pressure to change the set point. Increase the pressure to increase the set point, and decrease the pressure to decrease the set point.

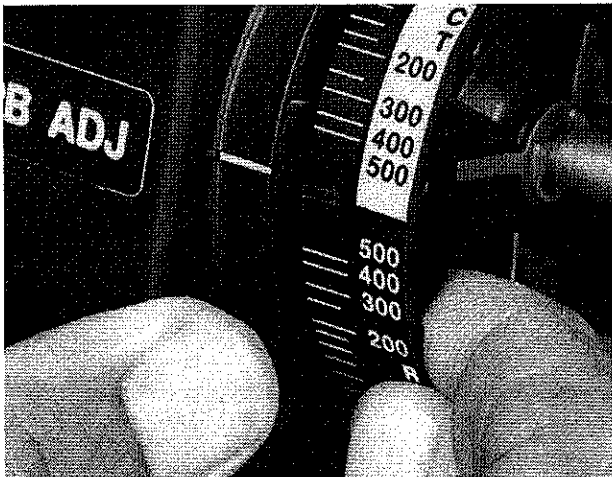
### Proportional Band Adjustment (PB ADJ)

The proportional band adjusts the width of the gap between switching points. To adjust the proportional band, open the controller cover and locate the proportional band adjustment (PB ADJ) knob. Rotate the knob until the desired value is opposite the line on the proportional band indicator cover.

### Changing Controller Action

To change the controller action from direct to reverse or vice versa, loosen the screws on the proportional band indicator cover. Lift the cover out as shown in figure 5-2 and rotate the proportional band adjustment

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W3439 J. E.

Figure 5-2. Changing Controller Action  
(4196S Series Controllers)

to the desired action. Setting the proportional band to the values in the white portion of the adjustment provides direct controller action; setting proportional band in the black portion provides reverse controller action.

## Switching the Auto/Manual Station (suffix letter E)



**Switching the controller between automatic and manual mode without balancing can disturb the process and cause controller cycling.**

Refer to figure 5-1 if the controller has the auto/manual station (suffix letter E). To switch from automatic to manual mode, or from manual to automatic, you must first balance the manual output with the controller output. Two balance methods are available to equalize the manual output with the controller output.

To switch from automatic to manual mode, carefully adjust the loader knob until the metal ball inside the plastic tube moves into the switching zone. Then, move the automatic/manual switch to MANUAL. Turn the loader knob clockwise to increase the controller output or counterclockwise to decrease it.

To switch from manual to automatic mode, adjust the set point to move the ball into the switching zone. Turn the switch to AUTO and adjust the set point to control the output.

When the automatic/manual switch is in AUTO, adjusting the loader knob has no effect on the controller out-

put. When the automatic/manual switch is in MANUAL, changing the set point has no effect on the controller output.

## Prestartup Checks for 4196S Series Controllers

Refer to figure 5-1 for adjustment locations and refer to figure 6-20 for key number locations.

When performing the checks, open loop conditions must exist. An open loop exists when the controller output does not affect the input temperature or other control signal to the controller.

### Note

**If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing prestartup checks.**

1. Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge. Connect supply pressure to the supply pressure regulator, and be sure it is delivering the proper supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.
2. For controllers with remote set point (suffix letter M), connect regulated pressure of 3 to 15 psig (0.2 to 1.0 bar) or 6 to 30 psig (0.4 to 2.1 bar) to the remote set point connection at the top of the controller case.
3. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
4. Adjust the set point a minimum of 20 percent of input span above the process pointer.
5. Adjust the proportional band for 5 percent DIRECT.
6. The process pointer should read ambient temperature  $\pm 1$  percent of span. Be sure that the bulb is exposed to air only and is not resting against the floor, test bench, or other surface.
7. The controller output pressure should be 0 psig.
8. Rotate the proportional band to 5 percent REVERSE.
9. The controller output should be within 2 psig (0.14 bar) of the supply pressure.
10. If the controller output is within tolerance, adjust the proportional band to 400 percent in the desired action, secure the proportional band indicator cover (key 36) with the machine screws (key 6), and go to the startup procedure. If the controller output pressure is not within tolerance, go to the 4196S Series calibration procedure for recalibration.

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## Startup for 4196S Series Controllers

Perform the prestartup checks and, if necessary, calibrate the controller prior to this procedure.

### Note

**When performing the startup procedures, keep in mind that the initial settings are guidelines and will vary, depending on the actual process being controlled.**

Set the controller switching points as described in the calibration procedures.

When placing a controller in service, slowly open the upstream and downstream manual control valves in the pipeline and close the manual bypass valve if such valves are used.

## Calibration of 4196S Series Controllers

### General Calibration Instructions

### Note

**If the controller has the auto/manual station (suffix letter E), be sure the controller is in the automatic mode before performing calibration.**

If the prestartup checks, or startup, reveal faulty controller operation, perform the calibration described in this section. These instructions are valid for either shop or field calibration, provided that open process loop conditions exist. Unless otherwise noted, key numbers are shown in figure 6-20.

Do not use gauges supplied with the controller during calibration. Monitor supply pressure, controller output pressure, and, if applicable, remote set point pressure with external gauges.

### Temperature Baths

The calibration procedure requires that the process temperature be simulated. A temperature bath (liquid or sand, depending on temperature requirements) is recommended. Bath temperature should be able to cover 0 to 100 percent of the temperature element input range.

If available, two baths could be used to simplify and speed up the calibration process. The minimum bath should be preset at 0 percent of input range and the maximum bath should be set at 100 percent of input range.

Also, provide a means of measuring bath temperature. Use a thermometer or resistance temperature detector (RTD) accurate to within  $\pm 0.05$  percent of input span.

### Process Indicator Zero and Span Calibration

Before starting this procedure:

- Provide a means of changing the process temperature to the controller and a means of measurement external to the controller.
- Provide a means of measuring the controller output pressure by connecting the controller output to a pressure gauge (open-loop conditions must exist). Provide a regulated supply pressure to the controller. Do not exceed the normal operating pressure in table 1-3.

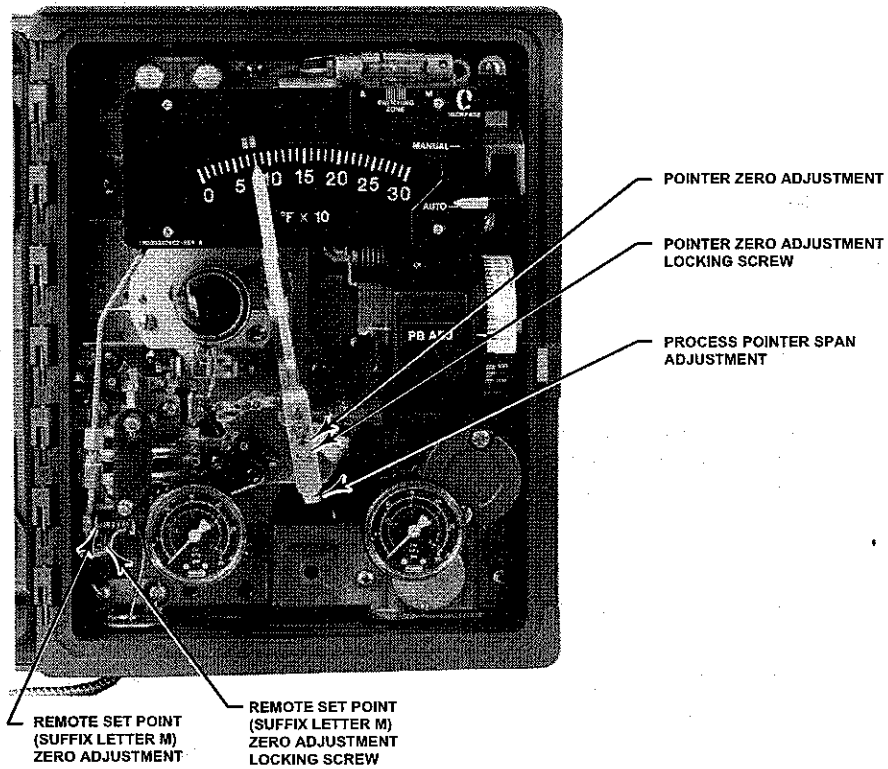
### Note

**Any change to the process pointer span adjustment will require readjustment of the process pointer zero adjustment.**

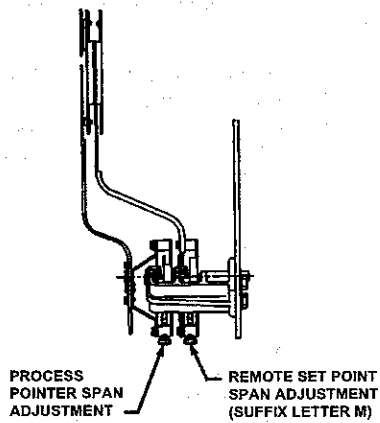
Refer to figures 5-1 and 5-3 for adjustment locations.

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
4. The process pointer should indicate the process scale lower limit. If not, adjust the process pointer to the process scale lower limit by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the zero adjustment locking screw.
5. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The process pointer should indicate the process scale upper limit. If not, adjust the span screw to correct one-half the error as follows: clockwise to increase the span for a low indication (below the upper limit); counterclockwise to decrease span for a high indication (above the upper limit).
7. Repeat steps 3 through 6 until the error is eliminated.
8. Place the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize. The process pointer should indicate the mid-scale mark,  $\pm 2$  percent of span. If the error is greater than  $\pm 2$  percent, refer to the Maintenance section and perform the zero and span adjustment procedure.

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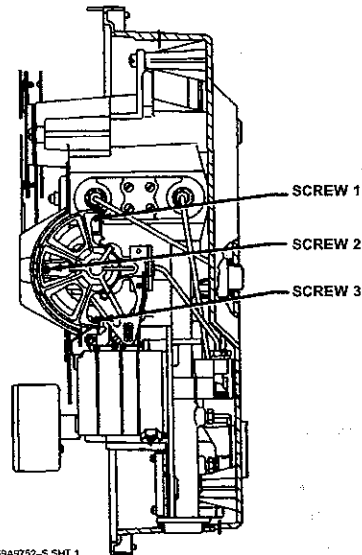


FRONT VIEW



SIDE VIEW OF SET POINT/PROCESS INDICATOR ASSEMBLY

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SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS

Figure 5-3. 4196S Series Controller Calibration Adjustment Locations

9. Adjust the process pointer to within  $\pm 1$  percent of the mid-scale mark by loosening the zero adjustment locking screw and turning the zero adjustment screw. This distributes the error over the entire scale span and brings all points within  $\pm 1$  percent of the process scale span. Tighten the zero adjustment locking screw.
10. Place the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
11. The process pointer should indicate the process scale lower limit  $\pm 1$  percent of the scale span.
12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
13. The process pointer should indicate process scale upper limit  $\pm 1$  percent of the process scale span.
14. If the error is greater than  $\pm 1$  percent, repeat steps 3 through 13.

## **Remote Set Point (suffix letter M) Zero and Span Calibration**

Refer to figures 5-1 and 5-3 for adjustment locations. Refer to figures 6-20 and 6-24 for key number locations.

### **Note**

**Any adjustment of the remote set point span adjustment screw will require readjustment of the remote set point zero adjustment screw.**

1. Remove the two screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Apply remote set point pressure equal to the lower range limit.
4. The set point indicator should indicate the process scale lower limit. If not, loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw until the set point indicator aligns with the process scale lower limit. Tighten the zero adjustment locking screw.
5. Apply remote set point pressure equal to the upper range limit.
6. The set point indicator should indicate the process scale upper limit. If not, adjust the remote set point span adjustment screw to correct one-half the error as follows: clockwise to increase span for a low indication; counterclockwise to decrease span for a high indication.

7. Repeat steps 3 through 6 until the error is eliminated.
8. Apply remote set point pressure equal to the mid-range value.
9. Make sure the set point indicator is within  $\pm 1$  percent of the mid-scale mark and if so, proceed to step 12. If the set point indicator is not within 1 percent, but is within  $\pm 2$  percent of the mid-scale mark, then proceed with step 10. If the set point indicator is not within  $\pm 2$  percent, proceed to the remote set point calibration procedure in the Maintenance section.
10. Loosen the remote set point zero adjustment locking screw and adjust the remote set point zero adjustment screw to correct for half the error at mid-scale. Tighten the zero adjustment locking screw.
11. Apply remote set point pressure equal to the lower and upper range limits and make sure the set point indicator is within  $\pm 1$  percent.
12. If necessary, perform the process indicator zero and span calibration procedure in this section.

## **Setting Switching Points**

### **Direct-Acting Controllers**

The controller output switches from zero pressure to full supply pressure when an increasing process temperature passes the upper switching point. The controller output does not return to zero pressure until a decreasing process temperature passes the lower switching point. When making adjustments as described in the following steps, keep in mind that:

- Changing the set point moves both switching points equally in the direction of adjustment.
- Changing the proportional band adjustment widens or narrows the differential gap between the two switching points by moving the lower switching point.

Figure 5-4 shows the relationship between the percent of sensor range between switching points and the proportional band setting on the controller. The following example illustrates how to use figure 5-4.

Example: The sensing element has a range of 100°F (38°C). The lower switching point is to be set at 30°F (-1°C) and the upper switching point is to be set at 80°F (27°C).

Proceed as follows:

- Divide the differential gap (the difference between the upper and lower switching points) by the sensing element range. Multiply the result by 100 as shown in the following equation:
- Locate the 50 percent line on figure 5-4. Move along this line until you intersect the curve. Read the pro-

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$$\frac{\text{Differential Gap}}{\text{Sensing Element Range}} \times 100 = \frac{50^{\circ}\text{F}(10^{\circ}\text{C})}{100^{\circ}\text{F}(38^{\circ}\text{C})} \times 100 = 50\%$$

portional band setting on the left hand axis. For this example, the setting is approximately 35 percent.

- Using the curve in figure 5-4 determine the correct proportional band setting for the desired gap (expressed as a percent of the input span) between the switching points.
- Set the proportional band to the desired setting determined in step 1.
- Adjust the set point to the desired upper switching point.
- Increase the process temperature until the controller output switches from zero pressure to full supply pressure.
- Decrease the process temperature to the desired switching point at which the controller output switches from full supply pressure to zero pressure.
- Narrow or widen the proportional band slowly until the output switches from full supply pressure to zero pressure.
- Repeat steps 4 through 6 until the controller output switches at the desired points.
- Observe the process pointer when the output switches at the upper switching point. The process pointer indication should be within  $\pm 2$  percent of the set point indication.

## Reverse-Acting Controllers

The controller output switches from zero pressure to full supply pressure when a decreasing process temperature passes the lower switching point. The controller output does not return to zero pressure until an increasing process temperature passes the upper switching point. When making adjustments as described in the following steps, keep in mind that:

- Changing the set point moves both switching points equally in the direction of adjustment.
- Changing the proportional band adjustment widens or narrows the differential gap between the two switching points by moving the upper switching point.

Figure 5-4 shows the relationship between the percent of sensor range between switching points and the proportional band setting on the controller. The following example illustrates how to use figure 5-4.

Example: The sensing element has a range of 100°F (38°C). The lower switching point is to be set at 30°F (-1°C) and the upper switching point is to be set at 80°F (27°C).

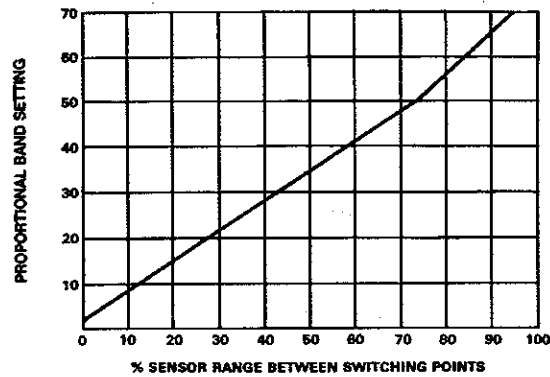


Figure 5-4. Curve for Determining the Proportional Band Setting

Proceed as follows:

- Divide the differential gap (the difference between the upper and lower switching points) by the sensing element range. Multiply the result by 100 as shown in the following equation:

$$\frac{\text{Differential Gap}}{\text{Sensing Element Range}} \times 100 = \frac{50^{\circ}\text{F}(10^{\circ}\text{C})}{100^{\circ}\text{F}(38^{\circ}\text{C})} \times 100 = 50\%$$

- Locate the 50 percent line on figure 5-4. Move along this line until you intersect the curve. Read the proportional band setting on the left hand axis. For this example, the setting is approximately 35 percent.

- Using the curve in figure 5-4 determine the correct proportional band setting for the desired gap (expressed as a percent of the maximum input element span) between the switching points.
- Set the proportional band to the desired setting determined in step 1.
- Adjust the set point to the lower desired switching point.
- Decrease the process temperature until the controller output switches from zero pressure to full supply pressure.
- Increase the process temperature to the desired switching point at which the controller output switches from full supply pressure to zero pressure.
- Narrow or widen the proportional band slowly until the output switches from full supply pressure to zero pressure.
- Repeat steps 4 through 6 until the controller output switches at the desired points.
- Observe the process pointer when the output switches at the lower switching point. The process

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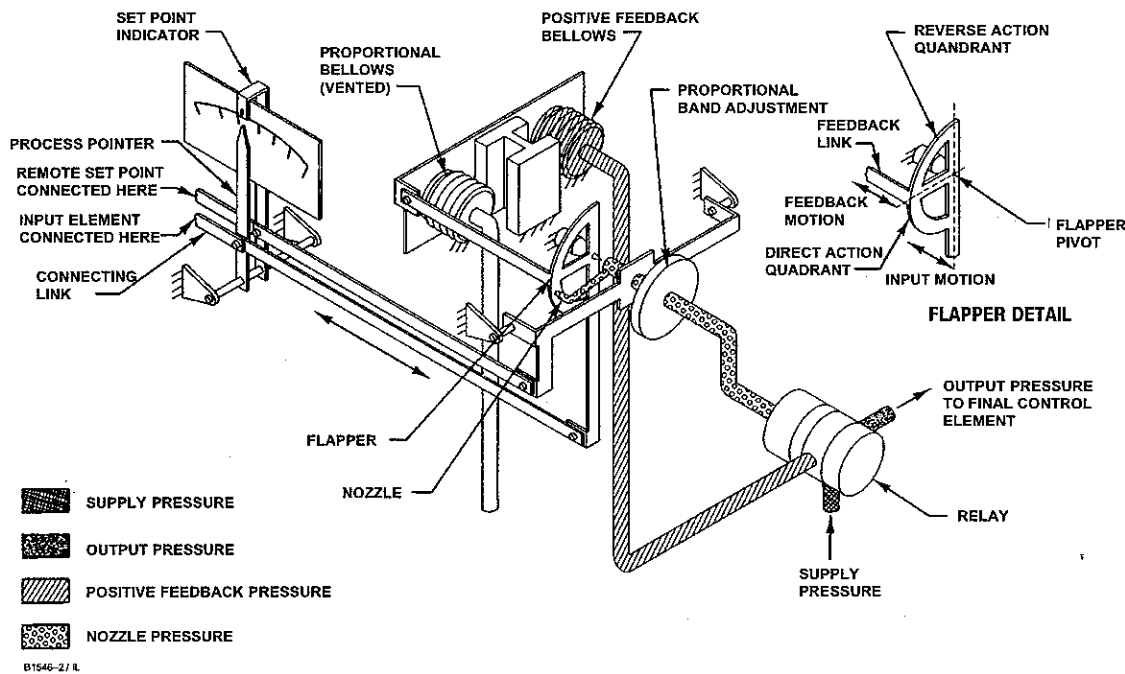


Figure 5-5. 4196S Series Controller Schematic

pointer indication should be within  $\pm 2$  percent of the set point indication.

## Principle of Operation for 4196S Series Controllers

### Overall Operation

Refer to the schematic diagram in figure 5-5.

The input element is connected to the process pointer and to the flapper by connecting links. As the process temperature increases (in a direct-acting controller), the flapper moves toward the nozzle, restricting flow through the nozzle and increasing nozzle pressure. When this occurs, relay action increases the output pressure (delivery) of the controller. Output pressure is fed back to the positive feedback bellows. The action of this bellows is a positive feedback action that moves the flapper closer to the nozzle, increasing the nozzle pressure even higher, which in turn, increases the relay output. Thus, the output pressure to the final control element switches to full supply pressure.

As the process temperature decreases, approaching the lower switching point, the flapper moves away from the nozzle (in a direct-acting controller), reducing nozzle pressure. Through relay action, pressure to the positive feedback bellows is reduced, moving the flapper further away from the nozzle. Thus, the nozzle

pressure falls even further. Output pressure to the final control element switches to zero.

Moving the set point indicator changes the distance between the nozzle and flapper as does a change in process temperature except that, when the set point is changed, the nozzle moves with respect to the flapper. Adjusting the set point moves both the upper and lower switching points.

The proportional band adjustment positions the nozzle on the flapper. Increasing (widening) the proportional band moves the nozzle away from the input connection. When the proportional band adjustment moves the nozzle across the feedback connection, the controller action changes between direct and reverse.

On a direct-acting controller, changing the proportional band adjustment widens or narrows the differential gap between the two switching points. This is accomplished by changing the position of the lower switching point. On a reverse-acting controller, changing the proportional band adjustment widens or narrows the differential gap between the two switching points. This is accomplished by changing the position of the upper switching point.

### Remote Set Point (suffix letter M) Operation

The capability to adjust the controller set point from a remote location is available with all 4196 Series con-

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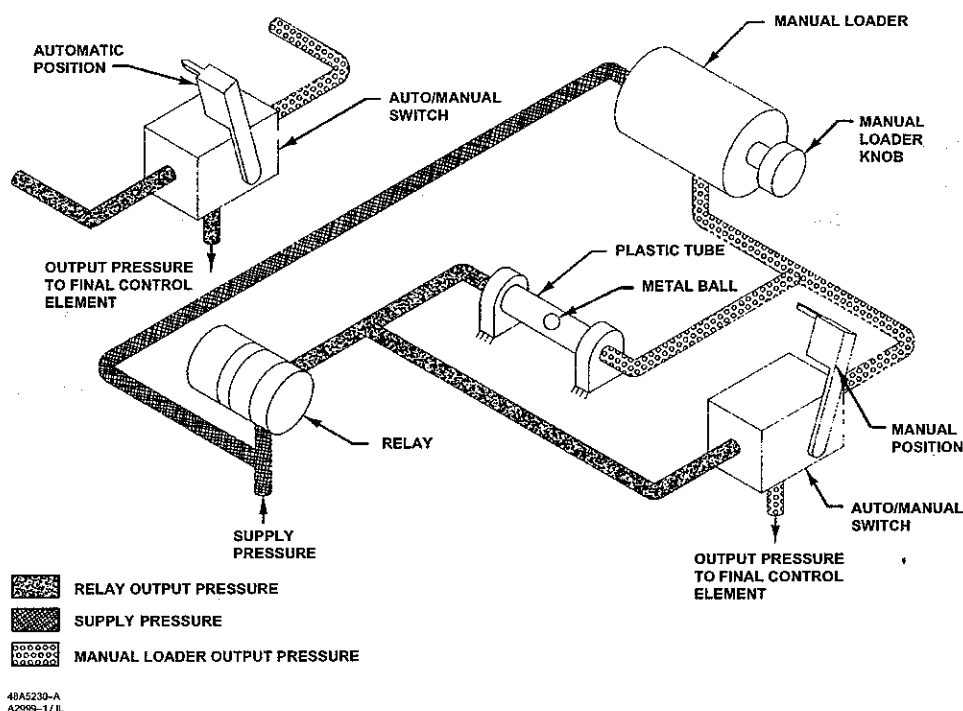


Figure 5-6. Auto/Manual Station Schematic (4196S Series)

trollers. This option is designated by the suffix letter M in the type number.

A control pressure is applied to the capsular element within the remote set point assembly. The expansion and contraction of the capsule moves the set point indicator via a connecting linkage. Increasing the control pressure to the capsule increases the set point setting and decreasing the control pressure reduces the set point setting.

## Auto/Manual Station (suffix letter E) Operation

A controller with the auto/manual station (designated by the suffix letter E in the type number) has piping on the output side of the relay as shown in figure 5-6. Supply pressure to the relay is also applied to the manual loader. The manual loader, functioning as a regulator, applies pressure to one side of the plastic tube and to the auto/manual switch.

Output pressure from the relay registers on the other side of the plastic tube as well as in the auto/manual switch.

When the auto/manual switch is in the MANUAL position, the manual loader output is channelled through the auto/manual switch and becomes the controller output. When the auto/manual switch is in the AUTO position, the relay output is channelled through the switch to become the controller output.

Before the auto/manual switch is operated, the relay output must equal the manual loader output to avoid bumping the process. Adjusting the set point varies the pressure on the left-hand side of the plastic tube. Adjusting the manual loader knob varies the pressure on the right-hand side. When the pressures are equal, the metal ball is centered in the tube and is held in place by a small magnet. A pressure imbalance forces the ball to one end of the tube where it forms a seal, blocking air flow through the tube.



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## Section 6 Maintenance

### Inspection and Maintenance

#### WARNING

The following maintenance procedures require taking the controller out of service. To avoid personal injury and property damage caused by uncontrolled process pressure, provide some temporary means of control for the process before taking the controller out of service.

Before performing any maintenance operations:

- Shut off the supply pressure to the controller.
- Disconnect any operating lines providing supply air pressure, a process input signal, or other pressure source to the controller.

#### Note

Unless otherwise noted, key numbers refer to figure 6-20. Figures 3-1 and 3-3 show the adjustment locations for 4196A Series controllers. Figures 4-1 and 4-3 show adjustment locations for 4196B and C Series controllers. Figures 5-1 and 5-3 show adjustment locations for 4196S Series controllers. For maintenance on the indicator assembly, please refer to figures 6-21 and 6-22.

Controller parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and parts replacement depends upon the severity of the service conditions. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job.

Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, materials of construction, and other product characteristics specified by Fisher Controls), use only replacement parts manufactured or furnished by Fisher Controls.

Select the appropriate maintenance procedure and perform the numbered steps. Shut off supply pressure before beginning maintenance.

The maintenance procedures section describes part replacement common to 4196A, B, C, and S Series controllers. After completing the maintenance procedures, perform the appropriate calibration procedures.

Unless otherwise noted, calibration procedures for the 4196A Series controller are in Section 3; calibration procedures for the 4196B and C Series controller are in Section 4; and calibration procedures for the 4196S Series controllers are in Section 5. If difficulty is encountered performing the calibration procedures in sections 3, 4, or 5, refer to the calibration procedures in this section.

Some procedures require temperature baths. Please refer to the appropriate calibration procedure for information on temperature baths.

### Troubleshooting

As an aid to troubleshooting, table 6-1 lists some common operating faults, their probable cause, and suggests procedures for correcting the fault.

### Replacing Common Controller Parts

#### WARNING

To avoid personal injury or property damage caused by the uncontrolled release of pressure, be sure any trapped process pressure is properly vented from the controller. Vent any supply pressure from the controller before disassembly.

### Replacing the Process Temperature Scale

#### CAUTION

To prevent inaccurate indication and operation, take care not to bend the process pointer or the set point indicator while performing the following procedure.

Refer to figure 6-1.

1. Adjust the set point indicator (either manually or with the remote set point pressure) to the mid-scale mark on the process scale.
2. Remove the four self-tapping screws (key 37).
3. Slide the process scale (key 61) downward so that the top of the slot touches the set point indicator. Deflect the lower portion of the slot outward, and carefully slide the scale upward and off, clearing the set point indicator as shown in figure 6-1.
4. To install the replacement scale, deflect the lower part of the slot slightly so that the scale slides downward over the set point indicator and under the process pointer.

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Table 6-1. Troubleshooting Chart

Fault	Possible Cause	Check	Correction
<p>1. Process wanders or cycles about set point</p>	<p>1.1 Proportional band and reset settings</p> <p>1.2 Supply pressure varying</p> <p>1.3 Process pointer rubbing on cover or scale</p> <p>1.4 Input element failure</p> <p>1.5 Linkage failure</p> <p>1.6 Relay malfunction</p> <p>1.7 Anti-Reset Windup differential relief valve set too low (suffix letter F only)</p>	<p>1.1 Refer to the Start-up section for controller settings.</p> <p>1.2 Monitor the supply pressure with an external gauge. Ensure that it is set correctly and does not fluctuate. Note the number of instruments being supplied by the regulator.</p> <p>1.3 Note if the pointer is bent.</p> <p>1.4 Inspect the element for loose screws and damaged flexures, links or pivots. Using a soap solution, check the sensing element for leaks.</p> <p>1.5 Check for links bent or not connected properly, flexures bent or broken, pivots broken.</p> <p>1.6 By changing the process set point and observing the output, verify that the output moves at about the same speed in both directions.</p> <p>1.7 The minimum relief valve setting is dependent on the loop dynamics and the controller settings. If under normal load changes the relief valve opens, instability can occur. Check by observing the controller reaction to a set point or load change under closed loop conditions.</p>	<p>1.1 If stable control cannot be attained, and all other elements of the loop are functionally correct, examine other possible causes related to the controller.</p> <p>1.2 Correct as necessary. One regulator per instrument is recommended.</p> <p>1.3 Bend pointer to provide clearance.</p> <p>1.4 Repair or replace parts as necessary.</p> <p>1.5 Replace or repair as necessary.</p> <p>1.6 If the output moves fast in one direction and sluggishly in the other, replace the relay.</p> <p>1.7 If the anti-reset windup differential relief valve appears to be set too low, perform the anti-reset windup calibration procedures in section 4.</p>
<p>2. Controlling off set point as reflected by process and set point indicators.</p> <p>Note: Some offset is inherent with proportional only controllers (4196A Series). The amount of offset is a function of the proportional band setting.</p>	<p>2.1 Supply pressure not set correctly</p> <p>2.2 Linkage not connected correctly.</p> <p>2.3 Leak in input element/tubing assembly.</p> <p>2.4 Indicators out of calibration.</p> <p>2.5 Flapper not aligned.</p> <p>2.6 Leak in feedback system.</p>	<p>2.1 Check with an external source.</p> <p>2.2 Inspect for loose screws and damaged flexures, links or pivots.</p> <p>2.3 Using soap solution, check the input element and tubing for leaks.</p> <p>2.4 Refer to the process indicator and remote set point (if applicable) zero and span calibration procedures in section 3, 4, or 5.</p> <p>2.5 Refer to the Flapper alignment procedures in section 3, 4, or 5.</p> <p>2.6 Open the reset valve to .01 minutes/repeat. Adjust output pressure to 20 psig (1.4 bar). Using soap solution, check for leaks in the proportional and reset bellows and in the tubing that connects these bellows.</p>	<p>2.1 Reset the supply pressure if necessary. If the condition occurs again, rebuild or replace the regulator.</p> <p>2.2 Repair or replace parts as necessary.</p> <p>2.3 Repair or replace parts as necessary.</p> <p>2.4 Adjust as necessary.</p> <p>2.5 Align the flapper as necessary.</p> <p>2.6 Repair as necessary.</p>

-Continued-

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Table 6-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
2. Controlling off set point as reflected by process and set point indicators.	2.7 Reset valve leaks.	2.7 Adjust output to 15 psig (1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output or 30 psig (2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output. Close the reset valve. If the controller output varies and no leaks were found in the rest of the feedback system (Step 2.6), the reset valve is leaking.	2.7 Replace the reset valve.
	2.8 Leak in the remote set point system (suffix letter M only).	2.8 Adjust remote set point pressure to 15 psig (1.0 bar). Using soap solution, check for leaks in the remote set point element and tubing assembly.	2.8 Repair or replace parts as necessary.
	2.9 Input element over pressured.	2.9 Check for zero shift.	2.9 Replace input element and adjust travel stops.
3. Controlling off set point but not reflected by process and set point indicators.	3.1 Out of calibration	3.1 Refer to the process indicator, remote set point (if applicable), and flapper alignment procedures in section 3, 4, or 5.	3.1 Adjust as necessary
4. No reset action (4196B and 4196C Series)	4.1 Reset valve is plugged	4.1 Turn the reset valve through its range several times to remove any restrictions.	4.1 If reset action returns, no further action is necessary. If not, replace the reset valve (4196B Series) or the rate/reset valve (4196C Series).
	4.2 Reset pressure leak	4.2 Adjust the output to 15 psig (1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output or 30 psig (2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output. Close the reset valve. If the output varies and no leaks were found in the rest of the feedback system (see Step 2.6), the reset valve is leaking.	4.2 Replace the reset valve (4196B Series) or the rate/reset valve (4196C Series)
	4.3 Tubing leak	4.3 With reset valve positioned at 0.01 minutes/repeat, put 15 psig (1.0 bar) to the output port. Using soap solution, check for leaks in the reset bellows and attached tubing assembly.	4.3 Repair or replace parts as necessary.
5. Abnormal control point shift when proportional band is changed.	5.1 Flapper is dirty or pitted	5.1 Inspect the flapper.	5.1 Clean, or replace flapper as necessary.
	5.2 Flapper is out of alignment	5.2 Refer to flapper alignment procedures in section 3, 4, or 5.	5.2 Align flapper as necessary.
6. Controller will not attain full output range.	6.1 Output pressure gauge not functioning	6.1 Measure the output with an external pressure gauge.	6.1 Replace the gauge if it is defective.
	6.2 Supply pressure not correct	6.2 Check with an external source.	6.2 Repair or replace the supply pressure regulator, if necessary. Replace the supply pressure gauge if necessary.
	6.3 Proportional band setting too wide (4196A Series only)	6.3 Adjust proportional band setting to 10. Manually cap the nozzle. Output should increase.	6.3 Use a narrower proportional band setting (decrease the proportional band setting).
	6.4 Input element or linkage failure	6.4 Inspect the element for alignment, loose screws and damaged flexures, links or pivots. Using soap solution, check the sensing element for leaks.	6.4 Repair or replace parts as necessary.
	6.5 Leak in nozzle pressure tubing	6.5 Using soap solution, check for leaks in the nozzle tubing assembly.	6.5 Replace faulty parts as necessary. Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged.

-Continued-

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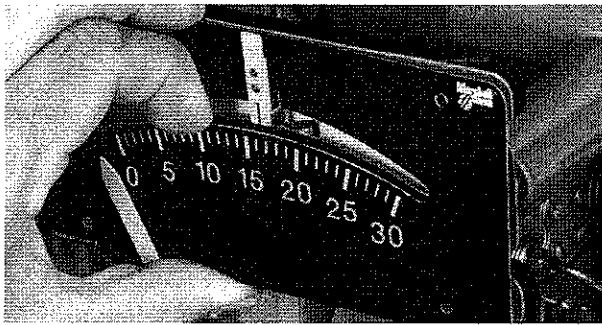
Table 6-1. Troubleshooting Chart (Continued)

Fault	Possible Cause	Check	Correction
6. Controller will not attain full output range.	6.6 Relay malfunction	6.6 Manually push the flapper away from the nozzle. The output pressure should be zero. Cap the nozzle. The output should increase rapidly to within 0.5 psig (35 mbar) of the supply pressure.	6.6 If the output does not change as described, remove the relay. Replace O-rings, if necessary. Replace relay, if necessary.
7. Controller remains at full output	7.1 Supply pressure too high 7.2 Output gauge not functioning 7.3 Input element or linkage failure 7.4 Mechanical alignment 7.5 Relay failure or restriction in nozzle passage 7.6 Flapper misaligned	7.1 Check with an external pressure gauge. 7.2 Vary supply pressure to see if output gauge responds. 7.3 Vary the process temperature and observe the flapper for movement. Inspect the input element and linkage for damage. 7.4 Move the set point and verify that the nozzle is uncapped by the flapper. If not, inspect linkages and flexures for damage. 7.5 Manually move flapper 1/16-inch (1.6 mm) from the nozzle. 7.6 Manually push the flapper away from the nozzle. Controller output should go to 0 psig.	7.1 Replace supply pressure regulator or gauge as necessary. 7.2 If output gauge does not respond, replace it. 7.3 Repair or replace parts as necessary. 7.4 Repair or replace parts as necessary. 7.5 If the output pressure remains at the supply pressure, remove the controller case and cover assembly and test again with the relay nozzle tubing nut (key 18) loose. If the output is 0 psig, clean or replace the nozzle assembly. If the output remains at supply pressure, replace the relay. 7.6 Perform the flapper alignment procedures in section 3, 4, or 5.
8. Controller remains at zero output	8.1 Gauge not functioning 8.2 Input element or linkage failure 8.3 Mechanical alignment 8.4 Relay malfunction 8.5 Nozzle pressure leak	8.1 Verify that the supply pressure is at its correct value and that the controller output is zero. 8.2 Vary the process temperature and observe the flapper for movement. Inspect the input element and linkage for damage. 8.3 Move the set point and verify that the nozzle is capped by the flapper. If not, inspect linkages and flexures for damage. 8.4 Check for air at the nozzle. Cap the nozzle and note that the controller output increases to within 0.5 psig of supply pressure. 8.5 Using a soap solution, check for nozzle tubing leaks with the nozzle capped by the flapper. Press the nozzle cap (key 23) gently to ensure nozzle O-ring (key 24) is sealing. Ensure the relay nozzle tubing nut (key 18) and the manifold screws (keys 34 and 131) are tight.	8.1 Replace gauges as necessary 8.2 Repair or replace parts as necessary 8.3 Repair or replace parts as necessary 8.4 Clean out the relay primary orifice with the cleanout wire attached to the relay to ensure the orifice is not clogged. If the problem persists, replace the relay. 8.5 Tighten the relay nozzle tubing nut (key 18), tighten manifold screws (keys 34 and 131), or replace nozzle assembly O-ring or set point beam assembly as appropriate.

5. Secure the scale with the four self-tapping screws (key 37).
6. If the controller has remote set point (suffix letter M), perform the appropriate remote set point zero and span calibration procedure in section 3, 4, or 5.

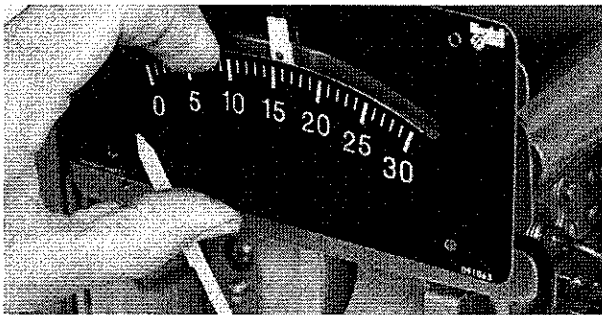
7. Perform the appropriate process indicator zero and span calibration and the flapper alignment procedures in section 3, 4, or 5.

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**DEFLECT LOWER PORTION OF THE SLOT**



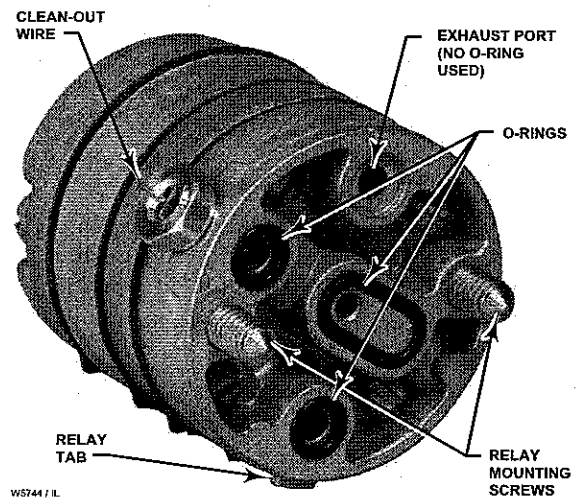
W4296 / IL

**AND LIFT THE SCALE UP AND OFF**

*Figure 6-1. Changing the Scale*

## Replacing the Relay

1. Loosen the two captive screws that hold the relay (key 50) in place.
2. Tip the relay slightly toward the side of the case to clear the output pressure gauge (key 46), and lift out the relay.
3. Make sure the replacement relay has three O-rings (keys 13 and 15) installed as shown in figure 6-2. The fourth port is for exhaust and does not require an O-ring.
4. Install the replacement relay, making sure the tab on the relay, shown in figure 6-2, aligns with the tab on the frame.
5. Tighten the two screws that hold the relay in place.
6. Perform the appropriate Flapper Alignment procedure in section 3, 4, or 5.



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*Figure 6-2. Relay Construction*

## Replacing the Case and Cover



**CAUTION**

The case and cover are an integral unit; attempting to separate them will damage the hinge. If the cover needs to be replaced, replace the case also.

1. Remove the external piping and fittings from the controller.
2. If the temperature bulb is not in a thermowell, make provisions to ensure that the process fluid does not escape from the process vessel as the temperature bulb is removed.
3. Remove the controller from its mounting to a maintenance area.
4. Remove the nine screws (key 38) from the case and cover assembly (key 1) and lift out the controller assembly. If the controller has remote set point (suffix letter M), use a screwdriver or appropriate tool to deflect the case slightly at the remote set point connection to remove the controller assembly.
5. Carefully draw the capillary tube and the temperature bulb through the process connection opening in the case. Inspect the O-rings around the external piping connections and replace as necessary.
6. Carefully feed the temperature bulb through the opening in the replacement case and pull the capillary tube all the way through.
7. Position the controller assembly in the replacement case and cover.
8. Start the nine mounting screws, but do not tighten.

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- Slide the controller assembly down to assure an O-ring seal at the pressure connections and thermal system connections along the bottom of the case. Hold the controller assembly in place while tightening the nine mounting screws.
- Remove the blow-out plug (key 72) from the original case, and install in the replacement case.
- Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.
- Mount the controller as described in the Installation section.
- Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## Replacing the Gauges



**Before performing this procedure, be sure the replacement gauges are the correct range so that they are not damaged by overpressure.**

- Unscrew the output pressure gauge (key 46) or the supply pressure gauge (key 46) from the frame (key 3).
- Before installing the replacement gauge, coat the threads on the gauge with a suitable sealant such as key 311 or equivalent.
- Screw the replacement gauge into the frame.
- Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure.

## Replacing the Supply Gauge, Proportional, Reset, and Reset Valve Tubing Assemblies

- Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
- Unscrew the nuts at each end of the tubing assembly. Remove the tubing assembly.
- Install the replacement tubing assembly.
- Set the reset adjustment to 0.01 (4196B and C Series) and set the rate adjustment to OFF (4196C Series).
- Apply the correct supply pressure and check for leaks with the nozzle capped for full output pressure. Then, remove the pressure.
- Perform steps 6 through 9 of the case and cover replacement procedure.

- Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.
- Mount the controller as described in the Installation section.
- Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## Replacing the Proportional Band Adjustment Knob, Nozzle Assembly, and Set Point Beam Assembly

Figure 6-3 shows the parts locations for the proportional band adjustment and set point beam. Unless otherwise noted, refer to this figure while performing the following procedures.

### Disassembly

- Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
- Remove the two machine screws (key 6), and lift off the proportional band indicator cover (key 36). See figure 6-20 for parts location.
- Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23).
- Remove the set point beam bias spring (key 28).
- Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame, and remove the pivot assembly.
- Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135).
- While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
- Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
- Remove the relay nozzle tubing assembly (key 18) from the set point beam assembly (key 23).
- Remove the E-ring (key 27) from the nozzle assembly (key 21).
- Remove the nozzle assembly (key 21) and Mylar washer (key 22) from the bottom of the set point beam assembly (key 23).
- Remove the retaining clip (key 26).
- Remove the proportional band adjustment knob (key 25) and Mylar washer from the set point beam assembly (key 23).
- Inspect the nozzle assembly (key 21) and replace it if necessary. Inspect the nozzle orifice, and clean it if

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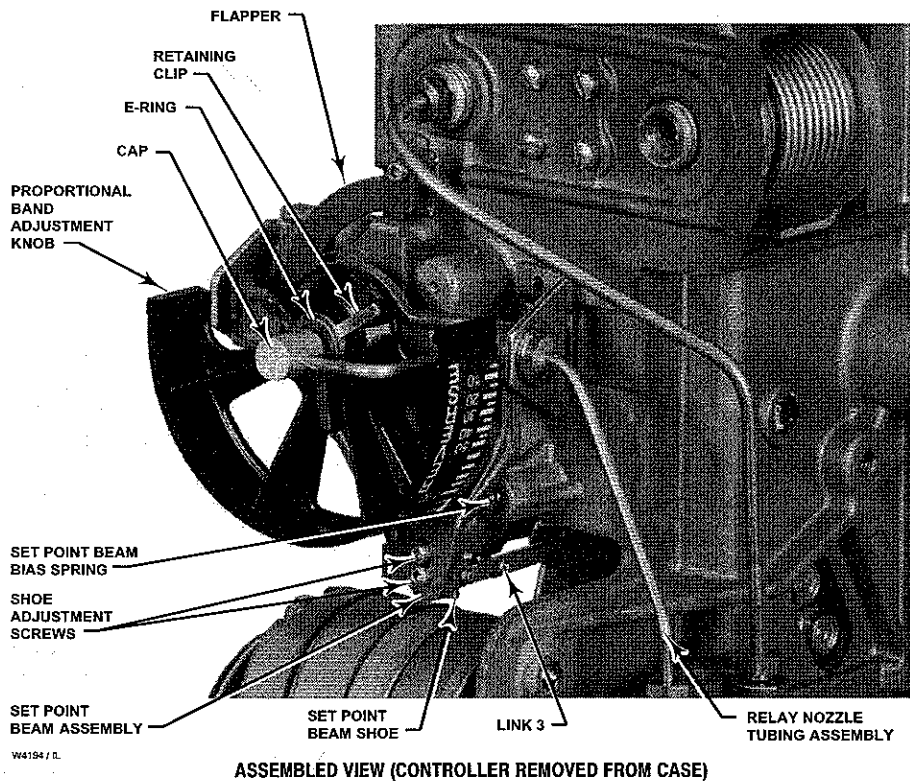
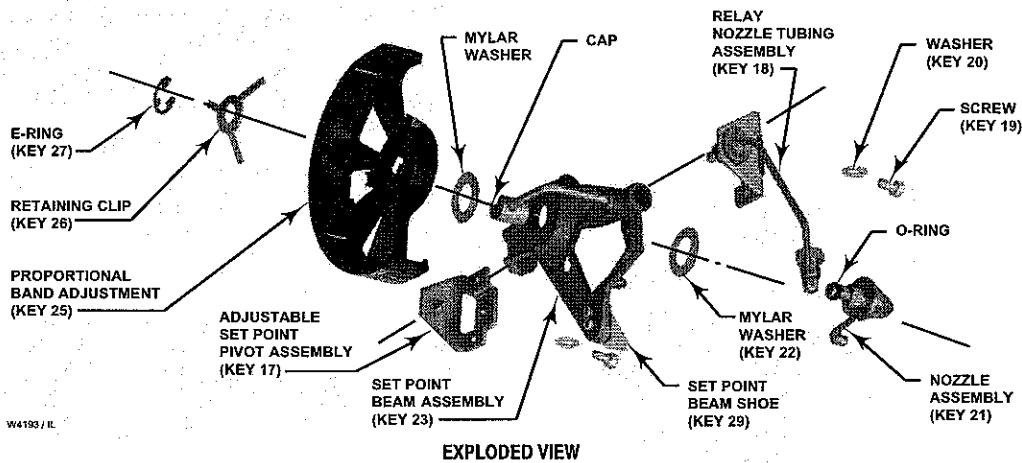


Figure 6-3. Proportional Band Adjustment and Set Point Beam Details

necessary. Also inspect the Mylar washers, and replace them if necessary.

15. Inspect the nozzle assembly O-ring (key 24) and replace it, if necessary.

### Assembly

16. Apply a suitable lubricant, such as key 318 or equivalent, to the set point beam assembly; then, posi-

tion a Mylar washer (key 22) and the proportional band adjustment knob (key 25) on the set point beam assembly (key 23) as shown in figure 6-3.

17. Position the retaining clip (key 26) on the three posts of the proportional band adjustment knob.

18. Place the second Mylar washer on the nozzle assembly. Apply a suitable lubricant, such as key 317 or equivalent, to the nozzle assembly O-ring.

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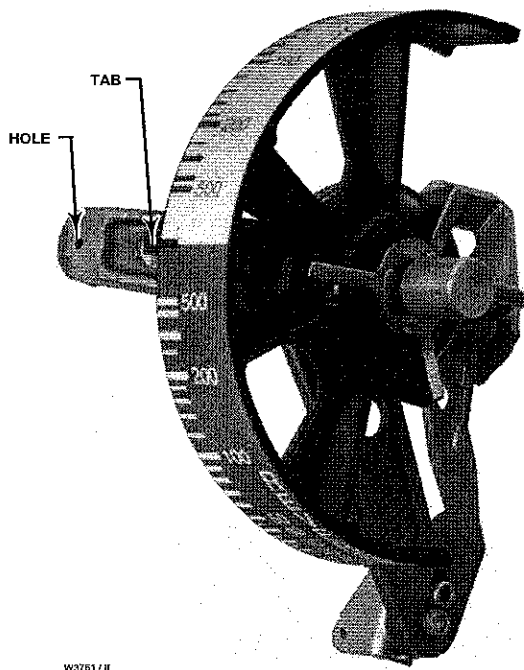


Figure 6-4. Proportional Band Adjustment Knob Setting

19. Insert the nozzle assembly (key 21) through the set point beam assembly (key 23), the Mylar washer (key 22), the proportional band adjustment knob (key 25) and the retaining clip (key 26) into the cap. Align the nozzle with the tab on the proportional band adjustment knob shown in figure 6-4; make sure the proportional band adjustment knob engages the flats on the nozzle assembly.

20. While holding the nozzle assembly (key 21) against the set point beam assembly (key 23), depress the retaining clip (key 26), and install the E-ring (key 27) into the E-ring groove on the nozzle assembly (key 21). Ensure that all three tabs of the E-ring are engaged.

21. Inspect the O-ring on the relay nozzle tubing assembly (key 18), and replace it, if necessary. Apply a suitable lubricant to the O-ring.

22. Install the relay nozzle tubing assembly (key 18) into the set point beam assembly.

23. Set the proportional band adjustment between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 6-4.

24. Position the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly on the frame. Screw the relay nozzle tubing nut loosely into the frame manifold.

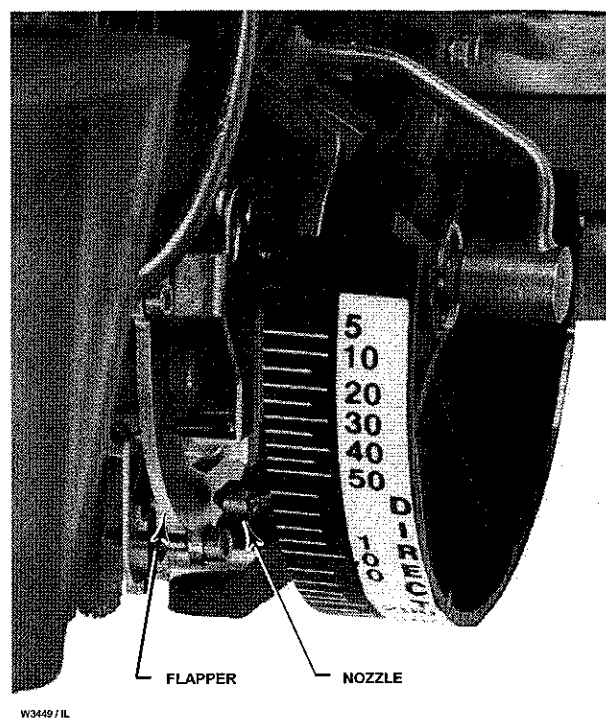


Figure 6-5. Nozzle-Flapper Positioning

25. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.

26. Center the nozzle on the flapper as shown in figure 6-5 while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.

27. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).

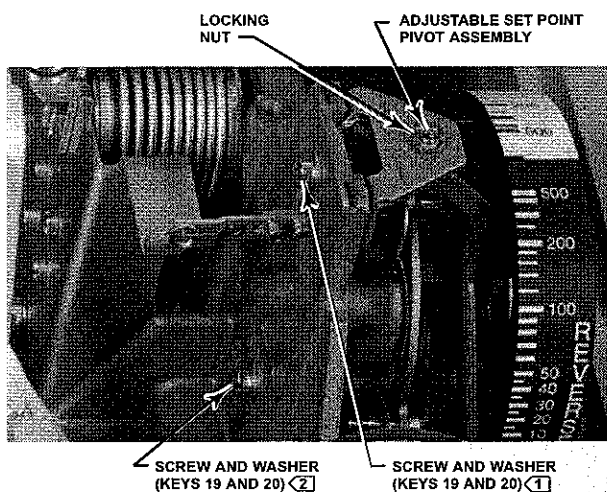
28. Insert the screw, with washer (keys 19 and 20) through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.

29. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws.

30. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 6-6 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw.



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### NOTES:

- ① SCREW INSERTED INTO THE ADJUSTABLE SET POINT PIVOT ASSEMBLY.
- ② SCREW INSERTED INTO THE RELAY NOZZLE TUBING ASSEMBLY.

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Figure 6-6. Adjustable Set Point Pivot Assembly Locking Nut Location

slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.

31. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing assembly (key 18). Apply full supply pressure with the nozzle capped and check for leaks. Remove supply pressure.

32. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat on the set point beam assembly.

33. Attach link 3 to the set point beam shoe as shown in figure 6-3.

34. For controllers with reset or rate adjustment (4196B and 4196C Series), turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position. Set the rate adjustment to the OFF position.

The controller output must be 0 psig (0 bar). To be sure the controller output is 0 psig (0 bar), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.

35. Apply the correct supply pressure (refer to table 1-3) to the controller and provide an accurate means of measuring the controller output pressure.

36. Perform the appropriate process indicator zero and span calibration procedure and, if necessary, the

remote set point zero and span calibration procedure in section 3, 4, or 5. When calibration is complete, continue with step 37 below.

### Note

The following procedure (steps 37 through 43) matches the process pointer motion to the set point indicator motion so the controller will control at set point at all positions on the process scale.

37. Set the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.

38. Adjust the set point to the lower limit on the process scale.

39. Disconnect link 1 from the temperature element, noting the hole from which it is removed and tape the process pointer to the lower limit on the process scale. The output pressure may be anywhere between 3 and 15 psig (0.2 and 1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range or between 6 and 30 psig (0.4 and 2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.

40. Adjust the set point to the upper limit on the process scale.

41. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 39. Note the process temperature indication.

42. The process temperature indication should be within  $\pm 2$  percent of the upper limit on the process scale.

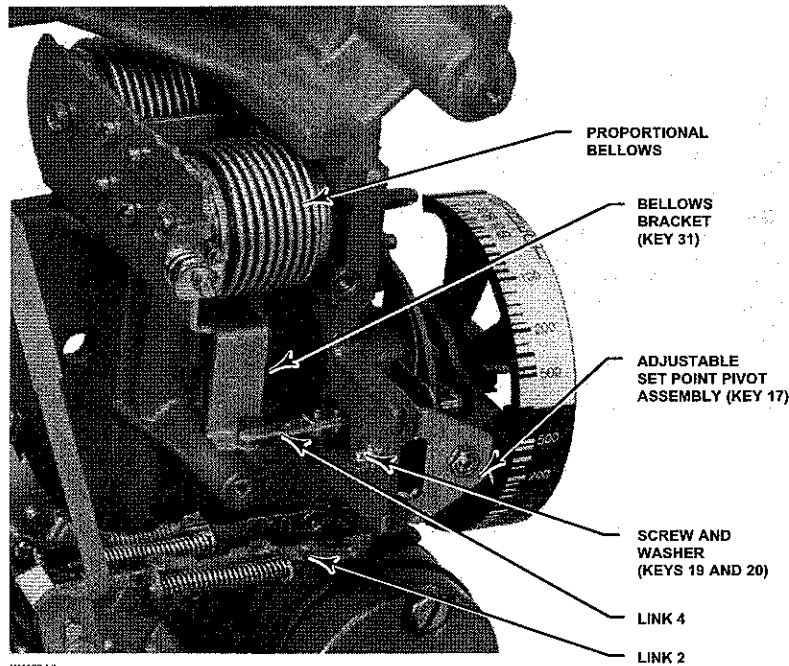
If the process temperature indication (in step 41) is greater than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 6-3, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

If the process temperature indication (in step 41) is less than the upper limit of the process scale by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 6-3, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.

43. Repeat steps 38 through 42 until the error is less than 2 percent of the process scale range at the upper limit of the process scale.

44. Remove the tape from the process pointer and reconnect link 1 to the temperature element. Be sure to reconnect link 1 in the same hole noted in step 39.

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Figure 6-7. Bellows Assembly and Proportional Band Adjustment  
(Process Scale and Proportional Band Indicator Cover Removed)

45. Perform steps 6 through 9 of the case and cover replacement procedure.
46. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.
47. Mount the controller as described in the Installation section.
48. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## **Replacing the Flapper Assembly And Flapper Flexure Pivot Assembly**

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two screws (key 6), and lift off the proportional band cover (key 36).
3. Disconnect link 3 from the set point beam shoe, part of the set point beam assembly (key 23). Refer to figure 6-3 for the link location.
4. Remove the set point beam bias spring (key 28), refer to figure 6-3 for the spring location.
5. Remove the screw and washer (keys 19 and 20) that hold the adjustable set point pivot assembly (key 17) to the frame.

6. Remove the adjustable set point pivot assembly (key 17).
7. Unscrew the nut that secures the relay nozzle tubing assembly (key 18) to the frame manifold (key 135). Refer to figure 6-3.
8. While holding the proportional band adjustment knob, remove the screw and washer (keys 19 and 20) that hold the relay nozzle tubing assembly (key 18) to the frame.
9. Remove the proportional band adjustment knob, relay nozzle tubing assembly, and the set point beam assembly from the controller.
10. Disconnect link 2 from the flapper assembly (key 11). Refer to figure 6-7 for the link location.
11. Disconnect link 4 from the bellows bracket (key 31). Refer to figure 6-7 for the link location.
12. Remove the two cap screws (key 12) from the flexure pivot assembly (key 9). See figure 6-8 for screw location.
13. Remove the flapper assembly and link 4 as shown in figure 6-9.
14. Remove the four machine screws (key 10) shown in figure 6-9 that hold the flexure pivot assembly to the frame.
15. Remove the flexure pivot assembly (key 9).
16. Install the replacement flexure pivot assembly with the four screws (key 10). Do not tighten the screws.

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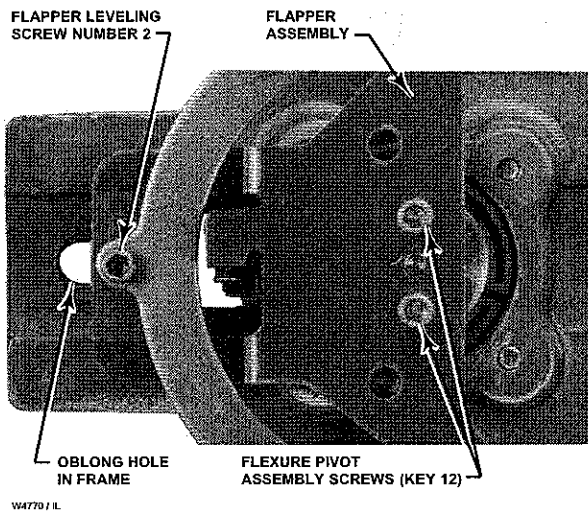


Figure 6-8. Leveling Screw Alignment

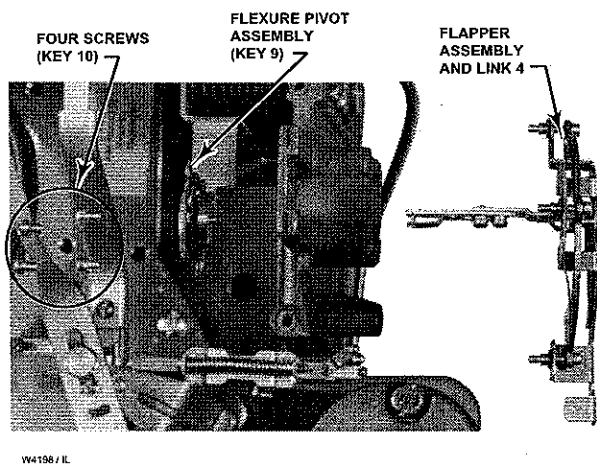


Figure 6-9. Exploded View of Flexure Pivot Assembly

17. With the controller in the upright position, slide the flexure pivot assembly down as far as possible, and tighten the four screws (key 10).

18. Place the flapper assembly (key 11) on the flexure pivot assembly (key 9) with link 4 through the hole in the frame.

19. Start the two cap screws (key 12) that hold the flapper assembly (key 11) to the flexure pivot assembly (key 9). Do not tighten the screws.

20. Align flapper leveling screw number 2 with the centerline of the oblong hole in the frame as shown in figure 6-8. Tighten the cap screws (key 12).

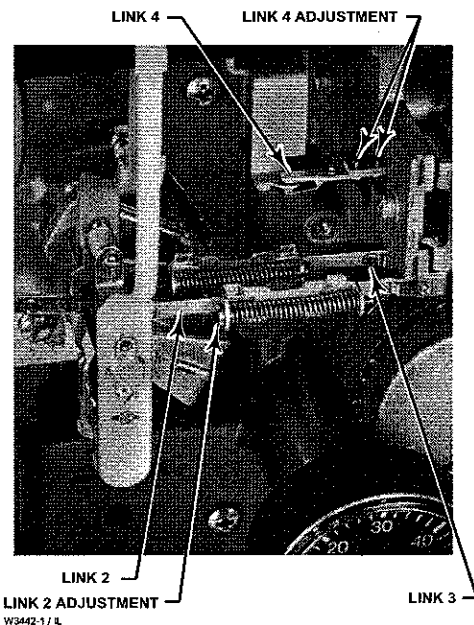


Figure 6-10. Link 2 and 4 Adjustment Locations

## Note

The following procedure (steps 21 through 23) adjusts link 2 to ensure that it will always be in tension to eliminate possible instability due to lost motion.

21. Note to which hole link 1 is connected and then disconnect link 1 from the temperature element, and manually position the process pointer to the process scale upper limit. Tape the pointer in this position.

22. Adjust the length of link 2 by turning the adjustment screw, shown in figure 6-10, clockwise to increase the length or counterclockwise to decrease the length, so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly, as shown in figure 6-11.

23. Connect link 2 to the flapper assembly.

24. Set the proportional band between DIRECT and REVERSE. Do this by aligning the tab on the proportional band adjustment knob with the hole in the set point beam assembly as shown in figure 6-4.

25. Position the proportional band adjustment knob, nozzle assembly, set point beam assembly, and nozzle tubing assembly on the frame, and screw the relay nozzle tubing assembly nut loosely onto the frame manifold (key 135).

26. Insert the machine screw, with plain washer (keys 19 and 20), through the frame and start it into the relay nozzle tubing assembly (key 18), but do not tighten.

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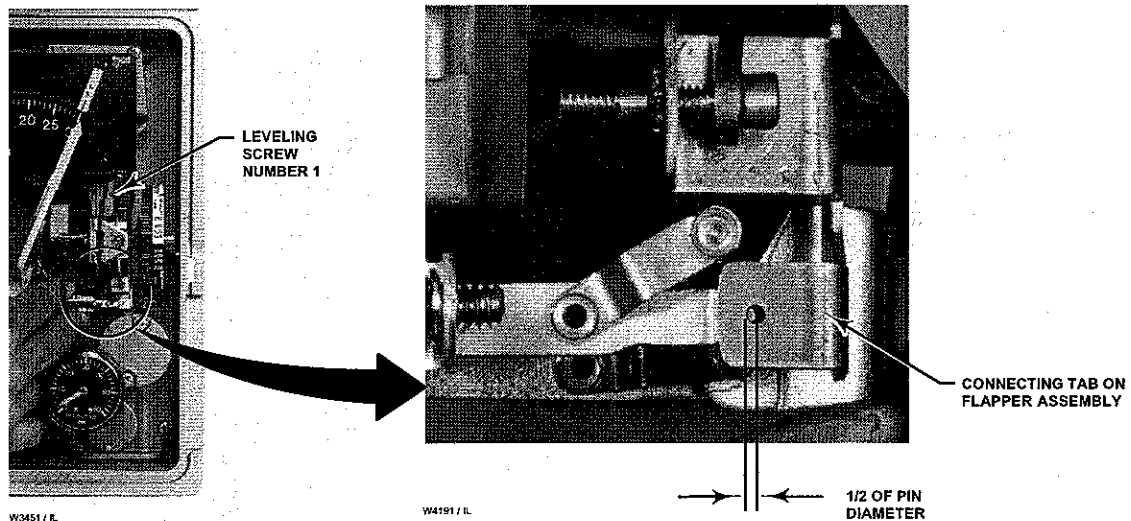


Figure 6-11. Link 2 Adjustment

27. Center the nozzle on the flapper as shown in figure 6-5, while squeezing the set point beam assembly firmly against the relay nozzle tubing assembly. With the nozzle centered on the flapper, tighten the machine screw (key 19). Ensure that the nozzle is still centered on the flapper.

28. Insert the pivot of the adjustable set point pivot assembly (key 17) into the hole in the set point beam assembly (key 23).

29. Insert the screw, with washer (keys 19 and 20), through the frame (key 3) and start it into the adjustable set point pivot assembly (key 17), but do not tighten.

30. Squeeze the adjustable set point pivot assembly against the set point beam assembly. Check to be sure the nozzle is still centered on the flapper and tighten the machine screw (key 19). If necessary, loosen both machine screws (key 19) to allow slightly moving the adjustable set point pivot assembly, set point beam assembly and the relay nozzle tubing assembly as a unit to center the nozzle on the flapper. After centering the nozzle, tighten the two machine screws

31. Turn the proportional band adjustment knob to 5 percent DIRECT. Refer to figure 6-6 to locate the locking nut on the adjustable set point pivot assembly. Loosen the locking nut and back out the set screw slightly so that the set point beam assembly falls under its own weight when pivoted upward. Also, maintain a minimum side play between the adjustable set point pivot assembly and the nozzle tubing assembly. Tighten the locking nut.

32. At the frame manifold (key 135), tighten the nut that secures the tubing from the relay nozzle tubing

assembly (key 18). Apply full supply pressure with the nozzle capped (to obtain maximum output pressure) and check for leaks. Remove supply pressure.

33. Install the set point beam bias spring (key 28) into the frame bore and onto the spring seat of the set point beam assembly as shown in figure 6-3.

34. Attach link 3 to the set point beam shoe as shown in figure 6-3.

### Note

**The following procedure (steps 35 through 41) adjusts link 4 so it will always be in compression to eliminate possible instability due to lost motion.**

35. For controllers with reset and rate adjustments (4196B or 4196C Series), remove the supply pressure; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.

The controller output must be 0 psig (0 bar). To be sure the controller output is at 0 psig (0 bar), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.

36. Apply the correct supply pressure (refer to table 1-3) to the controller, and provide an accurate means of measuring the controller output pressure.

37. Adjust the proportional band to 5 percent REVERSE, and adjust the set point to the process scale upper limit.

38. With link 1 disconnected, tape the process pointer at the process scale lower limit. The output pressure

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should be within 2 psig (0.14 bar) of the supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 2 psig (0.14 bar) of supply pressure.

39. Loosen the two adjusting screws on link 4, shown in figure 6-10, and connect the link to the bellows bracket (key 31), allowing the link to find its free length.

40. Tighten the two adjusting screws on link 4.

41. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, repeat steps 39 and 40.

42. Adjust the proportional band to 40 percent REVERSE or DIRECT depending on the desired controller action.

43. Adjust the set point to the process scale lower limit.

44. Tape the process pointer at the process scale lower limit. The output pressure may be anywhere between 3 and 15 psig (0.2 and 1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output signal range or between 6 and 30 psig (0.4 and 2.0 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output signal range. If the output is not within the specified range, adjust the flapper leveling screw nearest the nozzle until the output is within the range specified. Record the output pressure.

45. Adjust the set point to the process scale upper limit.

46. Remove the tape and move the process pointer until the controller output equals the pressure recorded in step 44. Note the process temperature indication.

47. The process temperature indication should be within  $\pm 2$  percent of the process scale upper limit.

If the process temperature indication (in step 47) is greater than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 6-3, and move the set point beam shoe (key 29) slightly away from the center of the flapper assembly.

If the process temperature indication (in step 47) is less than the process scale upper limit by 2 percent, loosen the shoe adjustment screws (key 30), shown in figure 6-3, and move the set point beam shoe (key 29) slightly toward the center of the flapper assembly.

48. Repeat steps 43 through 47 until the error is less than 2 percent of the process scale span at the process scale upper limit.

49. Remove the tape from the process pointer and reconnect link 1 to the temperature element. Be sure to reconnect link 1 in the same hole noted in step 21.

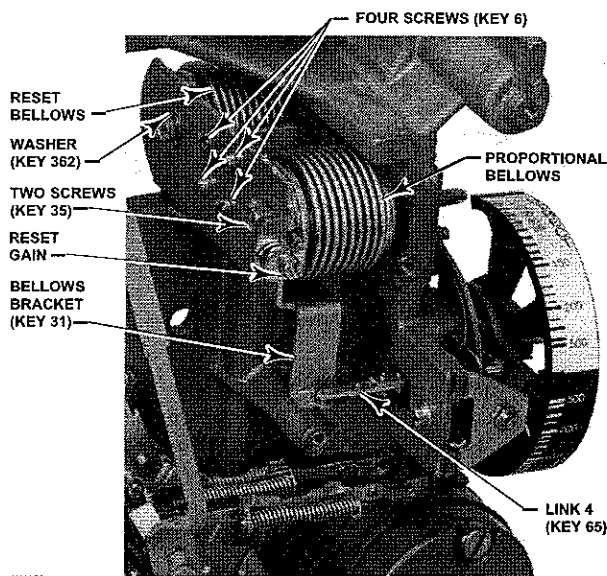


Figure 6-12. Bellows Assembly, Bellows Bracket, and Bellows Beam Location

50. Perform steps 6 through 9 of the case and cover replacement procedure.

51. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

52. Mount the controller as described in the Installation section.

53. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

### Replacing the Proportional or Reset Bellows

Refer to figure 6-12, unless otherwise noted.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.

2. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).

3. Disconnect link 4 (key 65) from the bellows bracket (key 31).

4. Remove the two machine screws (key 35) and washers (key 362) from the bellows assemblies.

5. Remove the four machine screws (key 6) from the bellows beam (key 49), and remove the bellows bracket (key 31).

6. Remove the proportional tubing assembly (key 40) from the proportional bellows, or remove the reset tubing assembly (key 43) from the reset bellows, depending on which bellows is to be replaced.

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7. Remove the four machine screws (key 71) from the bellows beam and remove the bellows beam from the frame.

## CAUTION

**When removing and replacing the proportional or reset bellows, keep in mind that the bellows has left-hand threads. Overtightening could damage the threads.**

8. Unscrew the bellows assembly (key 48). If the bellows assembly cannot be removed by hand, thread a machine screw (key 35) into the bellows until tight, then loosen the bellows assembly by applying clockwise torque to the machine screw.

9. Before installing the replacement bellows, coat the threads with a suitable lubricant, such as key 310 or equivalent. Screw in the replacement bellows until it is finger tight against the frame (key 3).

10. Reinstall the bellows beam (key 49) and tighten the four machine screws (key 71).

11. Position the bellows bracket (key 31) over the bellows. Insert a machine screw (key 35) through the bellows bracket (key 31) into the proportional bellows. Do not tighten.

12. Place the washer (key 362) on the second machine screw (key 35) and start the screw through the bellows bracket (key 31) into the reset bellows. Do not tighten.

13. Compress the bellows and start the four machine screws (key 6) through the bellows bracket (key 31) into the bellows beam (key 49), but do not tighten.

14. Be sure that the bellows bracket is aligned such that it does not rub on the frame at any point and tighten the screws (keys 6 and 35).

15. Install the proportional or reset tubing assembly on the bellows base.

16. For a 4196B or C Series controller, set the reset adjustment for 0.01 minutes per repeat. For a 4196C controller, set the rate adjustment to OFF.

17. Apply the correct supply pressure with the nozzle capped and check for leaks. Remove the supply pressure.

18. Reconnect link 4 (key 65) to the bellows bracket. Be sure that the link does not contact the frame. If it does, loosen the four screws (key 6) which attach the bellows bracket to the bellows beam, and reposition the bellows bracket to provide clearance. Be sure the bellows bracket does not rub the frame; then, tighten the screws.

19. Lift link 4 out of the hole in the bellows bracket (key 31) and ensure it drops back into the hole under its own weight. If not, perform steps 35 through 41 of the Flapper Assembly and Flapper Flexure Pivot Assembly replacement procedures.

20. If the controller is proportional only (4196A Series) go the step 34. If the controller has reset (4196B or C Series) continue with step 21.

## Note

**The following procedure (steps 21 through 33) adjusts the reset gain of the controller to minimize steady-state offset.**

21. Apply the correct supply pressure to the controller and provide an accurate means of measuring controller output pressure.

22. Adjust the proportional band to 100-percent DIRECT.

23. Adjust the set point to the mid-scale mark on the process scale.

24. Adjust the reset adjustment to 0.01 minute per repeat. For a 4196C Series controller, set the rate adjustment to OFF.

25. Note to which hole link 1 is connected and then disconnect link 1 from the temperature element.

26. Starting from the process scale lower limit, manually move the process pointer to the right until the output pressure stabilizes at 3 psig (0.2 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output or 6 psig (0.4 bar) for a 6 to 30 psig (0.4 to 2.0 bar) output. Record the process temperature indication.

## Note

**When the reset valve is at 0.01, the controller is very sensitive to any process pointer movement. Only a small amount of process pointer movement may be necessary.**

27. Very slowly move the process pointer until the output pressure stabilizes at 15 psig (1.0 bar) for a 3 to 15 psig (0.2 to 1.0 bar) output or 30 psig (2.0 bar) for a 6 to 30 psig (.04 to 2.0 bar) output. Record the process temperature indication.

28. If the difference between the recorded process temperature indications in step 26 and step 27 is larger than  $\pm 1$  percent of the process scale span, proceed with step 29. If the difference is less than  $\pm 1$  percent, go to step 34.

29. Loosen the proportional bellows screw (key 35).

30. If the indication recorded in step 27 is greater than in step 26, adjust the reset gain screw (key 34) one-

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half turn in (clockwise). If the indication recorded in step 27 is less than in step 26, adjust the reset gain screw (key 34) one-half turn out (counterclockwise).

31. Tighten the proportional bellows screw (key 35).
32. Repeat steps 26 through 31 until the difference is less than  $\pm 1$  percent of the process scale span.
33. If  $\pm 1$  percent of the process scale span cannot be achieved by adjusting the reset gain screw (key 34), loosen the screw (key 35) attaching the reset bellows and slide it to the left if the indication in step 27 is greater than in step 26, or to the right if the indication in step 27 is less than in step 26. Tighten the screw and repeat steps 26 through 32.
34. Remove the supply pressure and the output measurement device.
35. Reconnect link 1 to the temperature element. Be sure to connect link 1 in the same hole noted in step 25.
36. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
37. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.
38. Mount the controller as described in the Installation section.
39. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## **Replacing the Reset Restriction Valve (4196B Series)**

Refer to the 4196B Series portion of figure 6-20 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the reset valve tubing assembly (key 42) from the reset restriction valve (key 54).
3. Remove the reset tubing assembly (key 43) from the reset restriction valve.
4. For controllers with anti-reset windup (suffix letter F), remove the relief valve tubing assembly (key 44) from the reset restriction valve.
5. Remove the screw (key 162) that fastens the reset restriction valve to the frame.
6. Install the replacement reset restriction valve, and secure it with the screw removed in step 5.
7. Install the reset valve tubing assembly (key 42), the reset tubing assembly (key 43), and for controllers

with anti-reset windup, the relief tubing assembly (key 44). Tighten all connections.

8. Set the reset adjustment to 0.01 minutes per repeat.
9. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.
10. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
11. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.
12. Mount the controller as described in the Installation section.
13. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## **Replacing the Rate/Reset Valve Assembly (4196C Series)**

### **Note**

**Read this entire procedure before removing any parts. Refer to the 4196C Series portion of figure 6-20 for key number locations.**

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Remove the two machine screws (key 71) on the side of the rate/reset valve assembly (key 262).
3. Gently pull the rate tubing assembly away from the rate/reset assembly and remove the gasket (key 5) from the side of the rate/reset assembly.
4. Unscrew the nut holding the reset tubing assembly (key 43) into the rate/reset valve assembly.
5. Unscrew the nut holding the proportional tubing assembly (key 40) into the rate/reset valve assembly.
6. For controllers with anti-reset windup (suffix letter F), unscrew the nut holding the relief tubing assembly (key 44) into the rate/reset assembly.
7. While holding the rate/reset valve assembly, remove the machine screw (key 162) from the frame.
8. Remove the rate/reset valve assembly from the frame.
9. Inspect, and if necessary, replace the gasket (key 5).
10. To install the replacement rate/reset valve assembly, position the assembly on the frame (key 3) and secure it with the mounting screw (key 162).

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11. Position the gasket (key 5) on the rate/reset valve assembly. Hold the gasket in place while installing the rate tubing assembly (key 137) on the valve assembly using the two machine screws (key 71).

12. Insert the reset tubing assembly (key 43) into the rate/reset valve assembly and tighten the nut.

13. Insert the proportional tubing assembly (key 40) into the rate/reset valve assembly and tighten the nut.

14. For controllers with anti-reset windup (suffix letter F), insert the relief tubing assembly (key 44) into the rate/reset valve assembly and tighten the nut.

15. Set the reset to 0.01 minutes per repeat and the rate to OFF.

16. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks.

17. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.

18. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

19. Mount the controller as described in the Installation section.

20. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## **Replacing the Anti-Reset Windup (suffix letter F) Differential Relief Valve**

Refer to the 4196B or 4196C Series suffix letter F portion of figure 6-20 for key number locations.

1. Loosen the two screws in the differential relief valve (key 55) and remove the relief valve.

2. Inspect the O-rings on the replacement relief valve. Apply a suitable lubricant (key 318 or equivalent) to the O-rings.

3. Install the replacement relief valve into the controller frame, keeping in mind that:

◦ When the arrow points up, the valve relieves with decreasing output pressure.

◦ When the arrow points down, the valve relieves with increasing output pressure.

4. Tighten the two screws that hold the relief valve to the frame.

5. The relief valve differential pressure is factory-set at 5 psi (0.3 bar). Maximum differential pressure is 7 psi (0.5 bar); minimum differential pressure is 2 psi (0.1 bar). If a different differential pressure setting is

desired, refer to the anti-reset windup valve calibration procedure in section 4.

## **Replacing the Anti-Reset Windup (suffix letter F) Relief Valve Tubing Assembly**

Refer to the 4196B or 4196C Series suffix letter F portion of figure 6-20 for key number locations.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.

2. Loosen the nuts at both ends of the relief valve tubing (key 44), and remove the tubing.

3. Install the replacement relief valve tubing, and tighten the tubing nuts at both ends.

4. Apply the correct supply pressure to the controller, cap the nozzle and check for leaks. Remove the supply pressure.

5. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.

6. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

7. Mount the controller as described in the Installation section.

8. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

## **Replacing the Temperature Element**

1. Note in which hole link 1 (key 128) is connected and disconnect the link from the temperature element.

2. Remove the three screws (key 127) from the temperature element assembly.

3. Remove the two screws (key 129) at the bottom of the controller case.

4. Lift off the temperature element assembly and withdraw the capillary tube and temperature bulb through the opening in the bottom of the case.

5. Thread the bulb and capillary tube of the replacement assembly into the opening and out through the bottom of the case.

6. With the assembly in position, install and tighten the three screws (key 127).

7. Install the screws (key 129) at the bottom of the controller case.

8. Connect link 1 (key 128) to the temperature element takeoff assembly.

9. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.



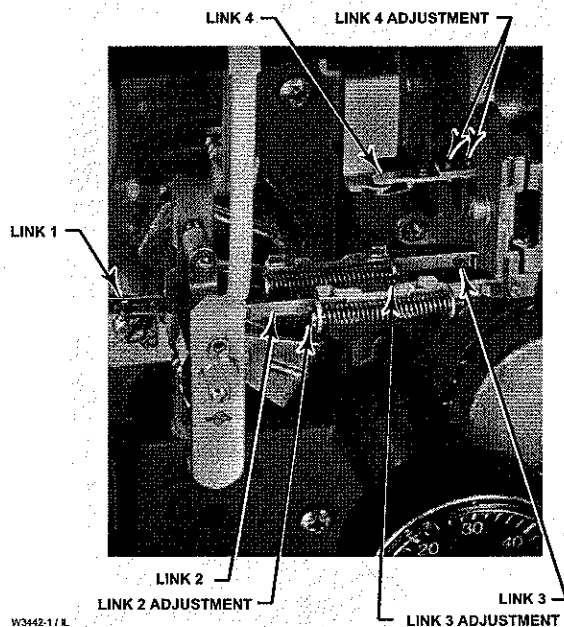


Figure 6-13. Link Locations

## Replacing the Links

This section describes the separate replacement of four links in the controller. Figure 6-13 shows the location of each link. To clarify the location of each link, the links are numbered as follows:

- Link 1 connects the temperature element assembly and the process pointer
- Link 2 connects the process pointer and the flapper assembly (key 11)
- Link 3 connects the set point indicator and the set point beam assembly (key 23)
- Link 4 (key 65) connects the flapper assembly and the bellows bracket (key 31).

### Replacing Link 1

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Note the hole position of link 1 in the temperature element assembly and the process pointer assembly. Disconnect the link from the temperature element assembly and from the process pointer. Remove the link.
3. Adjust the length of the replacement link to the same length as the link being replaced.

4. Attach the replacement link in the same holes noted in step 2 to the process pointer and temperature element assembly.

5. Move the set point indicator, manually or with remote set point pressure, to the mid-scale mark on the process scale, and set the proportional band between DIRECT and REVERSE.

6. The process pointer should be aligned with the pointer subassembly as shown in figure 6-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the process pointer and pointer subassembly. Tighten the zero adjustment locking screw.

7. Place the temperature bulb in the 50 percent bath. The process pointer should indicate  $50 \pm 3$  percent of the process scale span. If not, loosen the screws on link 1, move the pointer to 50 percent of process scale span, and tighten the screws.

8. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

### Replacing Link 2

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).

2. Disconnect link 2 from the process pointer and from the flapper assembly (key 11). Remove the link.

3. Install the replacement link with the screw head nearest the process pointer as shown in figure 6-13. Connect the link to the process pointer only.

4. The process pointer should be aligned with the pointer subassembly as shown in figure 6-14. If not, loosen the zero adjustment locking screw and adjust the process pointer zero adjustment to align the pointer with the process pointer subassembly. Tighten the zero adjustment locking screw.

5. Move the set point indicator, manually or with remote set point pressure, to the process scale lower limit, and set the proportional band to 5 percent REVERSE. The nozzle should not be touching the flapper. If it is, adjust flapper leveling screw 1 (the screw nearest the nozzle) until clearance is obtained.

6. Note the hole position and disconnect link 1 from the temperature element assembly. Manually position the process pointer to the process scale upper limit, and tape the process pointer in this position.

7. Adjust the length of link 2 (by turning the adjusting screw clockwise to increase the length or counterclockwise to decrease the length) so that the pin on the end of the link is approximately one-half of its diameter short of aligning with the hole in the flapper assembly as shown in figure 6-11. This adjustment provides the proper tension on the link to eliminate lost motion.

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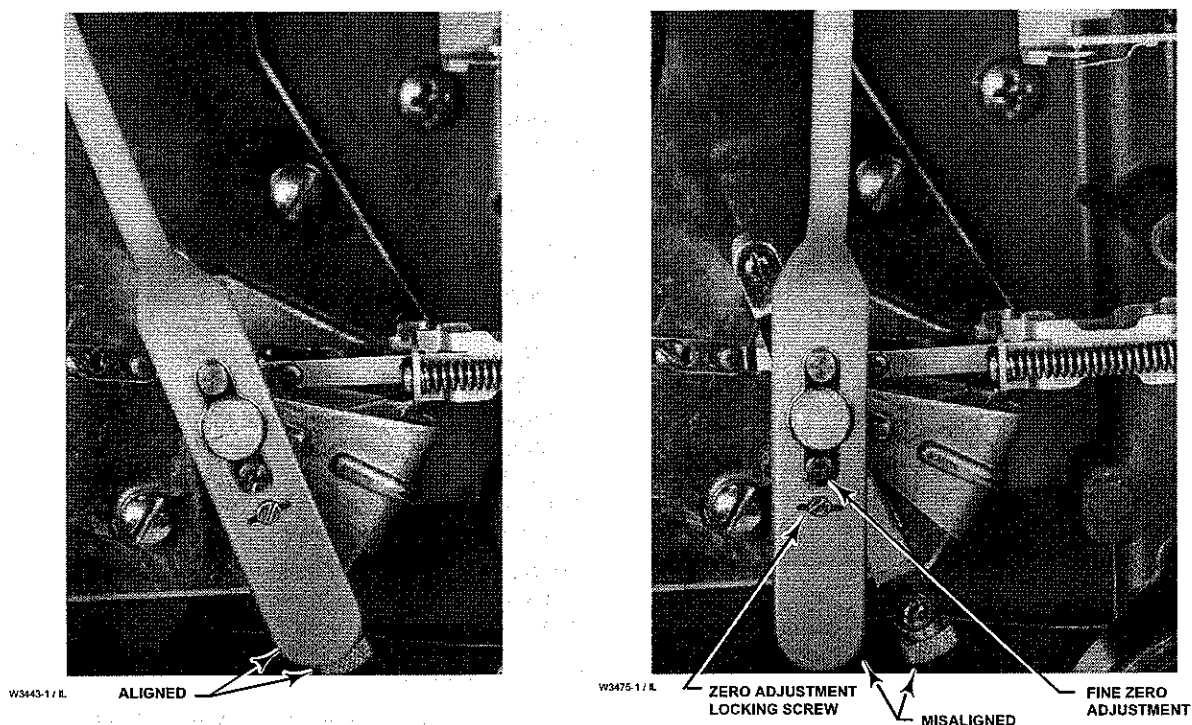


Figure 6-14. Process Pointer Alignment

8. Connect link 2 to the flapper assembly.
9. Remove the tape from the process pointer and reconnect link 1 to the hole in the temperature element assembly noted in step 6.
10. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

## Replacing Link 3

1. Remove the two screws (key 6), and lift off the proportional band indicator cover (key 36).
2. Disconnect link 3 from the set point indicator assembly and the set point beam assembly (key 23).
3. Adjust the replacement link to the same length as the link removed.
4. Install the replacement link with the screw head toward the set point beam assembly as shown in figure 6-13.
5. Check that the set point beam bias spring (key 28) is correctly located in the frame bore and the spring seat on the set point beam assembly as shown in figure 6-3.
6. Move the set point indicator to the mid-scale mark on the process scale.

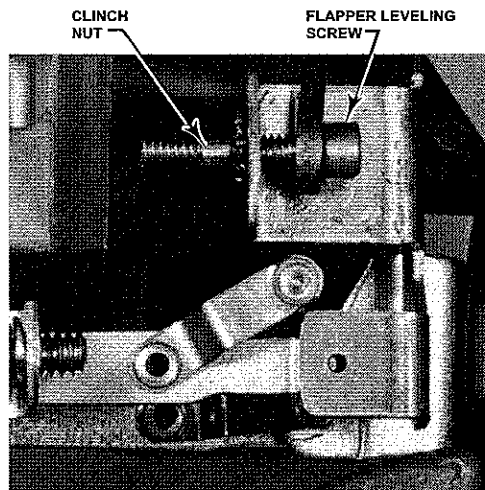
7. Disconnect link number 1 from the temperature element assembly and tape the process pointer at the mid-scale mark on the process scale.

8. Adjust the proportional band to 5 percent DIRECT. Turn flapper leveling screw 3 (the screw nearest the nozzle) until the nozzle just touches the flapper.
9. Adjust the proportional band to 5 percent REVERSE. Turn flapper leveling screw 1 (the screw nearest the nozzle) until the nozzle just touches the flapper.
10. Flapper leveling screws 1 and 3 should protrude the same distance from the clinch nuts (see figure 6-15).
11. If leveling screw 1 protrudes further than leveling screw 3, turn the link 3 adjusting screw counterclockwise. If leveling screw 3 protrudes further than leveling screw 1, turn the link 3 adjusting screw clockwise.
12. Repeat steps 8 through 11 until leveling screws 1 and 3 protrude an equal distance from the clinch nuts.
13. Remove the tape and reconnect link number 1 to the same hole in the temperature element assembly.
14. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

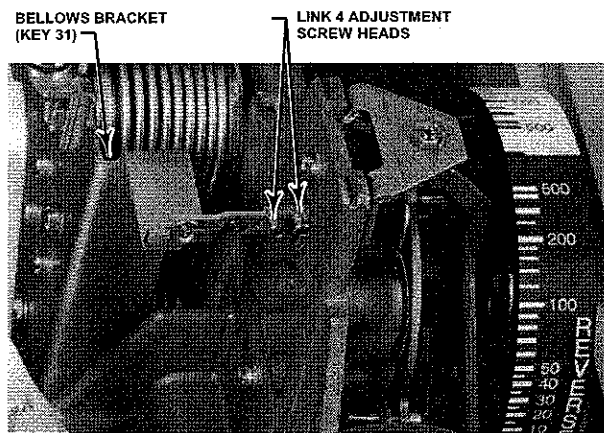
## Replacing Link 4

1. Remove the screws (key 6), and lift off the proportional band indicator cover (key 36).

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W4195-1/IL  
Figure 6-15. Flapper Leveling Screw and Clinch Nut



W4195/IL  
Figure 6-16. Position of Link 4 Adjustment Screws

2. Disconnect link 4 from the bellows bracket (key 31) and the flapper assembly (key 11).

3. Connect the replacement link to the flapper assembly so that the two adjusting screws on the link are nearest to the bellows bracket (key 31) and so that the screw heads are facing the bottom of the controller as shown in figure 6-16.

4. For controllers with reset (4196B Series) or reset and rate (4196C Series), turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position. Turn the rate adjustment (4196C Series) to the OFF position.

The controller output must be 0 psig (0 bar). To be sure the controller output is at 0 psig (0 bar), remove supply pressure, set the reset adjustment to 0.01 minutes per repeat and wait 30 seconds; then, turn the reset adjustment to the CLOSED (4196B) or OFF (4196C) position.

5. For controllers with reset (4196B Series) or reset and rate adjustments (4196C Series), disconnect the tubing that connects the reset bellows to either the reset restriction valve (key 54 or the rate/reset valve assembly (key 252). Make the disconnection at the valve.

6. Adjust the proportional band to 5 percent REVERSE and move the set point indicator to the process scale upper limit.

7. Disconnect link 1 from the temperature element assembly. Tape the process pointer to the process scale lower limit (the last mark on the left side of the scale).

8. Apply the correct supply pressure to the controller. The output of the controller should be within 2 psig (0.14 bar) of supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 2 psig (0.14 bar) of supply pressure.

9. Loosen the two adjusting screws on link 4. Connect the free end of the link to the bellows bracket and allow the link to find its free length.

10. Tighten the two adjusting screws on the link.

11. Raise link 4 out of the hole in the bellows bracket (key 31) and ensure that it drops back into the hole under its own weight. If not, repeat steps 9 and 10.

12. For a controller with reset (4196B or C Series), reconnect the reset tubing assembly (key 43) to the reset restriction valve or to the rate/reset valve.

13. For a controller with reset, adjust the reset adjustment to 0.01. The rate adjustment (4196C) should remain in the OFF position.

14. The controller output should be within 2 psig (0.14 bar) of the supply pressure. If not, adjust flapper leveling screw 1 (the screw nearest the nozzle) until the output is within 2 psig (0.14 bar) of supply pressure.

15. Check the reset tubing for leaks and tighten if necessary.

16. Remove the tape from the process pointer and connect link 1 to the temperature element assembly.

17. Perform the controller calibration procedures and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

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## Process Pointer Zero and Span Adjustment

### Note

**For routine zero and span calibration, refer to the appropriate procedures in section 3, 4, or 5. Use the following maintenance zero and span procedure only if difficulty is encountered with the routine procedure or if nonlinearity occurs.**

Provide a means of changing the process temperature to the controller and a means of measurement external to the controller. Also provide a regulated supply pressure adjusted to the normal operating pressure (see table 1-3). Plug the controller output or connect it to a gauge. Monitoring the controller output is not necessary. However, the flapper should not contact the nozzle at any time while performing this procedure. If it does, adjust flapper screw 2 (the screw nearest the nozzle) to provide clearance. Refer to figure 6-17 for adjustment locations. Refer to figure 6-20 for the key number locations.

### Note

**Any adjustment of the process pointer span adjustment screw requires readjustment of the process pointer zero adjustment screw. When checking the zero and span adjustments, ensure that the temperature element assembly does not contact the travel stops.**

1. Remove the two machine screws (key 6) and lift off the proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Adjust the reset valve (4196B and C Series only) to 0.01 minutes per repeat.
4. Adjust the rate valve (4196C Series only) to OFF.

### Note

**Temperature baths are required for the following steps. Please refer to the appropriate section of this manual for more information on temperature baths.**

5. Immerse the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.
6. The takeoff assembly should be vertical. If not, loosen the temperature element adjusting screw and

reposition the assembly so it is vertical. Tighten the adjusting screw.

7. The process pointer should be aligned with the pointer subassembly as shown in figure 6-14. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw to align the process pointer with the pointer subassembly. Tighten the zero adjustment locking screw.

8. The process pointer should indicate  $50 \pm 3$  percent of the process scale span. If not, loosen the screws on link 1 and adjust the length so that the process pointer indicates 50 percent of scale span. Tighten the two screws.

9. Immerse the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

10. Check for 0.03 to 0.04 inch (0.80 to 1.0 mm) clearance between the temperature element takeoff assembly and the travel stop located farthest from the process pointer. If the clearance is incorrect, loosen the travel stop locking nut and readjust the travel stop. Retighten the locking nut.

11. The process pointer should indicate the process scale lower limit. If not, loosen the zero adjustment locking screw and adjust the zero adjustment screw until the process pointer indicates the lower limit. Tighten the zero adjustment locking screw.

12. Place the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

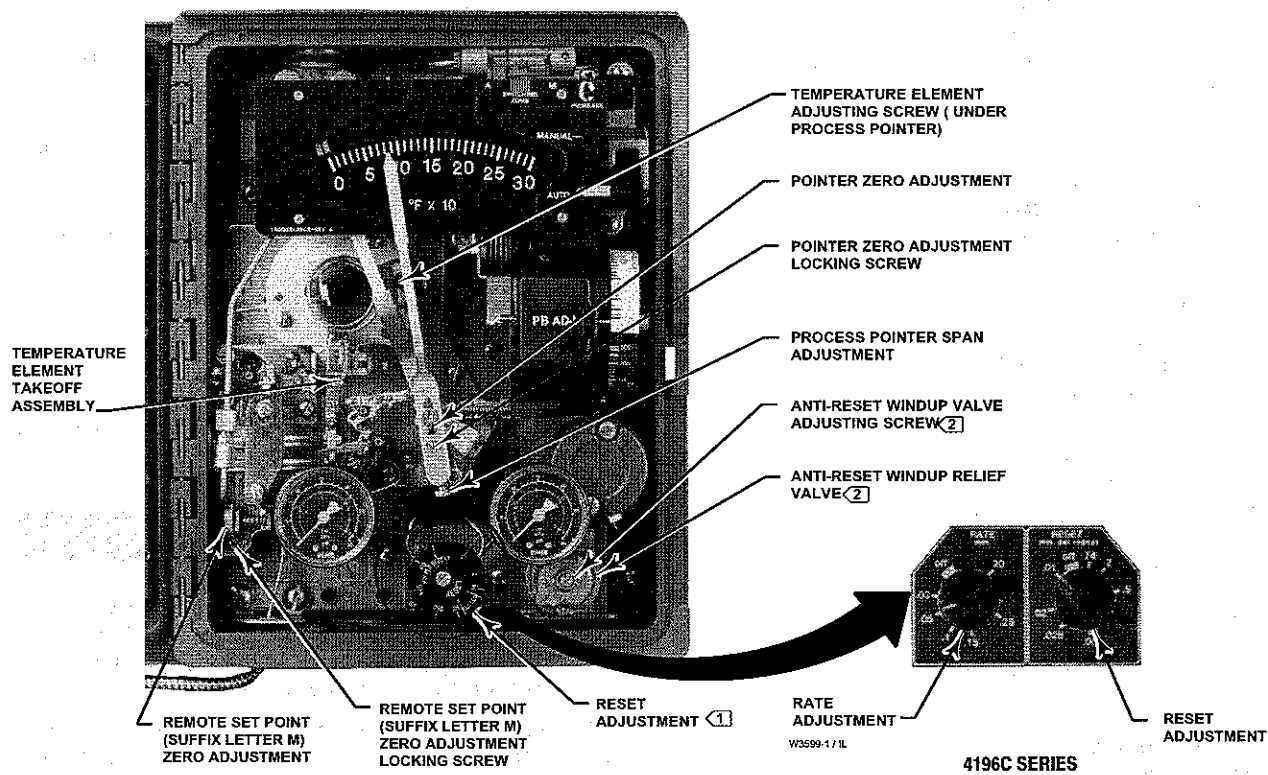
13. Check for 0.03 to 0.04 inch (0.80 to 1.0 mm) clearance between the temperature element takeoff assembly and the travel stop located nearest the process pointer. If the clearance is incorrect, loosen the travel stop locking nut and readjust the travel stop. Retighten the locking nut.

14. The process pointer should indicate the process scale upper limit. If not, proceed as follows:

- a. If the pointer indication is less than the process scale upper limit, rotate the pointer span adjustment clockwise to increase the span. Adjust the span adjustment screw to correct for one-half of the error.
- b. If the pointer indication is greater than the process scale upper limit, rotate the pointer span adjustment counterclockwise to decrease the span. Adjust the span adjustment screw to correct for one-half of the error.

15. Repeat steps 9 through 14 until the zero and span indications are within  $\pm 1$  percent of the scale limits with no further adjustment. If the span adjustment screw is adjusted to its limit and the span is still too short or too long, proceed with step 16. If proper span is achieved, proceed to step 17.

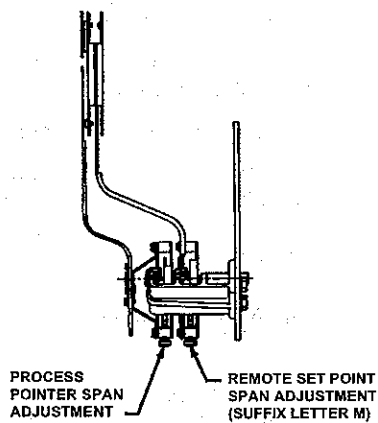
# 4196A, B, C, and S Series



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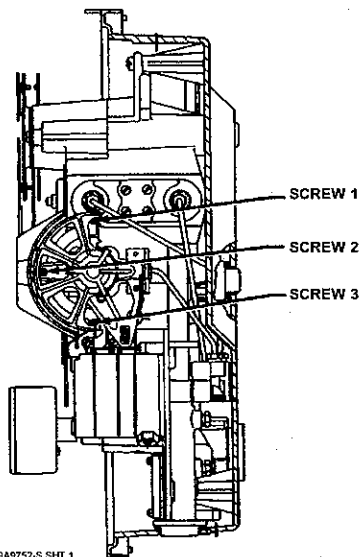
**FRONT VIEW, 4196B SERIES**

NOTES:  
 (1) AVAILABLE ON 4196B SERIES ONLY  
 (2) AVAILABLE ON 4196B AND C SERIES SUFFIX LETTER F ONLY



**SIDE VIEW OF SET POINT/PROCESS INDICATOR ASSEMBLY**

39A1126-B  
A67311 / K



**SIDE VIEW OF CONTROLLER SHOWING FLAPPER LEVELING SCREWS**

59A9752-S SHT 1

Figure 6-17. 4196 Controller Calibration Adjustment Locations

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16. At either end of link 1 there are three holes in which the link may be connected. A coarse span adjustment can be made by moving both ends of link 1 up or down.

a. If the span is short (process pointer indication is less than the process scale upper limit), disconnect both ends of link 1, move the link down one set of holes, and return to step 5.

b. If the span is long (process pointer indication is greater than the process scale upper limit), disconnect both ends of link 1, move the link up one set of holes, and return to step 5.

17. Immerse the temperature bulb in the 50 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

18. If the process pointer indicates  $50 \pm 1$  percent of process scale span, tighten the zero adjustment locking screw and proceed to the appropriate flapper alignment procedure. If the error is greater the  $\pm 1$  percent but less than  $\pm 2$  percent, correct for half of the error with the zero adjustment screw.

19. Immerse the temperature bulb in the 0 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

20. The process pointer should indicate the process scale lower limit  $\pm 1$  percent of scale span.

21. Immerse the temperature bulb in the 100 percent bath. Allow a minimum of 5 minutes for the controller to stabilize.

22. The process pointer should indicate the process scale upper limit  $\pm 1$  percent of process scale range.

23. If the error is greater than  $\pm 1$  percent, repeat steps 9 through 22.

24. Perform the flapper alignment procedure and, if necessary, the appropriate remote set point calibration procedure in section 3, 4, or 5.

## Remote Set Point (suffix letter M) Maintenance

### Replacing the Remote Set Point Assembly

Use the following procedures to replace the remote set point assembly. Figure 6-18 shows the parts locations. Refer to figure 6-24 for key number locations.

#### Note

**Remove the supply pressure gauge before attempting to remove the remote set point assembly.**

1. Decrease the remote set point pressure to 0 psig.
2. Remove the supply pressure gauge.
3. Disconnect the union (key 93) from the pedestal assembly (key 105).
4. Disconnect link B (key 126) from the connecting hole on the set point indicator.
5. Remove the three mounting screws (keys 120 and 140) that attach the remote set point assembly to the process/set point indicator assembly. Figure 6-18 shows the mounting screw locations.



#### CAUTION

**In the following step, do not lift out the remote set point assembly by holding the capsular element or linkages. These parts may be damaged.**

6. Lift out the remote set point assembly by holding the tie bar (key 106, mounting plate (key 111), travel stop (key 83), or pedestal assembly (key 105).
7. Align the replacement assembly with the mounting screw holes. Replace the mounting screws.
8. Reconnect the remote set point pressure connection union (key 93). Apply full remote set point pressure, and check for leaks.
9. Connect link B (key 126) to the connecting hole on the set point indicator.
10. Replace the supply pressure gauge.
11. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedure in section 3, 4, or 5.

### Replacing Remote Set Point Assembly Parts

Figure 6-18 shows the parts and adjustment locations. Refer to figure 6-24 for key number locations.

#### Replacing Pivot Assembly A (Key 114)

1. Decrease the remote set point pressure to 0 psig.
2. Remove the two screws (key 103) and the tie bar (key 106).
3. Note where link A is connected. Disconnect link A (key 116) from the lever arm on pivot assembly A (key 114).

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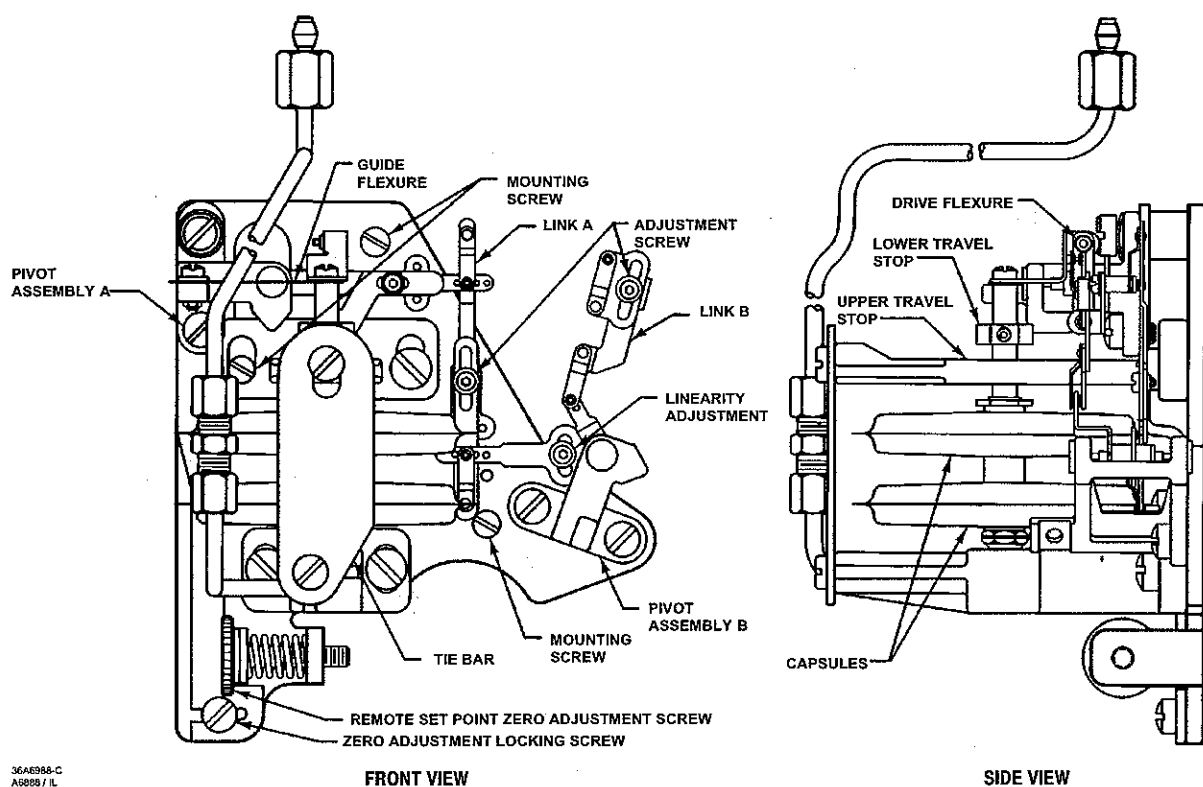


Figure 6-18. Remote Set Point (suffix letter M) Parts and Adjustment Locations

4. Disconnect the drive flexure (key 79) from the adjustment arm of pivot assembly A. Be careful not to bend or kink the drive flexure.
5. Remove the screw (key 122), washer (key 123) and nut (key 124) that attach the guide flexure (key 119) to the top of the pivot assembly.
6. Remove the pivot screw and spring washer (keys 109 and 112) and the mounting screw (key 102) attaching the pivot assembly to the mounting plate (key 111). Lift out pivot assembly A.
7. Loosen the adjustment screw (key 118) on the adjustment arm of the replacement pivot assembly and set the arm to the same length as the arm on the pivot assembly being replaced. Tighten the screw.
8. To replace the pivot assembly, first put the spring washer (key 112) on the screw (key 109). Then, insert the screw through the replacement pivot assembly and into the mounting plate and tighten. Install the mounting screw (key 102) and tighten.
9. Connect the guide flexure (key 119) to the top of the replacement pivot assembly with the screw (key 122), washer (key 123), and nut (key 124) as it was before. The guide flexure should be straight and horizontal as shown in figure 6-18. If not, loosen the screws (key 122) and retighten to eliminate any bowing. Loosen the screws (key 139) and raise or lower

the pedestal assembly (key 105) to get the link horizontal. Retighten the screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.

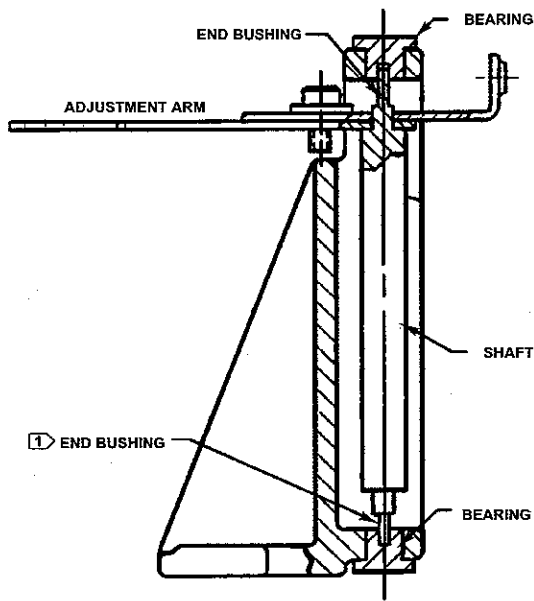
10. Apply remote set point pressure equal to 50 percent of the remote set point input range.

## Note

See figure 6-19. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.

11. Connect the drive flexure (key 79) to the arm on the replacement pivot assembly, making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the flexure is vertical. Before tightening the drive flexure screws, hold the pivot assembly shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold pivot assembly A in this position. Do not bend or twist the flexure when tightening the screws.
12. Decrease the remote set point pressure to 0 psig.

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NOTES:  
 ① BEFORE TIGHTENING THE DRIVE FLEXURE MOUNTING SCREWS, POSITION THE SHAFT SO THE END BUSHINGS "FLOAT" IN THE BEARINGS.  
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Figure 6-19. Cutaway of Long Pivot Clevis Assembly

13. Connect the end of link A (key 116) to the pivot lever arm in the same holes noted in step 3.
14. Replace the tie bar (key 106).
15. Perform the remote set point maintenance calibration procedures. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in section 3, 4, or 5.

## Replacing Pivot Assembly B (Key 115)

1. Decrease the remote set point pressure to 0 psig.
2. Note the holes where links A and B are connected. Disconnect links A and B (keys 116 and 126) from the arms of pivot assembly B (key 115).
3. Remove the two screws (key 102) that attach pivot assembly B to the mounting plate (key 111). Remove the pivot assembly.
4. Loosen the linearity adjustment screw on the replacement pivot assembly, and set it in the same position as the adjustment on the original pivot assembly. Tighten the screw.
5. Set the replacement pivot assembly on the mounting plate, and attach it with the two machine screws.
6. Attach links A and B (keys 116 and 126) to the arms of the replacement pivot assembly in the same holes noted in step 2

7. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in section 3, 4, or 5.

## Replacing the Drive Flexure

1. Using an Allen wrench, remove the cap screws (key 12) and washers (key 13) to disconnect the drive flexure (key 79) from the drive bracket (key 121) and from the adjustment arm of pivot assembly A. Remove the drive flexure.
2. Set the remote set point pressure to 50 percent of the remote set point input range.

### Note

See figure 6-19. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.

3. Connect the new drive flexure making sure it stays straight and vertical. Adjust the length of the pivot arm, if necessary, until the drive flexure is straight. Before tightening the drive flexure screws, hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing. Tighten the drive flexure screws to hold the pivot shaft in that position. Do not bend or twist the flexure when tightening the screws.
4. Decrease the remote set point pressure to 0 psig.
5. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in section 3, 4, or 5.

## Replacing the Remote Set Point Tubing

1. Decrease the remote set point pressure to 0 psig.
2. Using two, 5/16-inch open-end wrenches, disconnect the pressure connection union (key 93) from the pedestal assembly (key 105) and the connection to the case exterior at the top of the case.
3. Remove the tubing (key 104).
4. Install the replacement tubing, and reconnect the two pressure connections.
5. Apply full remote set point pressure, and check for leaks.

## Replacing Link A

This procedure describes link A (key 116) replacement in the input portion of the remote set point assembly. Figure 6-18 shows the link location.



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1. Note the holes where link A is connected. Disconnect link A (key 116) from the lever arms on pivot assembly A and pivot assembly B.
2. Loosen the screw in the replacement link A and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 6-18 for the correct link orientation. Attach the replacement link A to the two lever arms in the same holes noted in step 1.
4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in section 3, 4, or 5.

## Replacing Link B

This procedure describes the link B (key 126) replacement of the remote set point assembly. Figure 6-18 shows the link location.

1. Note the holes where link B is connected. Disconnect link B (key 126) from the pivot arm and from the set point indicator.
2. Loosen the screw in the replacement link B and adjust the length to match the link being replaced. Tighten the screw.
3. Refer to figure 6-18 for the correct orientation of link B. Attach replacement link B to the pivot arm and to the set point indicator in the same position as noted in step 1.
4. Perform the remote set point maintenance calibration procedure. Perform the appropriate process indicator zero and span calibration and flapper alignment procedures in section 3, 4, or 5.

## Remote Set Point (suffix letter M) Maintenance Calibration

Refer to figure 6-18 for parts and adjustment locations. Refer to figure 6-24 for key number locations.

### Precalibration Procedures

1. Remove the two screws (key 6) and lift off proportional band indicator cover (key 36).
2. Set the proportional band between DIRECT and REVERSE.
3. Remove the two screws (key 103) and remove the tie bar (key 106) from the remote set point assembly.

### Aligning the Flexures

1. Apply remote set point pressure input equal to 50 percent of the remote set point input range.
2. The guide flexure (key 119) should be straight and horizontal. If not, straighten the flexure by loosening

the machine screw (key 122) on the end of the flexure that is attached to the top of pivot assembly A (key 114), and allow the flexure to straighten itself. Tighten the machine screw.

3. If the flexure is not horizontal, loosen the two machine screws (key 139) and raise or lower the pedestal assembly (key 105) until the guide flexure is horizontal. Retighten the machine screws (key 139) and ensure the diaphragm assembly extension (key 134) is centered in the upper travel stop (key 83) hole.

4. The drive flexure (key 79) should be straight. If not, proceed as follows:

- a. Loosen the screw (key 118) on the adjustment arm of pivot assembly A (key 114) and loosen the screws holding the drive flexure.
- b. Set the length of the adjustment arm so that the drive flexure is parallel to the centerline of the diaphragm capsule assembly (key 80).
- c. Tighten the screw (key 118) on the adjustment arm.

### Note

**See figure 6-19. The adjustment arm of the remote set point pivot assembly A turns on a bushing at each end of the shaft supporting the adjustment arm. In the next step, position the shaft so both bushings "float" inside the bearings and do not rest against the end of either bearing.**

- d. Hold the pivot assembly A shaft in the middle of the bushing end play. Be sure neither bushing is resting against the inside end of either bearing.
- e. Tighten the screws that hold the drive flexure in place.

### Setting the Travel Stops

1. Loosen the set screw (key 87) in the travel stop nut (key 86).

### Note

**Make sure the loose travel stop nut does not bind on the diaphragm capsule extension (key 134) when pressurizing the capsules (key 80). Damage to the capsules may result.**

2. **Full span stop**—Adjust the remote set point pressure to 2-1/2 percent of span greater than the remote set point input range upper limit.

Loosen the two screws (keys 139 and 140) that secure the travel stop (key 83) to the mounting plate (key

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111). Slide the travel stop until it is just touching the end of the capsule stack. Tighten the travel stop mounting screws to lock it into position.

3. **Zero stop**—Adjust the remote set point pressure input to 2-1/2 percent of span less than the remote set point input range lower limit.

Slide the travel stop nut (key 86) along the diaphragm capsule extension (key 134) until it is just touching the travel stop (key 83). Tighten the set screw (key 87) to lock the travel stop nut in position.

## Aligning the Linkage

1. Adjust the remote set point pressure to 50 percent of the remote set point input range.

2. Set the linearity adjustment screw in the center of the slot on the lever arm of pivot clevis assembly B (key 115). See figure 6-18 for the linearity adjustment location.

3. Set the length of link A (key 116) so the lever arms of pivot assembly A and pivot assembly B are parallel and link A is perpendicular to them.

4. Set the length of link B (key 126) so the set point indicator indicates mid-scale on the process scale span.

5. Replace the tie bar (key 106) and install the two screws (key 103).

## Remote Set Point Zero and Span Adjustment

### Note

**For routine remote set point zero and span calibration, refer to the appropriate procedures in section 3, 4, or 5. Use the following maintenance remote set point zero and span adjustment procedure only if difficulty is encountered with the routine procedures or if nonlinearity occurs.**

Refer to figures 6-17 and 6-18 for adjustment locations.

1. Decrease remote set point pressure to 0 percent of remote set point input range.

2. The set point indicator should indicate the lower limit of the process scale span. If not, loosen the adjustment screw on link A (key 116), and adjust the length so that the set point indicator points to the lower limit of the process scale. Tighten the screw.

3. Make fine zero adjustments by loosening the zero adjustment locking screw (key 102) and turning the

zero adjustment screw (key 108). Tighten the locking screw. Refer to figure 6-18 for the screw locations.

4. Apply a remote set point pressure equal to 100 percent of the remote set point input range.

5. The set point indicator should indicate the upper limit of the process scale span.

6. To increase the span, proceed as follows:

a. Turn the remote set point span adjustment screw clockwise.

b. To increase the span further than the adjustment screw allows, move both ends of link A (key 116) to the right.

c. Make fine adjustments with the remote set point span adjustment screw.

7. To decrease the span, proceed as follows:

a. Turn the remote set point span adjustment screw counterclockwise.

b. To decrease the span further than the adjustment screw allows, move both ends of link A (key 116) to the left.

c. Make fine adjustments with the remote set point span adjustment screw.

8. Repeat the adjustments until the upper and lower indications are aligned with the upper and lower limits on the process scale.

9. Adjust the remote set point pressure for 50 percent of the remote set point input range.

10. The set point indicator should indicate mid-scale  $\pm 2$  percent of the process scale span. If the error is within  $\pm 2$  percent, proceed to step 11. If the error is greater than  $\pm 2$  percent of the scale span, proceed to the remote set point linearity adjustment procedure.

11. Adjust the set point indicator to  $50 \pm 1$  percent of the process scale span by loosening the zero adjustment locking screw and turning the zero adjustment screw. Tighten the locking screw.

12. Adjust the remote set point pressure to the upper and lower limits of the the remote set point input range and make sure the set point indicator is still within  $\pm 1$  percent at the lower and upper limits of the process scale.

13. Perform the appropriate flapper alignment procedure and, if necessary, the process indicator zero and span calibration procedure in section 3, 4, or 5.

## Remote Set Point Linearity Adjustment

Adjust the linearity by loosening and repositioning the linearity adjustment screw in the curved slot on the

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lever arm of pivot assembly B (key 115). Adjusting the linearity affects the zero and span adjustment.

1. Adjust the remote set point pressure to 50 percent of the remote set point input range. The set point indicator should indicate  $50 \pm 1$  percent, of the process scale span. If not, make fine adjustments by loosening the zero adjustment locking screw and turning the zero adjustment screw.
2. Adjust the remote set point pressure to 0 percent of the remote set point input range and note the indicator position relative to the process scale lower limit.
3. Adjust the remote set point pressure to 100 percent of the remote set point input range and note the indicator position relative to the process scale upper limit.
4. If the greatest misalignment is positive (the set point indicator is to the right of the process scale limits), loosen the linearity screw and move it clockwise in the slot. If the misalignment is negative, move the linearity screw counterclockwise in the slot.
5. If misalignment is greater than 1 percent of the process scale span at the lower and upper limits, with one positive and the other negative, perform the remote set point zero and span adjustment procedure to correct a span error.
6. Repeat steps 1 through 4 until lower, middle, and upper indications are within  $\pm 1$  percent of the process scale markings.

## Auto/Manual Station (suffix letter E) Maintenance

### Replacing the Auto/Manual Station

Refer to figure 6-20 and 6-25 for key number locations.

#### Note

**This procedure also permits replacement of the switch manifold O-rings (key 312), the auto/manual tubing assembly (key 138), and the frame gaskets (keys 4 and 5).**

#### Disassembly

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.
2. Loosen the screw (key 316) that holds the auto/manual station (key 273) to the controller frame.
3. Loosen the two screws (keys 314 and 315) that hold the auto/manual station to the auto/manual tubing assembly (key 138).

4. Remove the auto/manual station from the controller frame.
5. Remove the switch manifold O-rings (key 312).
6. Carefully loosen the nut on the relay nozzle tubing assembly (key 18) where it connects to the auto/manual tubing assembly (key 138). Loosen three screws (keys 34 and 131), and remove the tubing assembly and frame gaskets (keys 4 and 5).
7. Inspect the gaskets (keys 4 and 5) and O-rings (key 312) for wear. Replace if necessary.

#### Assembly

8. Install the gaskets and the tubing assembly to the frame. Start, but do not tighten, the three screws (keys 34 and 131) and the nut on the nozzle tubing assembly (key 18).
9. Install the switch manifold O-rings (key 312), and secure the auto/manual station to the controller frame with the screw (key 316) and to the tubing assembly (key 138) with two screws (keys 314 and 315). Do not tighten any screws.



#### CAUTION

**In the next step, take care to tighten the two screws (keys 314 and 315) evenly. Uneven tightening could damage the tubing assembly.**

10. Position the auto/manual station as far down on the frame and toward the scale as possible. Carefully tighten the two screws (keys 314 and 315) so that the auto/manual station contacts the three pads on the tubing assembly.
11. Carefully tighten the remaining screws and nuts.
12. Plug the controller output connection and apply supply pressure to the controller. Check for leaks.
13. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.
14. Perform the appropriate calibration procedure in section 3, 4, or 5.

### Replacing the Switch Body Assembly, Lever O-Ring, Switch Body O-Ring, and the Tubing Assembly

Refer to figure 6-25 for key number locations.

#### Disassembly

1. Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station procedure.
2. Loosen the two screws (key 288), and remove the lever cover plate (key 305).

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## CAUTION

The lever spring (key 302) is under preload. Take care not to lose any parts during disassembly.

- Using a 1/16-inch (1.5 mm) punch, push the groove pin (key 303) out toward the surface of the lever cover plate.
- Remove the switch lever (key 304), lever spring (key 302), and lever spring seat (key 301).
- Remove the tubing assembly (key 309).

## CAUTION

The switch body springs (key 295) are under preload. Take care not to lose any parts when separating the switch body assembly from the loader assembly.

- Loosen the two screws (key 290), and separate the switch body assembly (key 291) from the loader assembly (key 282).
- Remove the O-rings (keys 292, 293, and 294), switch body springs (key 295), and balls (key 296).
- Loosen two screws (key 308), and remove the closing plate (key 307) and the closing plate gasket (key 306).
- Pull the clip (key 300) from its engagement with the shaft of the lever assembly (key 297).
- Pull the lever assembly from the switch body assembly (key 291) and rocker (key 299).
- Remove the O-ring (key 298).
- Inspect the O-ring and gaskets for damage or wear; replace if necessary.

### Assembly

- Insert the lever assembly (key 297) into the switch body assembly (key 291), and hold the rocker (key 299) with the flats on the lever assembly shaft.
- Insert the clip (key 300) in the groove of the lever assembly shaft to hold the lever assembly (key 297) in the switch body assembly (key 291).
- Position the closing plate gasket (key 306) and the closing plate (key 307). Secure with two screws (key 308).

### Note

After assembly in step 15, be sure the side of the closing plate marked **OUT** is visible.

- Place the balls (key 296), switch body springs (key 295), and O-rings (keys 292, 293, and 294) in the switch body assembly (key 291).

### Note

In the following step, the ends of the springs must be in the counterbored spring seats before compression.

- Compress the switch body springs with the loader assembly (key 282), and bolt the switch body assembly (key 291) to the loader assembly using the two screws (key 290).
- Reconnect the tubing assembly (key 309).
- Locate the lever spring (key 302) and the spring seat (key 301) on the switch lever (key 304), and position these parts in the opening of the loader assembly (key 282).
- Push the switch lever down, using the lever spring seat (key 301) and the lever assembly (key 297) to preload the spring. Make sure the notch of the switch lever engages the pin of the lever assembly.
- Drive in the groove pin (key 303) to hold the switch lever.
- Replace the lever cover plate (key 305), and attach with two screws (key 288).
- Install the auto/manual station on the controller as described in steps 10 through 14 of the Replacing the Auto/Manual Station procedure.

## **Replacing the Loader Range Spring, Diaphragm Assembly, Ball Seat, Tubing, and Ball**

Refer to figure 6-25 for key number location.

### Disassembly

- Remove the auto/manual station from the controller as described in steps 1 through 4 of the Replacing the Auto/Manual Station procedure.
- Remove the tubing assembly (key 309).

## WARNING

To avoid personal injury caused by preload from the range spring (key 283), turn the loader knob (key 287) counterclockwise (opposite to the arrow) to relieve pressure on the spring.

- Loosen the four screws (key 289), and separate the upper loader assembly (key 282) and the lower loader assembly (key 274).

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4. Remove the loader range spring (key 283), range spring cup (key 284), and diaphragm assembly (key 281).

5. Remove the tube (key 278), ball seats (key 280) and ball (key 279).

## Assembly

6. Turn the loader knob (key 287) counterclockwise to back the spring adjustment screw (key 285) all the way out to eliminate loading the range spring.

7. Position the range spring cup (key 284), the range spring (key 283), and the diaphragm assembly (key 281) on the upper loader assembly (key 282).

8. Position the ball (key 279), the tube (key 278), and the ball seats (key 280) between the ears of the loader assemblies (keys 282 and 274); position the diaphragm assembly (key 281) between the main halves of the loader assemblies.

## Note

**The tube (key 278) must be well seated in the cups of the ball seats (key 280).**

9. Bolt the loader assembly halves together using the four screws (key 289).



## CAUTION

**Be sure that the supply and exhaust seats of the loader are correctly aligned. Misalignment will impair loader performance.**

10. Attach the tubing assembly (key 309).

11. Perform the assembly procedure in the replacing the auto/manual station procedure.

## Replacing the Loader Valve Plug and Valve Plug Spring

Refer to figure 6-25 for key number location.

1. Remove the controller assembly from the case by performing steps 1 through 5 of the case and cover replacement procedures.

2. Loosen the spring seat screw (key 275).

3. Remove the valve plug spring (key 276) and the valve plug (key 277).

4. Inspect the parts, and replace as necessary.

5. Install the valve plug spring and valve plug.

6. Tighten the spring seat screw.

7. Temporarily plug the controller output connection, apply supply pressure, and check for leaks.

8. Install the controller into the case by performing steps 6 through 9 of the case and cover replacement procedure.

9. Mount the controller as described in the Installation section.

10. Connect the external piping to the controller, and install the temperature bulb in the process fluid.

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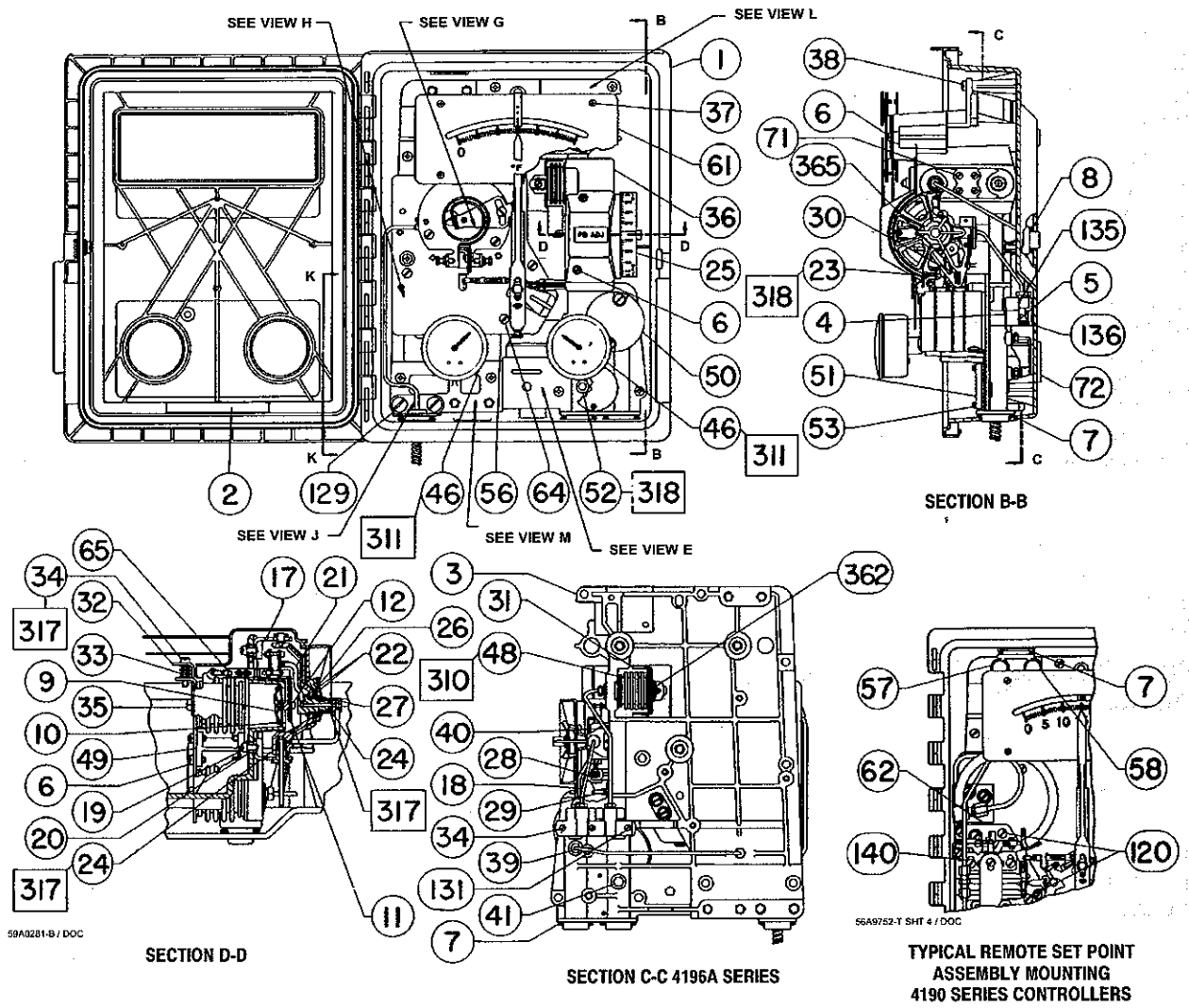
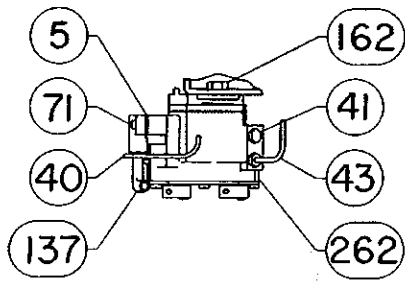
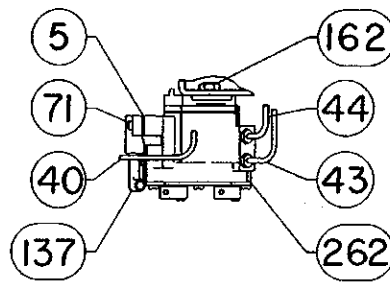


Figure 6-20. Controller Assembly Drawings

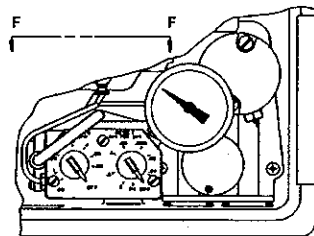
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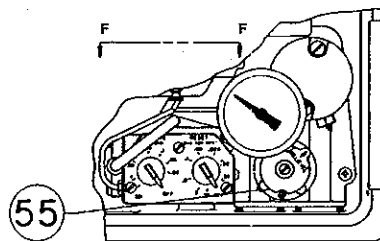
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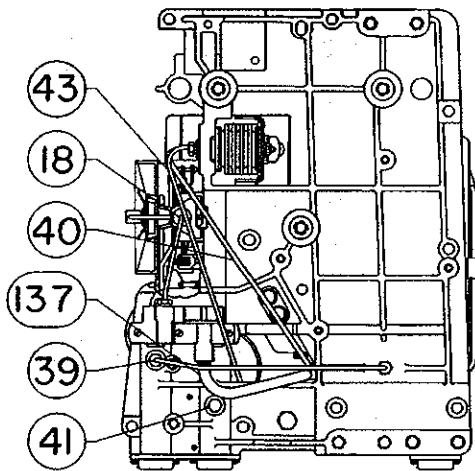
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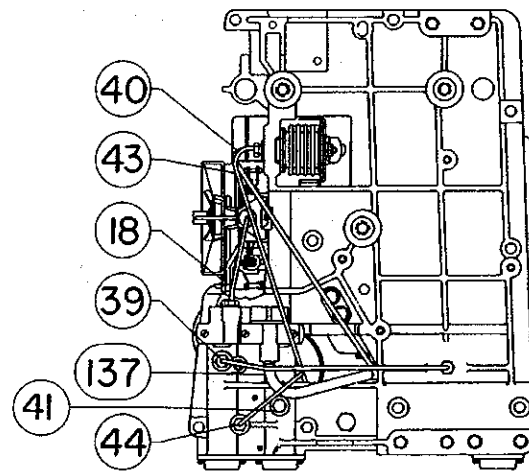
VIEW E, 4196C SERIES



VIEW E, 4196C SERIES  
WITH ANTI-RESET WINDUP (SUFFIX LETTER F)



VIEW C-C, 4196C SERIES



VIEW C-C, 4196C SERIES  
WITH ANTI-RESET WINDUP (SUFFIX LETTER F)

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Figure 6-20. Controller Assembly Drawing (cont'd)

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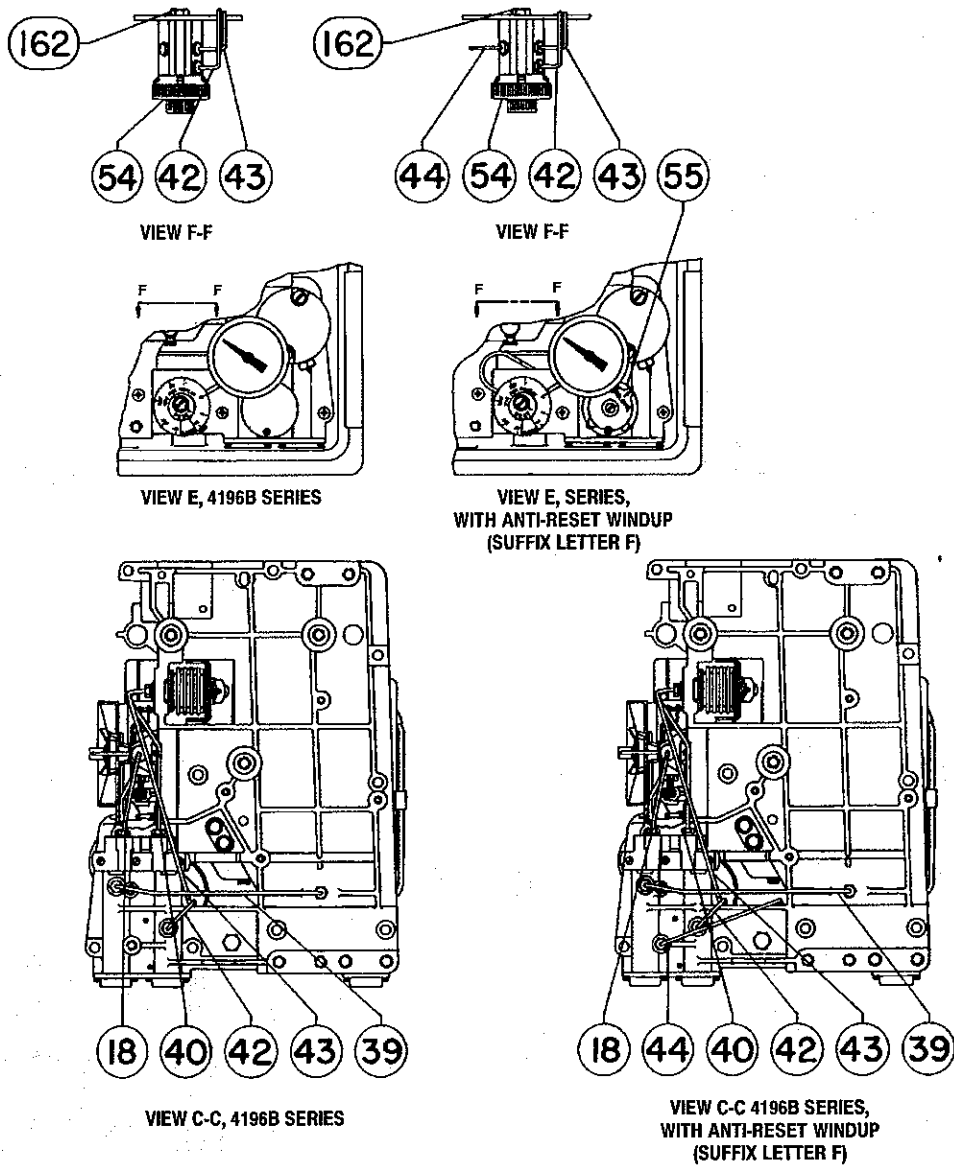
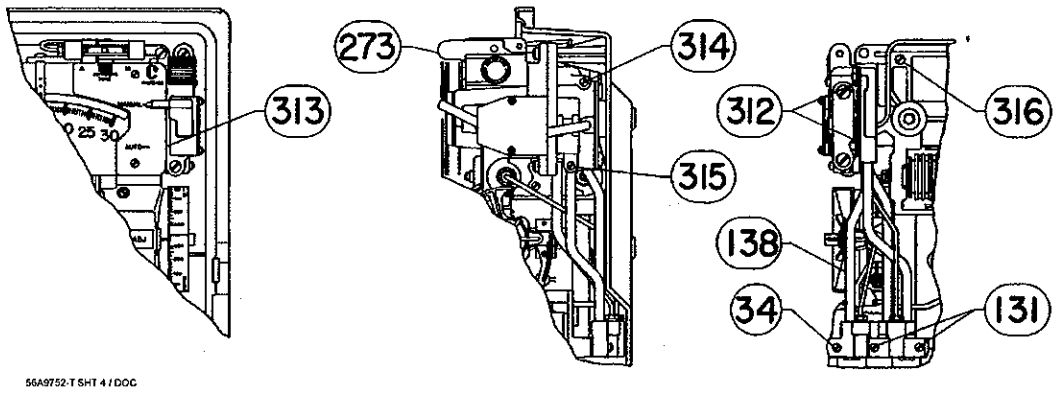
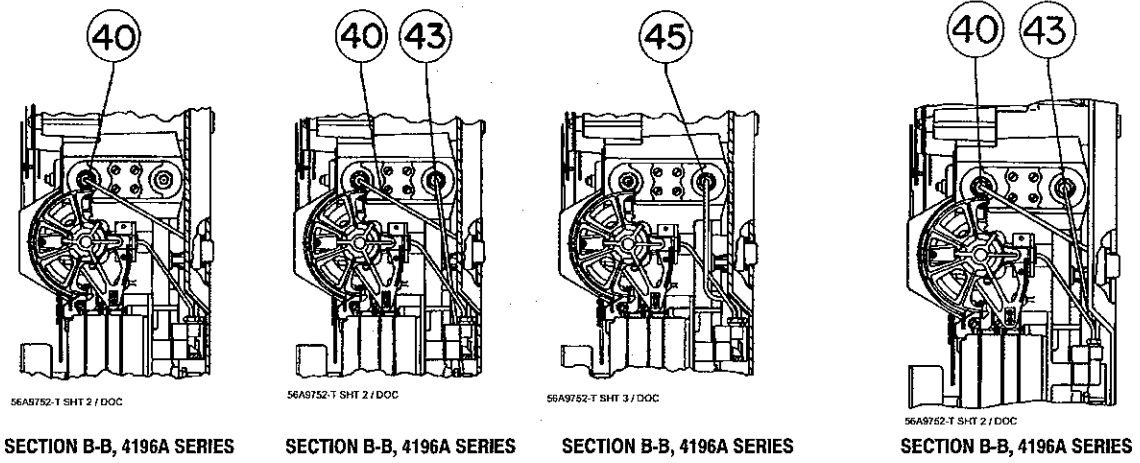


Figure 6-20. Controller Assembly Drawing (cont'd)



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**CONTROLLERS WITH AUTO/MANUAL STATION  
(SUFFIX LETTER E)**

*Figure 6-20. Controller Assembly Drawing (cont'd)*

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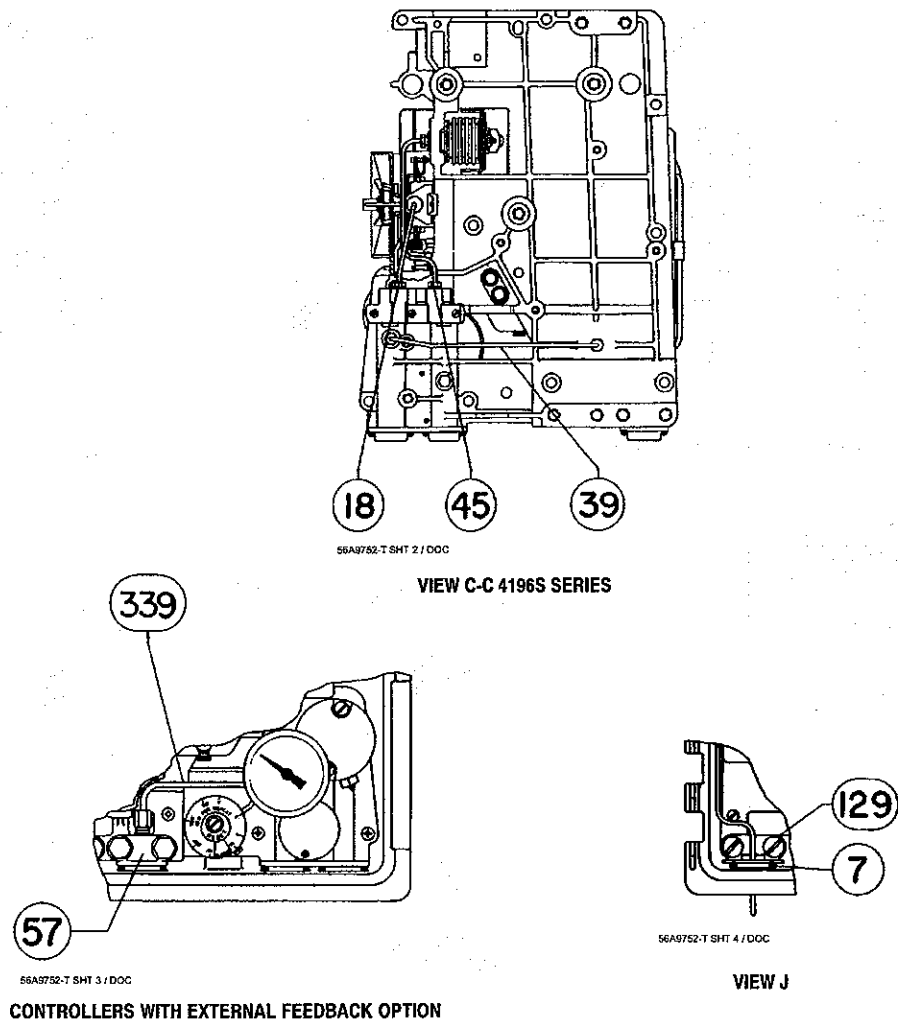
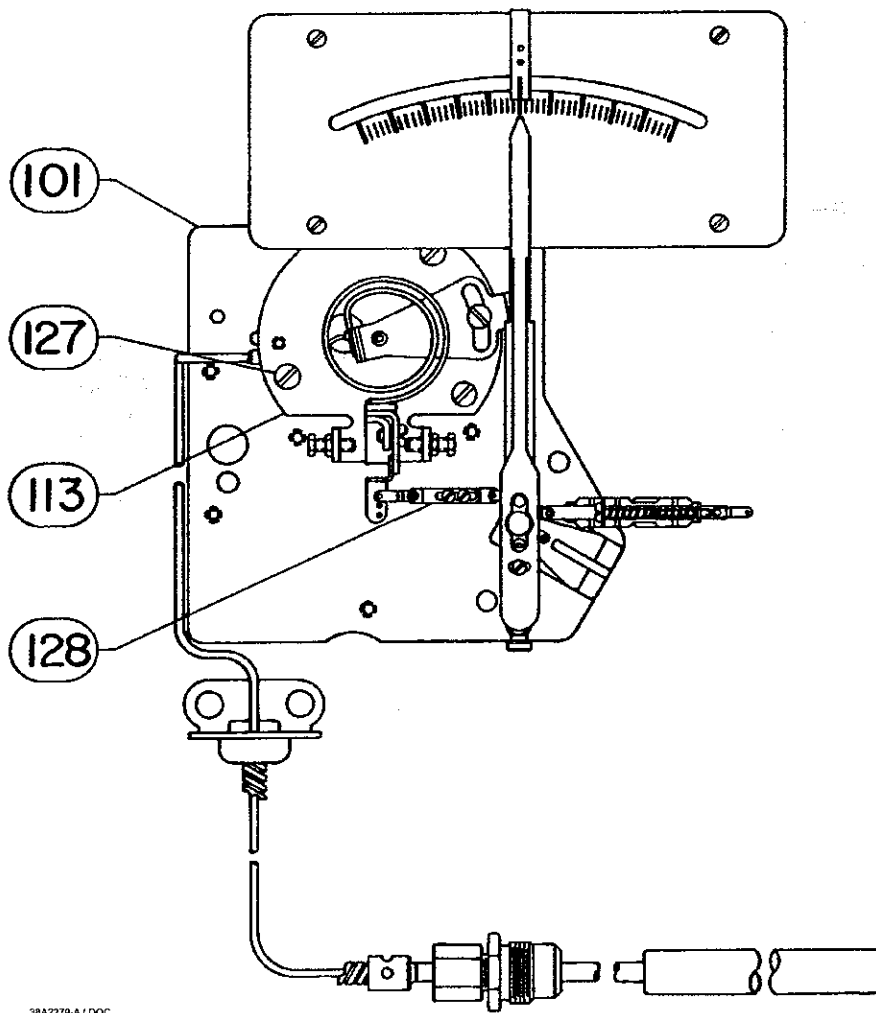


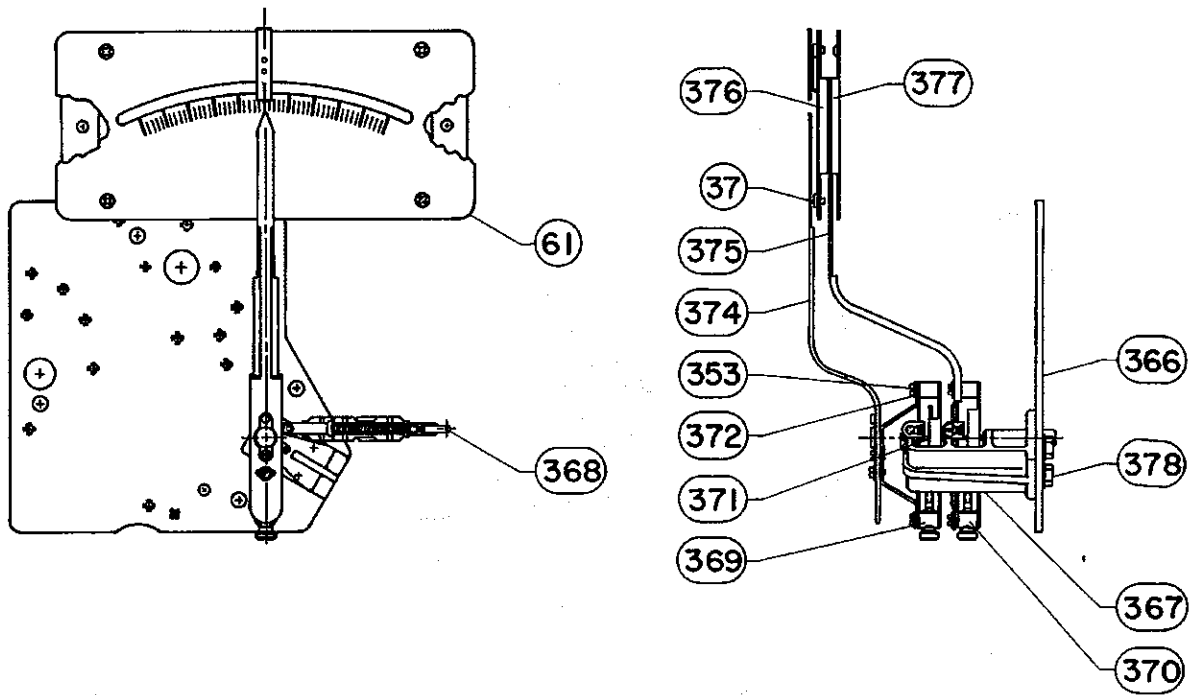
Figure 6-20. Controller Assembly Drawing (cont'd)



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Figure 6-21. Process and Set Point Indicator Assembly

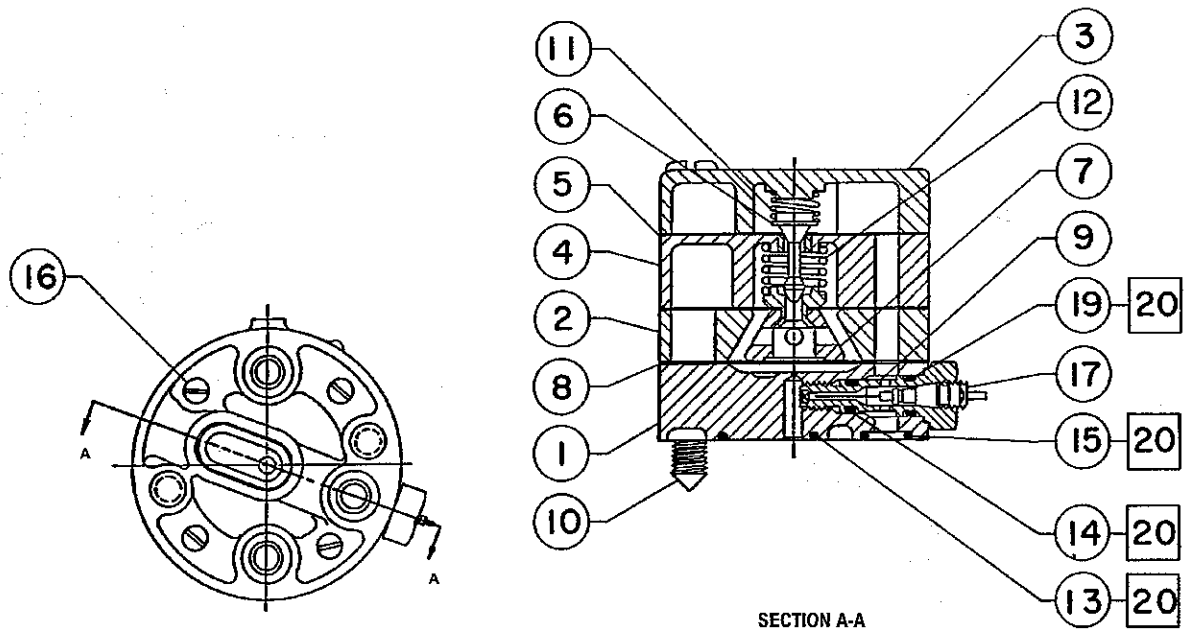
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39A1128-H1/DOC

Figure 6-22. Indicator Assembly

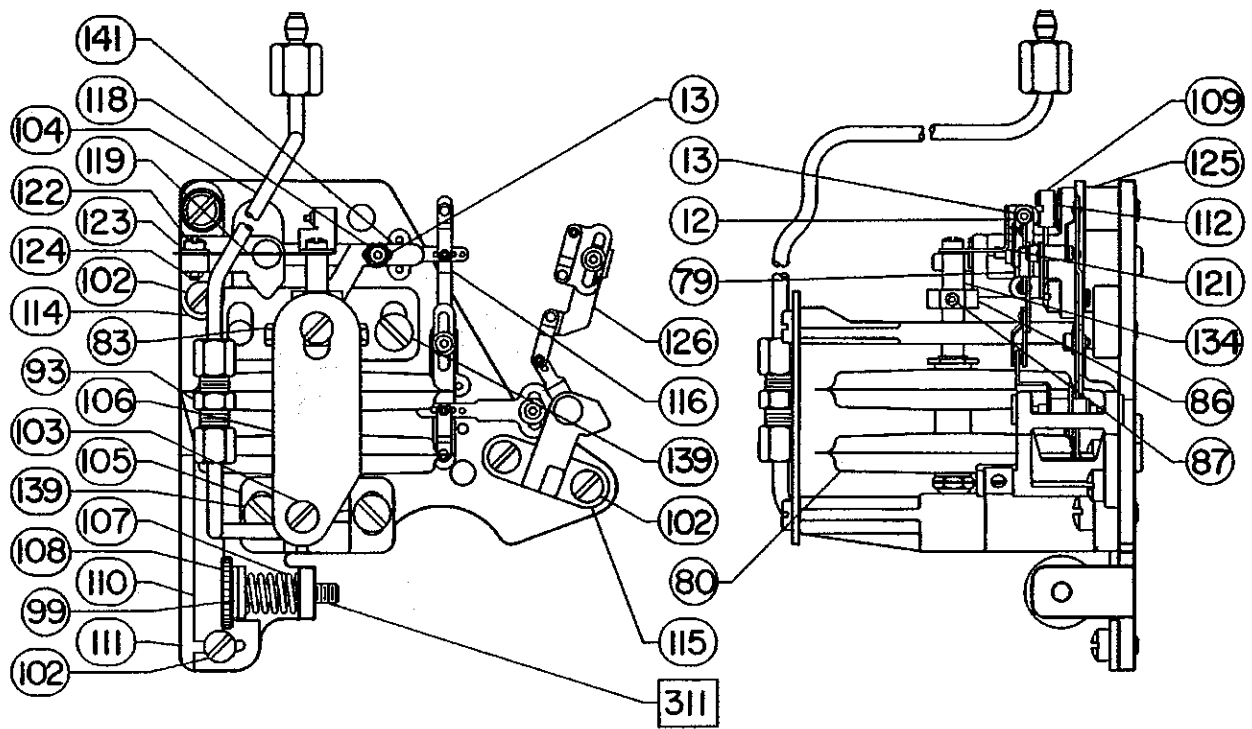
# 4196A, B, C, and S Series



□ APPLY LUB  
32B0257-A-1 DOC

Figure 6-23. Type 83U Relay

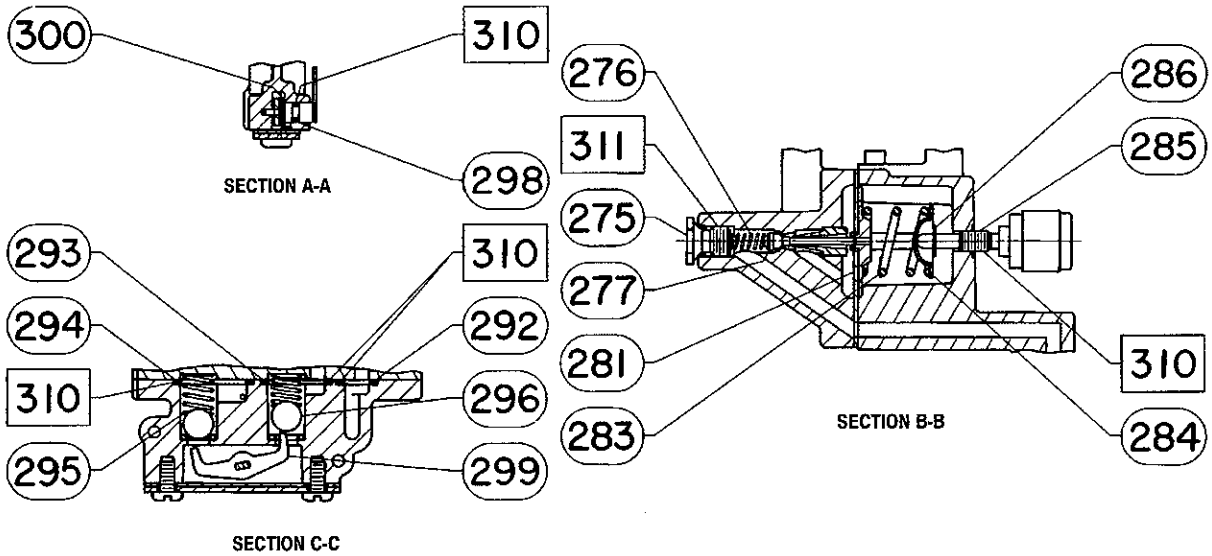
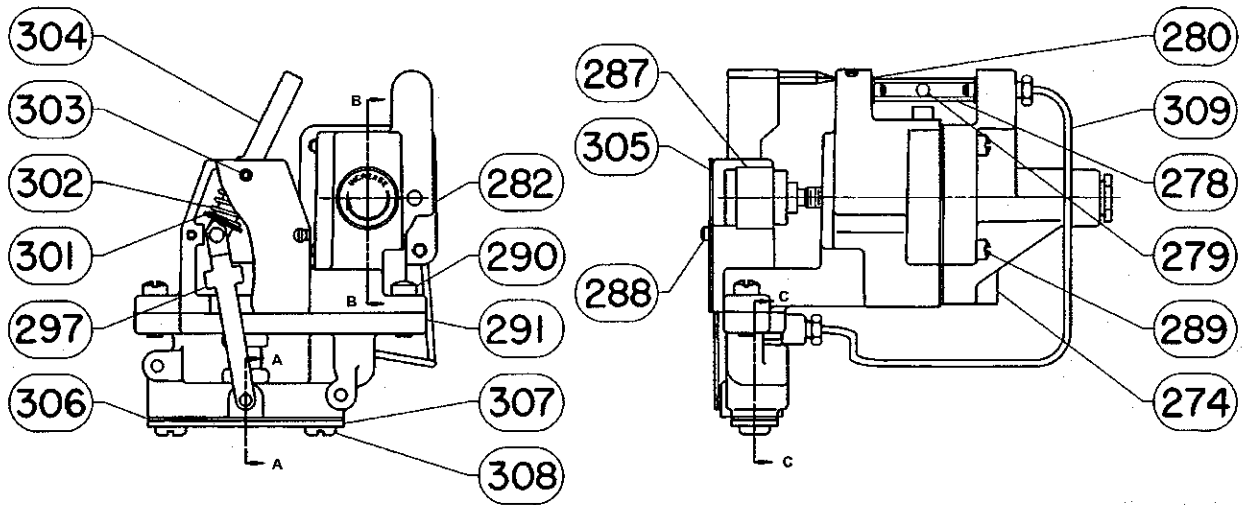
# 4196A, B, C, and S Series



□ APPLY LUB/SEALANT  
36A6988-C / DOC

Figure 6-24. Remote Set Point Assembly Drawing

# 4196A, B, C, and S Series



□ APPLY LUB/SEALANT  
48A2905-A1 DDC

Figure 6-25. Auto/Manual Station Assembly Drawing

# 4196A, B, C, and S Series

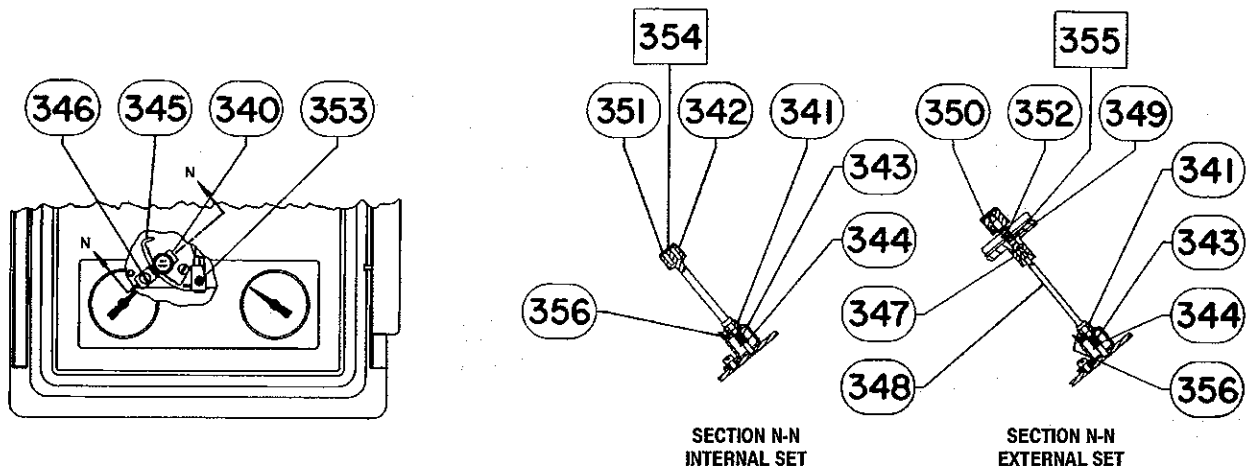


Figure 6-26. Internal and External Set Point Option



# 4196A, B, C, and S Series

## Section 7 Parts

### Parts Ordering

Whenever corresponding with the Fisher Controls sales office or representative about this equipment, always mention the controller serial number. When ordering replacement parts, refer to the 11-character part number of each required part as found in the following parts list.

### Parts Kits

Key	Description	Part Number
	4190 Series Auto/Manual Repair Kit Contains keys 277, 278, 279, 281, 292, 293, 294, 298, 306, and 312	R4190X0AM12
	4190 Series Auto/Manual Retrofit Kit Contains keys 138, 273, 312, 313, 314, 315, 316	
	Brass tubing	R4190X00B12
	SST tubing	R4190X00S12
	4190 Series Case Handle Kit Contains lever and mounting hardware	R4190X00H12
	4190 Series Controller Repair Kit Contains keys 4, 5, 7, 8, 24, 52	R4190X00C12
	4190 Series Pointer and Bracket Repair Kit Contains pointer and bracket ass'y, three machine screws, three washers	R4190X00P12
	4190 Series Type 83U Relay Repair Kit Contains keys 5, 6, 7, 8, 11, 13, 14, 15, 19	R83LX000012
	Type 4196BF and 4196CF Anti-Reset Windup Retrofit kits, contains keys 44 and 55)	
	Brass tubing	
	4196BF	R4190X00B22
	4196CF	R4190CX0B22
	SST tubing	
	4196BF	R4190X00S22
	4196CF	R4190CX0S22

### Parts List

#### Abbreviations Used In The Parts List

adj:	adjustment
alt desgntr:	alternative designation
ass'y:	assembly
conn(s):	connection(s)
diff:	differential (as in process differential pressure)
fdback:	feedback
fill hd:	fillister head (as in fillister head cap screw)
frame:	controller frame (key 3)
ext:	external
hd:	head (as in machine screw head)
ind:	indicator
int:	internal
OD:	outside diameter
pl:	plated (as in plated steel)
prop:	proportional
pt:	point (as in set point)
qty:	quantity
SST:	stainless steel
w/:	with
w/o:	without

Key Description Part Number

### Controller Common Parts (figure 6-20)

#### Note

Figure 6-20 shows key numbers for the 4196A, 4196B and 4196C Series controllers. Figure 6-20 continues over several pages. Be sure to check all pages to find the key numbers. This figure is included in the Maintenance section of this manual.

1	Case and cover assembly For use w/ or w/o int set pt and w/o remote or ext set pt For use w/remote set pt and w/o int or ext set pt For use w/ext set pt and w/o remote or int set pt	46A5903 X012 46A5902 X012 46A5900 X012
2	Nameplate, A9100 (aluminum)	---
3	Frame, A03600 (aluminum)	56A7001 X012
4*	Gasket, neoprene for use between frame and frame manifold (key 135)	18A0749 X012
5*	Gasket, neoprene 4196A and 4196B (1 req'd), 4196C (2 req'd)	18A0742 X012
6	Machine Screw, fill hd, S18800 (18-8 SST) 2 req'd to mount the prop band ind cover to the frame 4 req'd to mount bellows bracket (key 31) to bellows beam (key 49) 2 req'd to attach process scale brackets (keys 376, 377) to frame	1P4373 X0012 1P4373 X0012 1P4373 X0012
7*	O-Ring, nitrile Used between frame and case at conns: temperature bulb capillary, output and supply pressure, ext feedback and remote set pt conn 3 req'd w/o remote set pt and w/o ext feedback 4 req'd w/remote set pt or ext feedback 5 req'd w/remote set pt and ext feedback)	1C3762 06992 1C3762 06992 1C3762 06992
8*	O-Ring, nitrile (3 req'd) Used between frame and case on mounting bosses extending from the frame through the back of the case (3 req'd)	16A6903 X012
9	Flexure pivot assembly, sapphire/SST	29A4340 X012
10	Machine screw, fill hd, S18800 (18-8 SST) Used to attach the flexure pivot ass'y (key 9) to the frame (4 req'd)	14A7797 X012
11*	Flapper ass'y	29A9518 X012
12	Cap screw, hex socket, S18800 (18-8 SST) For flapper ass'y (key 11) (2 req'd)	10B0700 X012
17	Adjustable set pt pivot ass'y, SST	19A1121 X012
18	Relay nozzle tubing ass'y, SST	18A0765 X012
19	Machine screw, fill hd, S18800 (18-8 SST) 1 req'd to attach adjustable set pt pivot ass'y (key 17) to frame 1 req'd to attach relay nozzle tubing ass'y (key 18) to frame	1C8990 X0012 1C8990 X0012
20	Plain washer, S18800 (18-8 SST) Used w/key 19 (2 req'd)	1K2610 28992

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Key	Description	Part Number	Key	Description	Part Number
21	Nozzle ass'y, SST	26A6904 X012	48	Bellows ass'y, (2 req'd)	
22	Washer, plastic (1 req'd)	16A9767 X012		Brass	16A6953 X012
23	Set pt beam ass'y, aluminum/SST	16A6939 X012		S32100 (321 SST)/S30400 (304 SST)	16A6953 X022
24*	O-ring, nitrile		49	Bellows beam, A96061 (aluminum)	
	1 req'd for nozzle tubing ass'y (key 18)	1E2226 06992		3 to 15 psig (0.2 to 1.0 bar)	16A6957 X012
	1 req'd for nozzle ass'y (key 21)	1E2226 06992		6 to 30 psig (0.4 to 2.0 bar)	16A6958 X012
25	Proportional band knob, polycarbonate	36A6911 X012	50	Relay assembly	
26	Retaining clip, S30200 (302 SST)	16A6913 X012		The part numbers listed for key 50 are for the complete relay assembly only. Individual relay parts are listed in the Type 83U Relay subsection of the parts list. Key numbers for individual relay parts also appear in figure 6-23.	
27	E-ring, SST	1V5929 X0012		Relay 3 to 15 psig (0.2 to 1.0 bar)	32B0257 X0A2
28	Set pt beam bias spring, pl steel	16A6909 X012		Relay 6 to 30 psig (0.4 to 2.0 bar)	32B0257 X0B2
29	Set pt beam shoe, G10100 (pl steel)	16A6910 X012	51	Relief valve cover plate, A03600 (aluminum)	2V5973 08012
30	Cap screw, hex socket S18800 (18-8 SST)		52*	O-ring, nitrile	
	Used w/key 29 (2 req'd)	19A1155 X022		Used w/key 51 (2 req'd)	1C8538 06992
31	Bellows bracket, A95052 (aluminum)	26A6932 X012	53	Machine screw, fill hd, S18800 (18-8 SST)	
32	Bellows adj bracket, G10100 (pl steel)	16A6933 X012		Used w/key 51 (2 req'd)	1U8842 X0012
33	Bellows adj spring, pl steel	16A6934 X012	54	Reset restriction valve (4196B Series only)	19A4361 X032
34	Machine screw, fill hd, S18800 (18-8 SST)		55	Differential relief valve	
	Used to attach frame manifold (key 135) to frame and for reset gain adjustment (2 req'd)	1B9925 X0012		For all 4196B and C Series w/suffix letter F, anti-reset windup	21A6447 X0A2
35	Machine screw, hex hd, S18800 (18-8 SST)		56	Process and set pt indicator ass'y w/temperature element ass'y	
	Used to attach bellows bracket (key 31) to each bellows ass'y (key 48) (2 req'd)	16A6935 X022		The part numbers in the key 56 table are for the complete process and set pt indicator ass'y with temperature element ass'y. Individual indicator ass'y parts are listed in two subsections of this parts list: the Process and Set Point Indicator Assembly (key 56) subsection and the Indicator Assembly (key 101) subsection. Key numbers for individual indicator parts also appear in figures 6-21 and 6-22.	
36	Proportional band indicator cover, ABS w/polyester label	36A6936 X012		Process and set pt indicator ass'y w/temperature element ass'y, aluminum/stainless steel	see Key 56 table
37	Self-tapping screw, S18800 (18-8 SST)		57	Pressure control block, CF8M (316 SST casting)	
	4 req'd to attach process scale (key 61) to process scale bracket (key 376)	16A6938 X022		1 req'd w/remote set pt;	
38	Self-tapping screw, S18800 (18-8 SST)			2 req'd w/remote set pt and external feedback	26A6962 X012
	Used to attach frame inside case (9 req'd)	16A6959 X022	58	Cap screw, hex hd, SST	
39	Supply gauge tubing ass'y			2 req'd for use w/each pressure control block (key 57)	1A3525 38992
	Copper/brass	16A6952 X012	61	Process scale, aluminum	
	SST	16A6952 X022		for indicator ass'y (key 101)	See Key 61 table
40	Proportional tubing assembly		62	Remote set pt ass'y (suffix letter M)	
	For 4196A or 4196B Series			The part numbers listed for key 62 are for the complete remote set pt (suffix letter M) ass'y. Individual assembly parts are listed in the Remote Set Point Assembly subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 6-24.	
	Copper/brass	28A0766 X012		N09902 (Nickel Alloy, Ni-Span-C, Alloy 902)	
	SST	28A0766 X022		12 psi (0.8 bar) span	36A6988 X032
	For 4196C Series			24 psi (1.7 bar) span	36A6988 X042
	Copper/brass	27A3217 X012		SST	
	SST	27A3217 X022		12 psi (0.8 bar) span	36A6988 X012
41	Plug, S30300 (303 SST)			24 psi (1.7 bar) span	36A6988 X022
	For all 4196A & B Series (1 req'd)		64	Machine screw, fill hd, S18800 (18-8 SST)	
	For 4196C, CM, CE and CME (2 req'd)			4 req'd to attach process and set pt indicator ass'y (key 56) to frame	1J8415 X0012
	For 4196CF, CFM, CFE, and CFME (1 req'd)	1P2796 X0012	65	Feedback link ass'y aluminum/brass/SST	16A7036 X012
42	Reset valve tubing ass'y (for 4196B Series w/o ext feedback)		71	Machine screw, fill hd, S18800 (18-8 SST)	
	Copper/brass	16A6949 X012		For all 4196A and B Series (4 req'd)	
	SST	16A6949 X022		For all 4196C Series (6 req'd)	1P4743 X0012
43	Reset tubing ass'y		72	Blow out plug	2V7660 05312
	For 4196B Series				
	Copper/brass	26A6950 X012			
	SST	26A6950 X022			
	For 4196C Series				
	Copper/Brass	28A0764 X012			
	SST	28A0764 X022			
44	Relief tubing assembly				
	For Types 4196BF, BFE, BFM, and BFME only				
	Copper/brass	16A6951 X012			
	SST	16A6951 X022			
	For Types 4196CF, CFE, CFM and CFME only				
	Copper/brass	18A0763 X012			
	SST	18A0763 X022			
45	Positive feedback tubing ass'y (for 4196S Series only)				
	Copper/Brass	18A0769 X012			
	SST/Brass	18A0769 X022			
46*	Pressure gauges (2 req'd)	See Key 46 table			

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Key 46 Pressure Gauge<sup>(1)</sup>

RANGE	GAUGE MATERIAL	
	Brass	SST
<b>Dual Scale Gauge</b>		
0 to 30 psig/ 0 to 2 kg/cm <sup>2</sup>	11B8577 X042	11B8583 X032
0 to 60 psig/ 0 to 4 kg/cm <sup>2</sup>	11B8577 X052	—
<b>Triple Scale Gauge</b>		
0 to 30 psig/ 0 to 200 kPa/ 0 to 2 bar	11B8577 X012	11B8583 X012
0 to 60 psig/ 0 to 400 kPa/ 0 to 4 bar	11B8577 X022	11B8583 X022

1. One type of pressure gauge is used for both output pressure and supply pressure indication.

Key 56 Process and Set Point Indicator Assembly adjustable union

TEMPERATURE RANGE, DEGREES		W/O Remote Set Point		W/Remote Set Point	
		CAPILLARY LENGTH		CAPILLARY LENGTH	
		15 ft (4.5 m)	25 ft (7.5 m)	15 ft (4.5 m)	25 ft (7.5 m)
Fahrenheit	0 to 100	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	50 to 150	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	100 to 200	38A2279 XS22	38A2279 XT42	38A2279 XU62	38A2279 XV82
	50 to 200	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	0 to 150	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	-100 to 200	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
	0 to 200	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	50 to 250	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	100 to 300	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	100 to 400	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
	0 to 300	38A2279 XS42	38A2279 XT62	38A2279 XU82	38A2279 XW12
	0 to 400	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
0 to 500	38A2279 XS82	38A2279 XU12	38A2279 XV32	38A2279 XW52	
0 to 600	38A2279 XS92	38A2279 XU22	38A2279 XV42	38A2279 XW62	
Celsius	-20 to 40	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	0 to 60	38A2279 XS12	38A2279 XT32	38A2279 XU52	38A2279 XV72
	60 to 120	38A2279 XS22	38A2279 XT42	38A2279 XU62	38A2279 XV82
	-15 to 85	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	0 to 100	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	50 to 150	38A2279 XS32	38A2279 XT52	38A2279 XU72	38A2279 XV92
	50 to 200	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
	0 to 150	38A2279 XS42	38A2279 XT62	38A2279 XU82	38A2279 XW12
	-75 to 75	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
	0 to 200	38A2279 XS72	38A2279 XT92	38A2279 XV22	38A2279 XW42
	0 to 250	38A2279 XS82	38A2279 XU12	38A2279 XV32	38A2279 XW52
	0 to 300	38A2279 XS92	38A2279 XU22	38A2279 XV42	38A2279 XW62

Key	Description	Part Number	Key	Description	Part Number
120	Machine screw, fill hd, S18800 (18-8 SST) 2 req'd to attach remote set pt ass'y (suffix letter M) to indicator ass'y base plate (key 56)	1J8415 X0012	138	Automatic/manual tubing assembly Use w/suffix letter E, auto/manual station only	
129	Machine screw, SST (2 req'd)	1J8302 X0012		Copper/aluminum	38A2859 X012
131	Machine screw, fill hd, S30400 (304 SST) 2 req'd to attach rate/reset manifold (key 136) to frame manifold (key 135)	1C1015 35042		SST/aluminum	38A2859 X022
135	Frame manifold, A03600 (aluminum) For all types except w/suffix letter E, auto/manual station	28A0756 X012	140	Machine screw, fill hd, S18800 (18-8 SST) Used to attach remote set pt ass'y (suffix letter M) to indicator ass'y (key 56)	16A7007 X022
136	Rate/reset manifold A03600 (aluminum) For all types except 4196C Series	28A0747 X012	162	Machine screw, hex hd, S18800 (18-8 SST) Used to attach the reset valve (4196B Series) or rate/reset valve (4196C Series) to the frame For 4196B and C Series only	1B8480 X0012
137	Rate tubing assembly (for 4196C Series only) Copper/aluminum SST/aluminum	28A0762 X032 28A0762 X042	262	Rate/reset valve ass'y (for 4196C Series only) Brass bellows 3 to 15 psig (0.2 to 1.0 bar) 6 to 30 psig (0.4 to 2.0 bar)	39A6013 X052 39A6013 X072

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Key	Description	Part Number
262	Rate/reset valve ass'y (for 4196C Series only) Brass bellows (cont'd) SST bellows	
	3 to 15 psig (0.2 to 1.0 bar)	39A6013 X062
	6 to 30 psig (0.4 to 2.0 bar)	39A6013 X082
273	Auto/manual station (suffix letter E)	48A2905 X012
	The part number listed for key 273 is for the complete auto/manual station (suffix letter E). Individual assembly parts are listed in the Auto/Manual Station subsection of the parts list. Key numbers for individual ass'y parts also appear in figure 6-25.	
310	Lubriplate Mag-1 lubricant (not furnished with controller)	
311	Zink-Plate No. 770 Sealant (not furnished with controller)	
312*	O-ring, nitrile For all types w/suffix letter E, auto/manual station (3 req'd)	1P8453 X0022
313	Auto/Manual Scale, plastic For all types w/suffix letter E auto/manual station	38A2901 X012
314	Machine screw, fill hd, S30400 (304 SST) For all types w/suffix letter E auto/manual station	1C1015 35042
315	Machine screw, fill hd, S18800 (18-8 SST) For all types w/suffix letter E auto/manual station	1B9925 X0012
316	Machine screw, fill hd, S18800 (18-8 SST) For all types w/suffix letter E auto/manual station	1U8841 X0012
317	Molykote No. 33 Grease Lubricant (not furnished with controller)	
318	Dow Corning 111 Lubricant (not furnished with controller)	
339	External feedback assembly Brass tubing	28A7285 X012
	SST tubing	28A7285 X022
362	Spring Retaining Washer, SST	1B1961 38992
365	Washer, S18800 (18-8 SST)	11B6501 X012

## Process and Set Point Indicator Assembly (key 56) (figure 6-21)

Key	Description	Part Number
101	Indicator ass'y	
	The part numbers listed here for key 101 are for the indicator ass'y only. Individual part numbers are listed in the indicator assembly subsection of this parts list. Key numbers for individual assembly parts also appear in figure 5-22.	
	For use w/o remote set pt	39A1126 X012
	For use w/remote set pt	39A1126 X022
113	Temperature Element Ass'y	See key 113 table
127	Machine screw, fill hd, S18800 (18-8 SST) For mounting temperature element ass'y to indicator ass'y (3 req'd)	1D9561 X0012
128	Connecting link assembly, aluminum/SST	18A2278 X012

## Key 61 Process Scales, aluminum

	Temperature Range Degrees	Part Number
Fahrenheit	-100 to 200	1R0003 X2522
	0 to 100	1R0003 X0382
	0 to 150	1R0003 X2512
	0 to 200	1R0003 X0762
	0 to 300	1R0003 X0802
	0 to 400	1R0003 X0812
	0 to 500	1R0003 X1122
	0 to 600	1R0003 X0822
	50 to 150	1R0003 X0722
	50 to 200	1R0003 X0742
Fahrenheit	50 to 250	1R0003 X0772
	100 to 200	1R0003 X0732
	100 to 300	1R0003 X0782
	100 to 400	1R0003 X2532
Celsius	-20 to 40	1R0003 X2542
	-15 to 85	1R0003 X1462
	-75 to 75	1R0003 X2572
	0 to 60	1R0003 X2552
	0 to 100	1R0003 X0852
	0 to 150	1R0003 X0862
	0 to 200	1R0003 X0872
	0 to 250	1R0003 X0882
	0 to 300	1R0003 X0892
	60 to 120	1R0003 X2652
50 to 150	1R0003 X1472	
50 to 200	1R0003 X2582	
Per Cent	0 to 100	1R0003 X1042

Key Description Part Number

## Indicator Assembly (key 101) (figure 6-22)

### Note

Key numbers 37, 61, 376, 377, and 378 are not included as part of the indicator assembly (Key 101). If replacing the indicator assembly and these parts are required, order them separately.

37	Self-tapping screw, S18800 (18-8 SST) (4 req'd)	16A6938 X022
61	Process scale, aluminum	See Key 61 table
353	Machine screw, pan hd, S18800 (18-8 SST) (4 req'd)	16A7044 X022
366	Controller mounting plate, S18800 (18-9 SST)	38A1735 X012
367	Support bracket ass'y, zinc/brass	16A7013 X012
368	Link ass'y, SST/brass (2 req'd)	16A7039 X012
369	Process pointer adj ass'y, aluminum/SST/brass	28A1736 X012
370	Set pt pointer adj ass'y aluminum/SST/brass	26A9750 X012
371	Pivot pin, S18800 (18-8 SST) (2 req'd)	16A7027 X012
372	Plain washer, S18800 (18-8 SST) (4 req'd)	1V7657 X0012
374	Pointer and bracket ass'y aluminum/steel	26A7059 X012
375	Set pt indicator ass'y, A93003 (aluminum) for controllers w/remote set pt for controllers w/o remote set pt	31B2241 X012 26A7045 X012
376	Dial bracket, G10080 (steel)	36A7050 X012
377	Dial bracket, G10080 (steel)	36A7051 X012
378	Self-tapping screw, S18800 (18-8 SST) (2 req'd)	16A9772 X022

# 4196A, B, C, and S Series

**Key Description Part Number**

## Type 83U Relay (key 50) (figure 6-23)

1	Relay base, A03600 (aluminum)	42B0245 X012
2	Exhaust block, A03600 (aluminum)	2U9002 08012
3	Relay cap, A03600 (aluminum)	3U9019 08012
4	Output block ass'y, aluminum/S30300 (303 SST)	1U9006 000A2
5*	Gasket	1V5579 02032
6*	Inner valve, S30300 (303 SST)	1U9016 35032
7*	Diaphragm ass'y	1U9018 000A2
8	Diaphragm	1V5578 02032
9	Nozzle and adaptor ass'y, aluminum/sapphire 3 to 15 psig (0.2 to 1.0 bar) output 6 to 30 psig (0.4 to 2.0 bar) output	12B0250 X012 12B0251 X012
10	Relay mounting screw, S18800 (18-8 SST) (2 req'd)	1U9012 38982
11	Spring, S30200 (302 SST)	1P4204 37022
12	Spring, A228 ("music wire") alt desgntr: K08500 (pl steel)	19A8907 X012
13*	O-ring, nitrile	17A6891 X012
14*	O-ring, nitrile	1D1346 06992
15*	O-ring, nitrile (2 req'd)	1D6875 06992
16	Machine screw, fill hd, S18800 (18-8 SST) (4 req'd)	1A8176 X0012
17	Core and wire ass'y, SST 3 to 15 psig (0.2 to 1.0 bar) output 6 to 30 psig (0.4 to 2.0 bar) output	1V5992 X0012 1V5992 X0022
19*	O-ring, nitrile	1D1347 06992
20	Dow Corning 111 Lubricant (not furnished with controller)	

## Remote Set Point Assembly (suffix letter M) (key 62) (figure 6-24)

12	Cap screw, hex socket, S18800 (18-8 SST) (2 req'd)	1U6213 32982
13	Plain washer, S18800 (18-8 SST) (3 req'd)	610003 10X12
79	Drive flexure, S30200 (302 SST)	16A9794 X012
80	Diaphragm capsule ass'y 12 psi (1 bar) span, N09902 (Nickel Alloy, Ni-Span-C, Alloy 902) SST 24 psi (1.6 bar) span, N09902 (Nickel Alloy, Ni-Span-C, Alloy 902) SST	26A9776 X032 28A2848 X022 26A9778 X022 28A2850 X022
83	Travel stop, CF8 (SST casting)	16A9797 X012
86	Travel stop nut, S30300 (303 SST)	16A9799 X012
87	Set screw, hex socket, S18800 (18-8 SST)	1J8406 X0012
93	Union, S31600 (316 SST)	1A5782 X0022
99	Plain washer, S18800 (18-8 SST)	610003 70X12
102	Machine screw, fill hd, S18800 (18-8 SST) (4 req'd)	1H2675 X0012
103	Machine screw, pan hd, S18800 (18-8 SST) (2 req'd)	18A0703 X022
104	Remote set pt tubing ass'y, S30400 (304 SST)	28A0697 X012
105	Pedestal ass'y, SST	18A0669 X022
106	Tie bar, G10100 (pl steel)	16A9789 X022
107	Spring, pl steel	18A0704 X012
108	Zero adj screw, S30300 (303 SST)	18A1737 X022
109	Pivot screw, S30300 (303 SST)	18A1738 X022
110	Zero adj bracket, S30400 (304 SST)	28A0661 X012
111	Mounting plate, G10100 (pl steel)	38A0668 X012
112	Spring washer, pl steel	17A2700 X012
114	Pivot clevis ass'y A, plastic/SST	18A0658 X012

Key 113 Temperature Element Ass'y, adjustable union

TEMPERATURE RANGE, DEGREES		CAPILLARY LENGTH	
		15 ft (4.5 m)	25 ft (7.5 m)
Fahrenheit	0 to 100	38A2270 X162	38A2270 X172
	50 to 150	38A2270 X162	38A2270 X172
	100 to 200	39A2955 X032	39A2955 X042
	50 to 200	38A2270 X162	38A2270 X172
	0 to 150	38A2270 X162	38A2270 X172
	-100 to 200	39A2955 X092	39A2955 X102
	0 to 200	38A2273 X162	38A2273 X172
	50 to 250	38A2273 X162	38A2273 X172
	100 to 300	38A2273 X162	38A2273 X172
	100 to 400	39A2955 X092	39A2955 X102
Celsius	0 to 300	38A2273 X182	38A2273 X192
	0 to 400	39A2955 X092	39A2955 X102
	0 to 500	39A2955 X112	39A2955 X122
	0 to 600	39A2955 X132	39A2955 X142
	-20 to 40	38A2270 X162	38A2270 X172
	0 to 60	38A2273 X162	38A2273 X172
	60 to 120	39A2955 X032	39A2955 X042
	-15 to 85	38A2273 X162	38A2273 X172
	0 to 100	38A2273 X162	38A2273 X172
	50 to 150	38A2273 X162	38A2273 X172
50 to 200	39A2955 X092	39A2955 X102	
0 to 150	38A2273 X182	38A2273 X192	
-75 to 75	39A2955 X092	39A2955 X102	
0 to 200	39A2955 X092	39A2955 X102	
0 to 250	39A2955 X112	39A2955 X122	
0 to 300	39A2955 X132	39A2955 X142	

Key	Description	Part Number
115	Pivot clevis ass'y B, plastic/SST	16A9808 X012
116	Connecting link ass'y, aluminum/bronze/brass	18A0666 X012
118	Cap screw, hex socket, S18800 (18-8 SST)	1U6213 32982
119	Guide flexure, S30200 (302 SST)	18A0660 X012
121	Drive bracket, S30400 (304 SST)	28A0662 X012
122	Machine screw, fill hd, SST (2 req'd)	1U3737 X0012
123	Plain washer, S18800 (18-8 SST)	1P7524 38982
124	Hex nut, S18800 (18-8 SST)	600004 10X12
125	Spacer, A92011 (aluminum)	18A0702 X012
126	Connecting link ass'y, aluminum/bronze/brass	18A0676 X012
134	Diaphragm ass'y extension, A92011 (aluminum)	18A1739 X012
139	Machine screw, fill hd, S18800 (18-8 SST) (3 req'd)	1J8415 X0012
141	Adj arm, S30400 (304 SST)	28A0663 X012
311	Zink-Plate No. 770 Sealant (not furnished with controller)	

## Auto/Manual Station (suffix letter E) (figure 6-25)

274	Lower loader ass'y, aluminum	18A2892 X012
275	Spring seat screw, pl steel	18A2876 X012
276	Valve plug spring, A228 ("music wire") alt desgntr: K08500 (pl steel)	18A2877 X012
277	Valve plug, S18800 (18-8 SST)	18A2878 X012
278	Tube, plastic	18A2880 X012
279	Ball, SST	18A2902 X012
280	Ball seat, nitrile (2 req'd)	18A2881 X012
281*	Diaphragm ass'y, nitrile/aluminum	18A2884 X012
282	Upper loader ass'y, aluminum/plastic	18A2893 X012
283	Range spring, SST	18A2885 X012
284	Range spring cup, pl steel	18A2869 X012
285	Spring adj screw, pl steel	18A2886 X012
286	Retaining ring, pl steel	18A2903 X012
287	Loader knob, plastic	18A2891 X012

# 4196A, B, C, and S Series

Key	Description	Part Number
288	Machine screw, rd hd, S18800 (18-8 SST) (2 req'd)	1C2082 35072
289	Machine screw, fill hd, S18800 (18-8 SST) (4 req'd)	1C8969 X0012
290	Machine screw, fill hd, S30200 (302 SST) (2 req'd)	1K3188 38992
291	Switch body ass'y, aluminum/nitrile	28A2890 X012
292*	O-ring, nitrile	1C8538 06992
293*	O-ring, nitrile	11A8741 X052
294*	O-ring, nitrile	13A1584 X012
295	Switch body spring, A228 ("music wire") alt desgn: K08500 (pl steel) (2 req'd)	18A2889 X012
296	Ball, SST (2 req'd)	1J1550 X0012
297	Lever ass'y, SST	18A2866 X012
298*	O-ring, nitrile	1E2226 X0032
299	Rocker, A96061 (aluminum)	18A2871 X012
300	Clip, SST	18A2872 X012
301	Lever spring seat, SST	18A2870 X012
302	Lever spring, A228 ("music wire") alt desgn: K08500 (pl steel)	18A2895 X012
303	Groove pin, SST	16A6380 X012
304	Switch lever, plastic/SST	38A2897 X012
305	Switch lever cover plate, aluminum/chromate	18A2873 X012
306*	Closing plate gasket, neoprene	18A2898 X012
307	Closing plate, SST	18A2875 X012
308	Machine screw, pan hd, S18800 (18-8 SST) (2 req'd)	18A2899 X022
309	Continuous output tubing ass'y, SST	28A2863 X012
310	Lubriplate Mag-1 lubricant, (not furnished with controller)	
311	Zink-Plate No. 770 Sealant, (not furnished with controller)	

## Internal/External Set Point Assembly (Option) (figure 6-26)

340	Bracket, alloy steel pl	26A5893 X012
341	Pinion gear, Ryton	16A5892 X012
342	Pinion shaft, Ryton For int set pt ass'y only	26A5894 X012
343	Spring, SST	19A2333 X012
344	E-ring, SST	1E2143 X0012
345	Pinion rack, polycarbonate	36A5895 X012
346	Machine screw, rd hd, S18800 (18-8 SST)	1E6453 X0022
347	Drive coupler, polycarbonate For ext set pt ass'y only	26A5897 X012
348	Flexible drive polycarbonate For ext set pt ass'y only	36A5896 X012
349*	O-ring, nitrile For ext set pt ass'y only	15A1283 X012
350	Knob, plastic For ext set pt ass'y only	26A5901 X012
351	Knob insert, aluminum For int set pt ass'y only	16A5904 X012
352	Spring, SST For ext set pt ass'y only	16A5898 X012
353	Machine screw, pan head, S18800 (18-8 SST)	16A7044 X022
354	Adhesive, vinyl For int set pt ass'y only (not furnished with controller)	
355	Dow Corning Comp 111 Lubricant For ext set pt ass'y only (not furnished with controller)	
356	Rack support, alloy steel pl	16A5905 X012

## Controller Mounting Parts

### Note

Contact your Fisher Controls sales office or representative for any additional parts required for controller mounting.

### Pipestand Mounting (figure 2-2)

66	Cap screw, hex hd, pl steel (3 req'd)	1A3526 24052
67	Lock washer, pl steel (7 req'd)	1C2257 28982
68	Bracket, pl steel	36A6990 X012
69	Clamp, pl steel (2 req'd)	1P4270 28982

### Pipestand Mounting with Regulator (figure 2-2)

66	Cap screw, hex hd, pl steel (3 req'd)	1A3526 24052
67	Lock washer, pl steel (7 req'd)	1C2257 28982
68	Bracket, pl steel	36A6990 X012
69	Clamp, pl steel (2 req'd)	1P4270 28982
362	Cap screw, hex hd, pl steel (2 req'd)	1B1961 38992
363	Lock washer, pl steel (2 req'd)	1C2256 X0012
364	Hex nut, A563 pl steel (2 req'd)	1A3527 24122
365	Tubing fittings (2 req'd)	See fittings subsection

### Panel Mounting (figure 2-3)

66	Cap screw, hex hd, pl steel (3 req'd)	1A3526 24052
67	Lock washer, pl steel (3 req'd)	1C2257 28982
68	Bracket, A569 (pl steel)	36A6990 X012
70	Machine Screw, rd hd, pl steel (4 req'd)	16A9763 X012

### Wall Mounting (figure 2-4)

66	Cap screw, pl steel (3 req'd)	1A3526 24052
67	Lock washer, pl steel (3 req'd)	1C2257 28982
68	Bracket, pl steel	36A6990 X012

### Controller Mounting Parts for Actuator with Casing-Mounted Controller

Spacer Spool, steel (3 req'd)	1C5590 24092
Cap screw, hex hd, pl steel (3 req'd)	1B7624 24052
Lock washer, pl steel (5 req'd)	1C2257 28982
Mounting bracket, G10100 (pl steel)	36A9754 X012
Cap screw, hex hd, pl steel (2 req'd)	1C3791 24052
Mounting bracket, pl steel	
For 657/667 size 80 & 100	26A0350 X012
For all other types	1F4012 25072
Cap screw, hex hd, pl steel (2 req'd)	1A3683 24052
Hex nut, pl steel (2 req'd)	1E9440 24112
Washer pl steel (2 req'd)	1B8659 28982
Washer G10100 (pl steel) (2 req'd)	1H7231 25072

### Controller Mounting Parts for Actuator With Yoke-Mounted Controller (figure 2-1)

Spacer spool, steel (3 req'd)	1C5590 24092
Cap screw, hex hd, pl steel (3 req'd)	1B7624 24052
Lock washer, pl steel (5 req'd)	1C2257 28982
Mounting bracket, steel	
For 1061 w/switches or manual operator	36A6991 X012
For all other types	36A9754 X012
Spacer spool, steel (2 req'd)	1J8307 24092
Cap screw, pl steel (2 req'd)	1A3525 24052

# 4196A, B, C, and S Series

**Key Description** **Part Number**

## Regulator Mounting Parts

### Regulator Mounting Parts for Casing-Mounted Regulator

Cap screw, hex hd, pl steel (2 req'd)	1A5828 24052
Lock washer, pl steel (2 req'd)	1C2257 28982
Cap screw, hex hd, pl steel (2 req'd)	1C1970 24052
Hex nut, pl steel (2 req'd)	1A3527 24122
Mounting bracket, G10100 (pl steel)	
For 657/667, size 80 & 100	26A0350 X012
For all other types	1F4012 25072

### Regulator Mounting Parts for Yoke-Mounted Regulator (Mounting Bracket Not Required)

Cap screw, hex hd, pl steel (2 req'd)	1C3988 24052
Lock washer, pl steel (2 req'd)	1C2257 28982

### Regulator Mounting Parts for Yoke-Mounted Regulator (With Mounting Bracket)

Cap screw, hex hd, pl steel (2 req'd)	1A3816 24052
Lock washer, pl steel (4 req'd)	1C2257 28982
Cap screw, hex hd, pl steel (2 req'd)	1C1970 24052
Hex nut, pl steel (2 req'd)	1A3527 24122
Mounting bracket, G10100 (pl steel)	
For 1061, size 30, all shaft sizes	23A8891 X012
For all other types	1C2218 25022

**Key Description** **Part Number**

## Fittings

Fittings for 3/8 inch tubing casing- or yoke-mounted controller with regulator	
Connector, brass, (2 req'd)	1B8856 18992
Elbow, brass, (2 req'd)	1B8846 18992
Fittings for 3/8-inch copper tubing, pipestand-mounted controller with regulator	
Elbow, brass (2 req'd)	1B8846 18992
Fittings for 3/8-inch copper tubing, all controllers without regulator	
Connector, brass (1 req'd)	1B8856 18992
Elbow, brass (1 req'd)	1B8846 18992
Fittings for 1/2-inch synthetic rubber hose, all controllers with or w/o regulator	
Connector, 316 SST	15A6002 XK32
Elbow, 316 SST	15A6002 XK12
Swivel, 316 SST (2 req'd)	15A6002 XK22

# 4196A, B, C, and S Series

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*For information, contact Fisher Controls:*  
Marshalltown, Iowa 50158 USA  
Cernay 68700 France  
Sao Paulo 05424 Brazil  
Singapore 0512





PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3			TEMPERATURE INSTRUMENTS ( FILLED SYSTEM )				SHEET 1 OF 1		
CUSTOMER : PLANT : STOCK 8B REFRIGERATION PLANT SERVICE : HIGH TEMPERATURE SHUTDOWN SWITCH			NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.T	
			0	RDD	03/11/05	FOR PURCHASE	JOB #	054468	
							DATE	03/11/2005	
							REQ.		
						BY	CHK'D	APPR.	
						RT			
1	TAG NO. TSDH-633	SERVICE: DEETHANIZER REBOILER							
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL _____ BLIND _____ TRANS. _____ OTHER _____ SWITCH _____							
3	CASE	MFR STD <u>X</u> _____ NOM SIZE _____ COLOR : MFR STD <u>X</u> _____ OTHER _____							
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER _____ LOCAL _____							
5	ENCLOSURE CLASS	GENERAL PURPOSE _____ WATERPROOF _____ EXPLOSIONPROOF _____ CLASS _____ FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____							
6	POWER SUPPLY	117 V 60Hz _____ OTHER AC _____ DC _____ VOLTS _____							
7	CHART	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____							
8	CHART DRIVE	SPEED _____ POWER _____							
9	SCALES	TYPE _____ RANGE 1 _____ 2 _____ 3 _____ 4 _____							
X	10 TRANSMITTER OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____ FOR RECEIVER SEE SPEC. SHEET _____							
C	11 CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____							
R	12 ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES _____ VENT _____							
O	13 AUTO - MAN SWITCH	NONE <u>X</u> _____ MFR STD _____ OTHER _____							
L	14 SET POINT ADJ.	MANUAL <u>X</u> _____ EXTERNAL _____ REMOTE _____ OTHER _____							
L	15 MANUAL REG.	NONE <u>X</u> _____ MFR STD _____ OTHER _____							
E	16 OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____							
R	17 FILL	SAMA CLASS _____ COMPENSATION _____							
E	18 PROCESS DATA	TEMP: NORMAL <u>204</u> ° C MAX. <u>287</u> ° C MAX. PRESSURE ATM _____ kPa (g)							
L	19 RANGE	FIXED _____ ADJ. RANGE <u>-85 to 260</u> ° C SET AT <u>225</u> ° C							
E	20 BULB	OVERRANGE PROTECTION TO _____ TYPE _____ MTL. _____ EXTENSION: LENGTH _____ mm TYPE _____ SIZE: DIAMETER _____ mm LENGTH _____ mm INSERTION _____ mm							
M	21 CAPILLARY	CONN. _____ LOCATION _____ mm ABOVE _____ BELOW _____ MFR. STD _____ LENGTH _____ mm MTL. _____ ARMOR _____							
N	22 WELL	MTL. <u>304SS</u> INSERTION <u>190.5</u> mm LAG EXT. _____ mm CONN. <u>27mm</u> CONST: DRILLED _____ BUILT - UP COUPLING _____ OTHER _____							
23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____							
24	FUNCTION	TEMP <u>X</u> _____ DEVIATION _____ CONTACTS TO <u>VENT</u> ON TEMP. INCREASE _____							
25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____ OTHER <u>C/W 6 meter 304 SS CAPILLARY</u>							
26	MFR. & MODEL NO.	<u>UNITED ELECTRIC</u>							
27	MODEL NO.	<u>820E-3BS-M300-M446 C/W 2-S385-L9 THERMOWELL</u>							
28	P. O. NUMBER	<u>COMES WITH SS NAME TAG</u>							
NOTES: MAX TEMPERATURE BASED ON SUN 21 HOT OIL									
AREA. UNIT # : .152									

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3			TEMPERATURE INSTRUMENTS ( FILLED SYSTEM )				SHEET 1 OF 1			
CUSTOMER : PLANT : STOCK 8B REFRIGERATION PLANT SERVICE : HIGH TEMPERATURE SHUTDOWN SWITCH			NO	BY	DATE	REVISION	SPEC NO	FILE 14.11.T		
			0	RDD	03/11/05	FOR PURCHASE	JOB #	054468		
							DATE	03/11/2005	REQ.	
							BY	CHK'D	APPR.	
				RT						
1	TAG NO. TSDH-650	SERVICE: GLYCOL REGENERATOR								
2	FUNCTIONS	RECORD _____ INDICATE _____ CONTROL _____ BLIND _____ TRANS. _____ OTHER _____ SWITCH _____								
3	CASE	MFR STD <u>X</u> _____ NOM SIZE _____ COLOR : MFR STD <u>X</u> _____ OTHER _____								
4	MOUNTING	FLUSH _____ SURFACE _____ YOKE _____ OTHER _____ LOCAL _____								
5	ENCLOSURE CLASS	GENERAL PURPOSE _____ WATERPROOF _____ EXPLOSIONPROOF _____ CLASS _____ FOR USE IN INTRINSICALLY SAFE SYSTEM _____ OTHER _____								
6	POWER SUPPLY	117 V 60Hz _____ OTHER AC _____ DC _____ VOLTS _____								
7	CHART	STRIP _____ ROLL _____ FOLD _____ CIRCULAR _____ TIME MARKS _____								
8	CHART DRIVE	SPEED _____ POWER _____								
9	SCALES	TYPE _____ RANGE 1 _____ 2 _____ 3 _____ 4 _____								
10	TRANSMITTER OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____ FOR RECEIVER SEE SPEC. SHEET _____								
11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST P _____ PI _____ PD _____ PID _____ IF _____ DF _____ IS _____ DS _____ OTHER _____								
12	ACTION	ON MEAS. INCREASE OUTPUT : INCREASES _____ DECREASES _____ VENT _____								
13	AUTO - MAN SWITCH	NONE <u>X</u> _____ MFR STD _____ OTHER _____								
14	SET POINT ADJ.	MANUAL <u>X</u> _____ EXTERNAL _____ REMOTE _____ OTHER _____								
15	MANUAL REG.	NONE <u>X</u> _____ MFR STD _____ OTHER _____								
16	OUTPUT	4 - 20 mA _____ 10 - 50 mA _____ 21 - 103 kPa(g) _____ 42 - 206 kPa (g) _____ OTHER _____								
17	FILL	SAMA CLASS _____ COMPENSATION _____								
18	PROCESS DATA	TEMP: NORMAL <u>124</u> ° C MAX. <u>204</u> ° C MAX. PRESSURE ATM _____ kPa (g)								
19	RANGE	FIXED _____ ADJ. RANGE <u>-85 to 175</u> ° C SET AT <u>140</u> ° C								
20	BULB	OVERRANGE PROTECTION TO _____ TYPE _____ MTL. _____ EXTENSION: LENGTH _____ mm TYPE _____ SIZE: DIAMETER _____ mm LENGTH _____ mm INSERTION _____ mm								
21	CAPILLARY	CONN. _____ LOCATION _____ mm ABOVE _____ BELOW _____ MFR. STD _____ LENGTH _____ mm MTL. _____ ARMOR _____								
22	WELL	MTL. <u>304SS</u> INSERTION <u>191</u> mm LAG EXT. _____ mm CONN. <u>27mm</u> CONST: DRILLED _____ BUILT - UP COUPLING _____ OTHER _____								
23	ALARM SWITCHES	QUANTITY _____ FORM _____ RATING _____								
24	FUNCTION	TEMP <u>X</u> _____ DEVIATION _____ CONTACTS TO <u>VENT</u> ON TEMP. INCREASE _____								
25	OPTIONS	FILT - REG. _____ SUP. GAGE _____ OUTPUT GAGE _____ CHARTS _____ OTHER <u>C/W 4 meter 304 SS CAPILLARY</u>								
26	MFR. & MODEL NO.	<u>UNITED ELECTRIC</u>								
27	MODEL NO.	<u>820E-2BS-M300-M446 C/W 2-S385-L9 THERMOWELL</u>								
28	P. O. NUMBER	<u>COMES WITH SS NAME TAG</u>								

NOTES:

AREA. UNIT # : .152

ISA FORM SM20.11A

MTEMP-INS.XLT



**800 Series**

TSDH-633 / 650

**800 Series**

**INDICATING TEMPERATURE CONTROLS  
AND THERMOMETERS**



**FEATURES**

- Temperature Indication and Control
- Single or Dual SPDT Output
- Stainless Steel Bulb and Capillary
- $\pm 1\%$  Repeatability
- NEMA 1, 4, and Explosion Proof Versions
- Temperature Ranges:  
-180 to 650°F  
(-117 to 340°C)



UNITED ELECTRIC  
CONTROLS

800-B-01

### OVERVIEW

For applications that require a visual display of process temperature and set point, the 800 Series offers a highly readable four inch setting/indication scale. It is available in two versions: a Lexan enclosure for NEMA 1 or 4 applications with option M300, and an epoxy-coated aluminum enclosure for Div. 1 explosion-proof applications. For temperature indication only, the T800 thermometer incorporates the same performance and construction features of the 800 Series.

800's are controlling and indicating the temperatures of food service appliances, ovens, packaging machines and HVAC equipment as well as other temperature applications within plants.

### FEATURES

- Temperature indication and control switching
- Single or dual SPDT output
- Stainless steel bulb & capillary
- $\pm 1\%$  repeatability
- NEMA 1, 4, and explosion proof versions
- Simple to adjust via external knob



Dual set point version



Explosion proof version

## SPECIFICATIONS

<b>STORAGE TEMPERATURE</b>	-65 to 160°F (-54 to 71°C)
<b>AMBIENT TEMPERATURE LIMITS</b>	-40 to 160°F (-40 to 71°C); set point typically shifts less than 1% of range for a 50°F (28°C) ambient temperature change
<b>SET POINT REPEATABILITY</b>	± 1% of adjustable range
<b>SHOCK</b>	Set point repeats after 15 G, 10 millisecond duration
<b>VIBRATION</b>	Set point repeats after 2.5 G, 5-500 Hz
<b>ENCLOSURE</b>	Types 800, 802, T800 - Lexan®, black finish; clear Lexan® faceplate Types 820E, 822E – Die cast aluminum, epoxy coated enclosure, gasketed
<b>ENCLOSURE CLASSIFICATION</b>	Designed to meet NEMA 1 requirements; NEMA 4 by specifying option M300
<b>INDICATION ACCURACY</b>	± 1% of adjustable range
<b>SWITCH OUTPUT</b>	One or two SPDT; dual switch may be separated up to 100% of range. Switches may be wired “normally open” or “normally closed”
<b>DUAL SWITCH ADJUSTMENT</b>	802: Dual switch controls have separate knob & temperature pointers for each switch set point (standard); turn inner green knob for setting #1 switch; outer black knob for switch #2; common adjustment available with type 822E: switch #2 can be set up to 25% of range span below the switch #1 set point
<b>ELECTRICAL RATING</b>	15 A 125/250/480 VAC resistive
<b>WEIGHT</b>	Approx. 3 lbs., 4 oz. (1,47 kg) (types 800, 802, T800), Approx. 7 lbs (3,18 kg) (types 820E, 822E)
<b>ELECTRICAL CONNECTION</b>	Types 800, 802: 7/8” diameter knockout on left hand side; 18 AWG color-coded leadwires, approx. 9 inches exposed with strain relief (option M100 adds terminal block wiring). Types 820E, 822E: terminal block wiring
<b>BULB AND CAPILLARY</b>	6 feet 304 stainless steel
<b>TEMPERATURE FILL</b>	Model 1BS: solvent filled; models 2-8: non-toxic oil filled
<b>TEMPERATURE DEADBAND</b>	Typically 1% of range under laboratory conditions (70°F ambient circulating bath at rate of 1/2°F per minute change)

## APPROVALS



**UL** Listed  
Types 800 and 802– UL 873, file #E10667



**CSA** certified  
Types 800 and 802– C22.2 no. 24 file #LR7814



**CE** Compliance with Low Voltage Directive (LVD)  
Types 800 and 802



**Class I**, Division 1 & 2, Groups B, C & D  
**Class II**, Division 1 & 2, Groups E, F & G  
**Class III**  
**Class I**, Zone 1, Group IIB + H<sub>2</sub> T6  
Enclosure Type 4X

**UL** Listed, **cUL** Certified  
Temperature: UL 50, 698; CSA C22.2 No. 25-1966,  
30-M1986, CEC Part 1 -- File #E43374  
Types 820E and 822E



**CENELEC/DEMKO A/S** (N.B. #0539)  
**Demko A/S** certified to **ATEX** Directive (94/9/EC)  
II 2 G EEx d IIC T6, Tamb.= -40 °C to +71 °C (-40 °F to +160 °F), IP 66  
II 2 D T+85°C, Tamb.= -40 °C to +71 °C (-40 °F to +160 °F), IP 66  
EN 50 014, EN 50 018, EN 50 281, EN 60529  
Certificate #DEMKO 03 ATEX 0305048  
Types 820E and 822E



UEC Compliant to LVD (73/23/EC & 93/68/EEC)  
Products rated lower than 50 VAC and 75 VDC are outside of the scope of the LVD  
The Low Voltage Directive does not apply to products for use in hazardous locations  
Types 820E and 822E

## TEMPERATURE MODEL CHART

Model	Adjustable Set Point Range		Max. Temp.		Scale Div.		Bulb Size
	°F	°C	°F	°C	°F	°C	OD x Length
Bulb & Capillary							
1BS*	-180 to 120	-117.8 to 48.9	170	76.6	5	5	3/8 x 3 3/4"
2BS	-125 to 350	-87.2 to 176.7	400	204.4	10	5	3/8 x 2 5/8"
3BS	-125 to 500	-87.2 to 260	550	287.8	10	5	3/8 x 2 1/8"
4BS	-40 to 120	-40 to 48.9	170	76.6	5	2	3/8 x 6 3/4"
5BS	-40 to 180	-40 to 82.2	230	110	5	2	3/8 x 5"
6BS	0 to 250	-17.8 to 121.1	300	148.8	5	2	3/8 x 4 1/2"
7BS	0 to 400	-17.8 to 204.4	450	232.2	10	5	3/8 x 3"
8BS	50 to 650	10 to 343.3	700	371.1	10	10	3/8 x 3 1/4"

Standard capillary length is 6 ft., optional capillary lengths and protection are available, consult UE.  
\*NOT AVAILABLE TYPE T800

## HOW TO ORDER

### BUILDING A PART NUMBER

#### Select a **Type**

Refer to the "Type" section below.

Determine type number based on switch output, enclosure, adjustment and reference.

Fill in the type portion of your part number with the corresponding number.

#### Select a **Model**

Refer to the "Model Charts".

Determine model based on adjustable range.

Fill in the model portion of your part number with the corresponding number.

#### Select an **Option**

Refer to the "Options" section.

Determine option number based on switch output, optional materials or other product enhancements.

Fill in the option portion of your part number with the corresponding number.

Leave "option" portion blank if no options are needed. FOR MULTIPLE OPTIONS: Call United Electric Controls.

### TYPE

### TEMPERATURE

Type 800 - Bulb and capillary; one SPDT output; external indication  
 Type 802 - Bulb and capillary; two SPDT outputs; external indication  
 Type 820E - Bulb and capillary; one SPDT output; external indication, explosion proof  
 Type 822E - Bulb and capillary; two SPDT outputs; external indication, explosion proof  
 Type T800 - Thermometer only with external indication

### OPTIONS

#### SWITCH OPTIONS

#### DESCRIPTION

0500 Close deadband, 5 A 125/250 VAC resistive. NOT AVAILABLE TYPE T800  
 2000 20 A 125/250 VAC resistive. NOT AVAILABLE TYPE T800

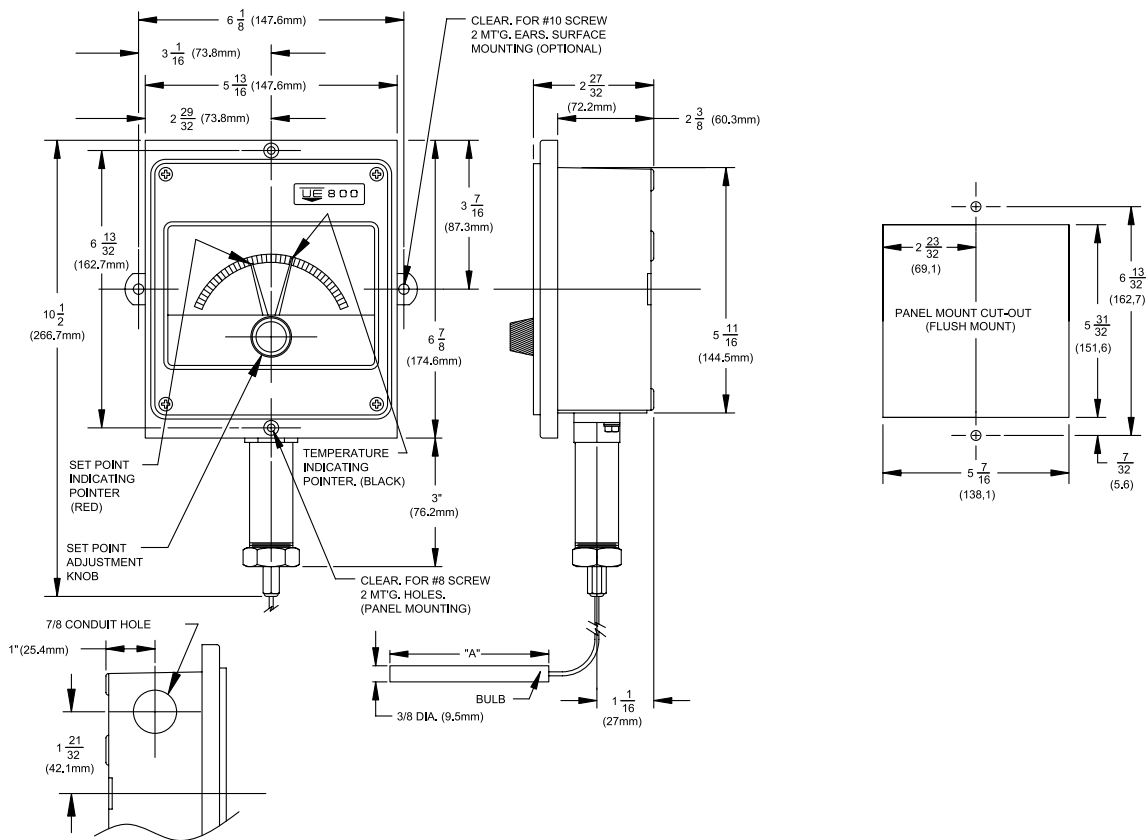
#### OTHER OPTIONS

M007 Drilled 7/8" electrical opening on right side. NOT AVAILABLE TYPES 820E, 822E and T800  
 M100 Terminal block wiring. NOT AVAILABLE TYPE 820E, 822E (standard) AND T800  
 M201 Factory set one switch; specify increasing or decreasing temperature and set point. NOT AVAILABLE TYPE T800  
 M202 Factory set two switches; specify increasing or decreasing temperature and set point. NOT AVAILABLE SINGLE SWITCH VERSIONS  
 M300 NEMA 4 construction; includes watertight conduit fitting and gasketing. NOT AVAILABLE TYPE 820E, 822E  
 M320 Tamper resistant cover. NOT AVAILABLE TYPES T800  
 M416 SAA approval. NOT AVAILABLE TYPES 800, 802, T800  
 M444 Paper ID tag  
 M446 Stainless steel ID tag & wire attachment (*attachment location will vary depending on product*)  
 M900 Watertight conduit fitting; converts 7/8" hole to 1/2" NPT fitting. NOT AVAILABLE TYPES 820E, 822E, T800



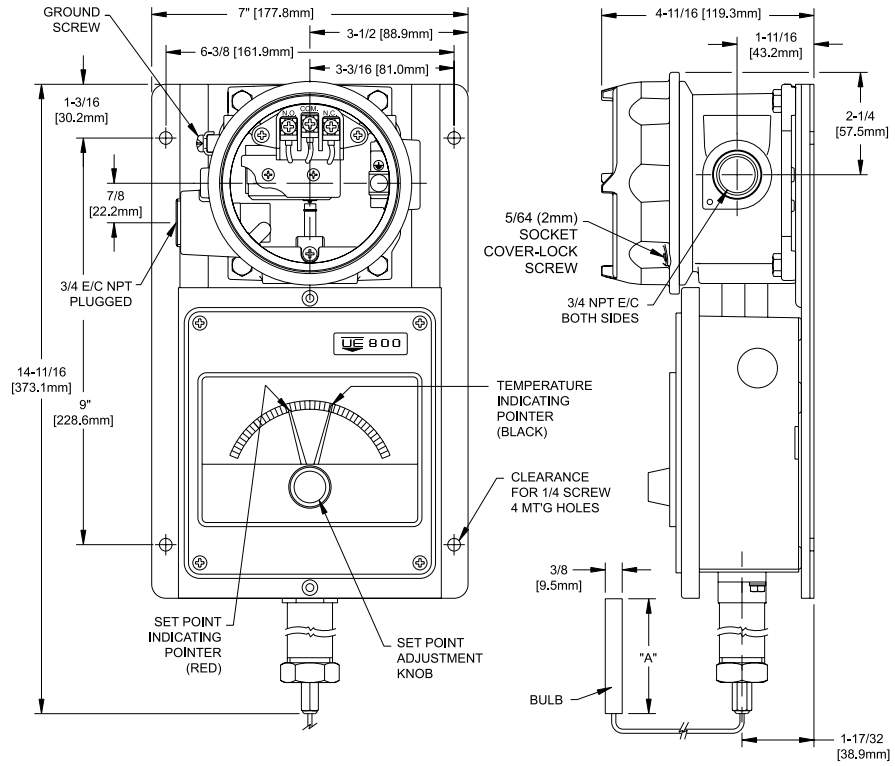
## DIMENSIONAL DRAWINGS

### 800 Series Set Point Adjustment via Reference Dial

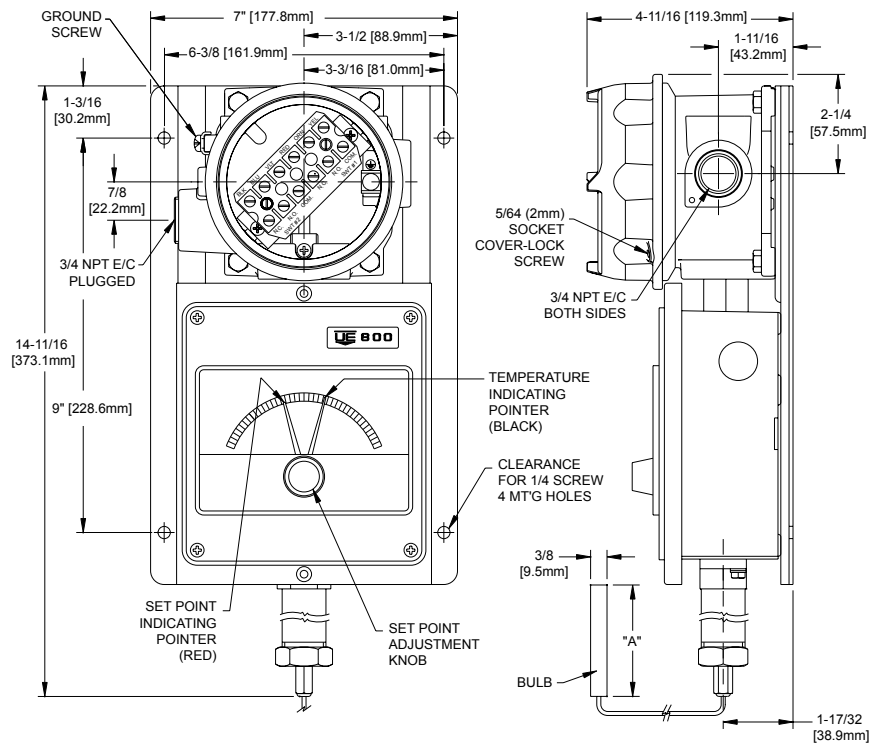




**820 E**



**822 E**



## RECOMMENDED PRACTICES AND WARNINGS

United Electric Controls Company recommends careful consideration of the following factors when specifying and installing UE pressure and temperature units. Before installing a unit, the Installation and Maintenance instructions provided with unit must be read and understood.

- To avoid damaging unit, proof pressure and maximum temperature limits stated in literature and on nameplates must never be exceeded, even by surges in the system. Operation of the unit up to maximum pressure or temperature is acceptable on a limited basis (e.g., start-up, testing) but continuous operation must be restricted to the designated adjustable range. Excessive cycling at maximum pressure or temperature limits could reduce sensor life.
- A back-up unit is necessary for applications where damage to a primary unit could endanger life, limb or property. A high or low limit switch is necessary for applications where a dangerous runaway condition could result.
- The adjustable range must be selected so that incorrect, inadvertent or malicious setting at any range point cannot result in an unsafe system condition.
- Install unit where shock, vibration and ambient temperature fluctuations will not damage unit or affect operation. Orient unit so that moisture does not enter the enclosure via the electrical connection. When appropriate, this entry point should be sealed to prevent moisture entry.
- Unit must not be altered or modified after shipment. Consult UE if modification is necessary.
- Monitor operation to observe warning signs of possible damage to unit, such as drift in set point or faulty display. Check unit immediately.
- Preventative maintenance and periodic testing is necessary for critical applications where damage could endanger property or personnel.
- For all applications, a factory set unit should be tested before use.
- Electrical ratings stated in literature and on nameplate must not be exceeded. Overload on a switch can cause damage, even on the first cycle. Wire unit according to local and national electrical codes, using wire size recommended in installation sheet.
- Do not mount unit in ambient temperature exceeding published limits.

## LIMITED WARRANTY

Seller warrants that the product hereby purchased is, upon delivery, free from defects in material and workmanship and that any such product which is found to be defective in such workmanship or material will be repaired or replaced by Seller (Ex-works, Factory, Watertown, Massachusetts. INCOTERMS); provided, however, that this warranty applies only to equipment found to be so defective within a period of 24 months from the date of manufacture by the Seller. Seller shall not be obligated under this warranty for alleged defects which examination discloses are due to tampering, misuse, neglect, improper storage, and in any case where products are disassembled by anyone other than authorized Seller's representatives. EXCEPT FOR THE LIMITED WARRANTY OF REPAIR AND REPLACEMENT STATED ABOVE, SELLER DISCLAIMS ALL WARRANTIES WHATSOEVER WITH RESPECT TO THE PRODUCT, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

## LIMITATION OF SELLER'S LIABILITY

SELLER'S LIABILITY TO BUYER FOR ANY LOSS OR CLAIM, INCLUDING LIABILITY INCURRED IN CONNECTION WITH (I) BREACH OF ANY WARRANTY WHATSOEVER, EXPRESSED OR IMPLIED, (II) A BREACH OF CONTRACT, (III) A NEGLIGENT ACT OR ACTS (OR NEGLIGENT FAILURE TO ACT) COMMITTED BY SELLER, OR (IV) AN ACT FOR WHICH STRICT LIABILITY WILL BE INPUTTED TO SELLER, IS LIMITED TO THE "LIMITED WARRANTY" OF REPAIR AND/OR REPLACEMENT AS SO STATED IN OUR WARRANTY OF PRODUCT. IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY SPECIAL, INDIRECT, CONSEQUENTIAL OR OTHER DAMAGES OF A LIKE GENERAL NATURE, INCLUDING, WITHOUT LIMITATION, LOSS OF PROFITS OR PRODUCTION, OR LOSS OR EXPENSES OF ANY NATURE INCURRED BY THE BUYER OR ANY THIRD PARTY.

*UE specifications subject to change without notice.*

## U.S. SALES OFFICES

United Electric Controls  
32 Highland Rd.  
South Hampton, NH 03827  
Phone: 603-394-0078  
FAX: 603-394-0175

United Electric Controls  
28 N. Wise Ave.  
Freeport, IL 61032  
Phone: 815-235-3501  
FAX: 815-235-3847

United Electric Controls  
1022 Vineyard Drive  
Conyers, GA 30013  
Phone: 770-483-8400  
FAX: 770-929-8716

United Electric Controls  
5829 Grazing Court  
Mason, OH 45040  
Phone: 513-398-3175  
FAX: 513-398-3076

United Electric Controls  
27 Summit Terrace  
Sparta, NJ 07871  
Phone: 973-271-2550  
FAX: 973-729-6099

United Electric Controls  
102 Salazar Court  
Clayton, CA 94517  
Phone: 925-524-0210  
FAX: 925-524-0210

United Electric Controls  
4306 Lakeshore Forest Drive  
Missouri City, TX 77459  
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FAX: 281-431-8158

## INTERNATIONAL OFFICES

AUSTRALIA  
United Electric Controls  
(Australia) PTY Ltd  
Unit 2, 615 Warrigal Road  
Locked Bag 600  
Ashburton, Victoria  
3147, Australia  
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United Electric Controls-Europe  
G. Van Gervenstraat 19A  
B-9120 Beveren-Waas, Belgium  
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5320 Bradco Boulevard  
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FAX: 905-625-5709

GERMANY  
United Electric Controls  
An Der Zentlinde 21  
D-64711 Erbach, Germany  
Phone: 496-062-7400  
FAX: 496-062-7501

MALAYSIA  
United Electric Controls, Far East  
No. 1-2-2, 2nd Floor  
Jalan 4/101C  
Cheras Business Centre  
Batu 5, Jalan Cheras  
56100 Kuala Lumpur, Malaysia  
Phone: 603-9133-4122  
FAX: 603-9133-4155



UNITED ELECTRIC  
CONTROLS

180 Dexter Avenue, P.O. Box 9143  
Watertown, MA 02471-9143 USA  
Telephone: 617 926-1000 Fax: 617 926-2568  
<http://www.ueonline.com>

PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3			TEMPERATURE INSTRUMENTS ( FILLED SYSTEM )				SHEET 1 OF 1					
CUSTOMER : PROPAK PLANT : STOCK REFRIG. 8B SERVICE : TEMPERATURE SWITCH			NO		BY	DATE	REVISION	SPEC NO	FILE 14.11.T			
			0		RDD	03/11/05	ISSUE FOR PURCHASE	JOB #	054468			
								DATE	03/11/2005			
								REQ.				
					BY	CHK'D	APPR.					
1	TAG NO. TSH-671	SERVICE	REFRIGERANT COMPRESSOR DISCHARGE									
2	FUNCTIONS	RECORD	_____	INDICATE	_____	CONTROL	_____	BLIND	_____	TRANS.	_____	
3	CASE	MFR STD	X	NOM SIZE	_____	COLOR : MFR STD	X	OTHER	_____			
4	MOUNTING	FLUSH	_____	SURFACE	_____	YOKE	_____	OTHER	_____			
5	ENCLOSURE CLASS	GENERAL PURPOSE	_____	WATERPROOF	_____	EXPLOSIONPROOF	X	CLASS I	_____			
6	POWER SUPPLY	FOR USE IN INTRINSICALLY SAFE SYSTEM	_____	OTHER AC	_____	DC	X	VOLTS	24			
7	CHART	STRIP	_____	ROLL	_____	FOLD	_____	CIRCULAR	_____	TIME MARKS	_____	
8	CHART DRIVE	SPEED	_____					POWER	_____			
9	SCALES	TYPE	_____									
		RANGE	1 _____	2 _____	3 _____	4 _____						
X	10	TRANSMITTER OUTPUT	4 - 20 mA _____	10 - 50 mA _____	21 - 103 kPa(g) _____	42 - 206 kPa (g) _____	OTHER	_____				
			FOR RECEIVER SEE SPEC. SHEET _____									
C	11	CONTROL MODES	P = PROP ( GAIN ), I = INTEGRAL ( AUTO RESET ), D = DERIVATIVE ( RATE ), SUB : S = SLOW F = FAST									
			P _____	PI _____	PD _____	PID _____	IF _____	DF _____	IS _____	DS _____		
			OTHER _____									
R	12	ACTION	ON MEAS. INCREASE OUTPUT :			INCREASES _____	DECREASES	X				
O	13	AUTO - MAN SWITCH	NONE _____	MFR STD	X	OTHER	_____					
L	14	SET POINT ADJ.	MANUAL _____	EXTERNAL	_____	REMOTE	_____	OTHER	_____			
L	15	MANUAL REG.	NONE _____	MFR STD	_____	OTHER	_____					
E	16	OUTPUT	4 - 20 mA _____	10 - 50 mA _____	21 - 103 kPa(g) _____	42 - 206 kPa (g) _____	OTHER	_____				
R												
	17	FILL	SAMA CLASS _____ COMPENSATION NO _____									
E	18	PROCESS DATA	TEMP: NORMAL	68	° C	MAX. 121	° C	MAX. PRESSURE	1724	kPa (g)		
L	19	RANGE	FIXED	66-190	ADJ. RANGE	_____	SET AT	100	° C			
E			OVERRANGE PROTECTION TO _____									
M	20	BULB	TYPE	_____	MTL.	_____	EXTENSION:	LENGTH	_____	mm	TYPE	_____
E			SIZE: DIAMETER	_____	mm	LENGTH	_____	mm	INSERTION	_____	mm	
N			CONN.	_____	LOCATION	_____	mm	ABOVE	_____	BELOW	_____	
T	21	CAPILLARY	MFR. STD	X	LENGTH	3000	mm	MTL.	304SS	ARMOR	X	
	22	WELL	MTL.	304SS	INSERTION	64	mm	LAG EXT.	51	mm	CONN.	27 NPT
			CONST: DRILLED	_____	BUILT - UP	_____	OTHER	_____				
	23	ALARM SWITCHES	QUANTITY	_____	FORM	_____	RATING	_____				
	24	FUNCTION	TEMP	X	DEVIATION	_____	CONTACTS TO	OPEN	ON TEMP. INCREASE	_____		
	25	OPTIONS	FILT - REG.	_____	SUP. GAGE	_____	OUTPUT GAGE	_____	CHARTS	_____		
			OTHER	_____								
	26	MFR. & MODEL NO.	SOR									
	27	MODEL NO.	205AG-EF115-U9-C7A									
	28	P. O. NUMBER	_____									

NOTES:

AREA. UNIT # :



## General

This instruction provides information for mounting, electrical connection, process connection, and calibration of SOR Temperature Switches.

**NOTE:** If you suspect that an instrument is defective, contact the factory or the SOR representative in your area for a return authorization number. If the instrument cannot be returned for service, field work should be performed by a qualified instrument technician using factory authorized procedures. Contact the factory or the SOR representative in your area for technical support.

The SOR Temperature Switch consists of a pressure switch with a sealed temperature sensing bulb attached directly to the pressure port. (An optional remote temperature sensing bulb can be connected to the pressure port with an armor-clad capillary.) The temperature sensing system is pressure filled with a volatile fluid. Process temperature changes cause proportional vapor pressure changes in the temperature sensing bulb that act on the diaphragm/piston assembly to actuate and deactuate a snap-action electrical switching element at discrete process temperatures. The instrument's behavior is determined by vapor pressure. (105 range model fill media is inert gas.)

*Design and specifications are subject to change without notice.*

## Installation

This product should only be installed by trained and competent personnel.

### Direct-Mount Probe

The temperature sensing probe is rigidly attached to the instrument's body/housing. Carefully insert sensing probe into process through suitable fitting or

# Temperature Switches

## General Instructions

thermowell. Standard process connection is 1/2-inch NPT(M). Ensure that ample clearance exists before rotating the instrument housing to make threaded connection. Tighten probe hex fitting with 1-1/8-inch open-end wrench for leak free fit. A locally customized mounting bracket may be used if more support is desired. Housings L, S, TA, V1, V2, V3, LC, SC, BA, B3, B4, B5 and B6 are not recommended for direct mount where vibration is expected. These housings should be securely mounted to a flat surface (bulk-head or panel rack) or pipe stanchion.

### Remote-Mount Probe — Capillary

1. Secure housing-mounting pad to bulkhead, panel rack or pipe stanchion with suitable 1/4-inch (6.35 mm) bolts.

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**IMPORTANT:** When mounting to an irregular or uneven surface, install rubber washers on bolts between housing and mounting surface (except for high vibration applications) to prevent deformation of housing, which could change relative positions of internal parts and affect calibration or render device inoperative.

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2. Mounting by electrical conduit connection is **NOT** recommended.
3. Suggested mounting orientation is electrical conduit connection at 3 or 9 o'clock and sensing body at 6 o'clock. However, device is not position sensitive and can be mounted in any position. If breather drain is installed, it must be oriented at 6 o'clock (pointing down) so condensation will drain. It must be kept clear of paint and foreign matter.
4. Carefully insert sensing probe into process through suitable fitting or thermowell. Adjust desired insertion length. Tighten probe hex fitting with 7/8" open-end wrench. Tighten 9/16" hex nut to fingertight. Then hold the 7/8" fitting with a wrench and tighten the 9/16" hex nut an additional 1-1/4 turns from finger tight. Avoid sharp bends in capillary.

## Process Connection

Temperature sensing probe is 300 series stainless steel. If process is compatible, it may be directly inserted into the process without use of a thermowell. Best results are obtained when the probe

is completely immersed in the process. A thermowell increases response time (lag). A thermowell filled with thermal transfer media reduces lag.

## Electrical Connection

**CAUTION:** Switching Element Assembly has been precisely positioned in the housing at the factory for optimum performance. Any inadvertent movement or replacement in the field will degrade performance and could render the device inoperative, unless factory authorized procedures are followed.

When making electrical connections, use care to apply minimal strain to the electrical switching element. Refer to wiring schematic on reverse for terminal and wire codes.

Ensure that wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.

## Calibration

Disconnect electrical power to temperature switch. Remove housing cover ( or weathertight cap).

**NOTE:** It is not necessary to disconnect electrical power with the Big Hermet series or models in B3, B4, B5 and B6 housings provided that only the cover fastened with four captive screws over Set Point adjustment is removed.

**WARNING:** Units in Hazardous Locations — Prior to calibration, make sure that the work area is declassified before removing the explosion proof cover to calibrate the unit. Failure to do so could result in severe personal injury or substantial property damage.

**For instruments with 1/8" hex Allen wrench set point adjustment under weathertight cap:** Use 1/8" hex Allen wrench to turn adjusting screw to achieve desired set point. Turn adjusting screw clockwise (in) to increase set point and counterclockwise (out) to decrease set point. Calibration scale is not installed, so external measurement of process temperature is necessary. Consult factory.

## For instruments with 3/4-inch hex set point adjustment:

Use 3/4-inch open-end wrench to turn hex adjusting nut clockwise to increase set point, and counterclockwise to decrease set point. Approximate set point can be obtained by sighting across top of adjusting nut to calibration scale on the housing floor. If precise set point calibration is required, it will be necessary to use a regulated thermal bath and suitable continuity tester. Consult factory.

## For instruments with dead band adjustment:

Use the fixed dead band procedure (above) to calibrate the desired decreasing temperature set point. The increasing temperature set point can then be adjusted by turning the white thumbwheel on the electrical switching element. Setting A yields the smallest possible dead band. Setting F yields the widest possible dead band. Settings above E may degrade repeatability.

## Special Conditions for Safe Use for ATEX Certified Mini-Hermet Temperature Switches only

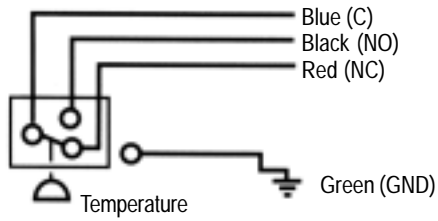
1. The terminal box to which the equipment is attached must, together with the switch, ensure the requisite thread engagement for Apparatus Group IIC.
2. The reliability of the diaphragm has been assessed on the basis of 100,000 operations. The diaphragm assembly must be changed before this number of operations is exceeded.
3. The permanently attached cables are to be suitably terminated and protected from impact.
4. When the switch is attached to an increased safety terminal box the assembly must be capable of withstanding the impact test specified in BS 5501: Part 1: 1997.
5. The sealing arrangements must maintain the minimum IP54 rating required by the increased safety enclosure.
6. The switch must attach to the enclosure using an existing entry.

## Wiring Schematics

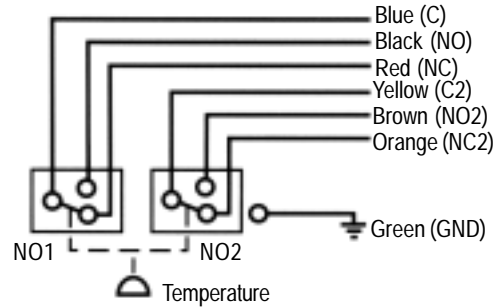
Housing Type	Conduit Connection	Contact Termination	Contact Identification
Open Bracket	None	Screw Terminals	Stamped on insulation
		Wire leads	Color coded and marked
All others	3/4 NPT(F), M 20 x 1.5 (F), or 1/2 NPT(M) unless optional adapter is specified	Screw terminals	Stamped on insulation
		Wire leads	Color coded and marked
		Terminal strip	Stamped on insulation

# Wiring Lead Code Colors

## SPDT

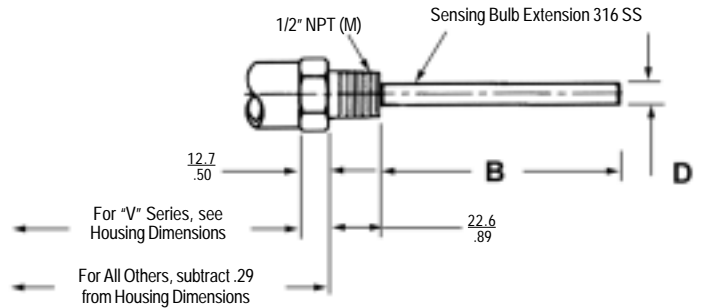
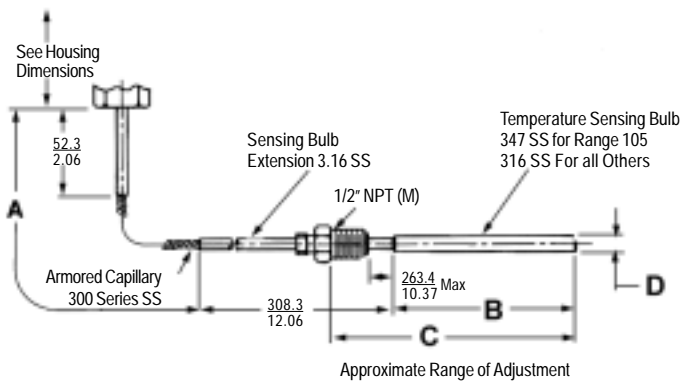


## DPDT



# Probe Dimensions

## Remote Mount



## Direct Mount

Linear =  $\frac{\text{mm}}{\text{in.}}$

Feature	A		B				B with NB option		C				D dia.			
	Range	All	135,125,115		105		135,125		135,125,115		105		135,125,115		105	
Probe	m	ft	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
201	NA	NA	105.7	4.16	--	--	107.2	4.22	128.3	5.05	--	--	9.7	0.38	--	--
203	1.8	6.0	112.0	4.41	148.3	5.84	112.0	4.41	135 to 396	5.3 to 15.6	170 to 433	6.7 to 17.1	9.7	0.38	16.0	0.63
205	3.0	10.0	124.7	4.91	148.3	5.84	112.0	4.41	147 to 409	5.8 to 16.1	170 to 433	6.7 to 17.1	9.7	0.38	16.0	0.63
207	4.5	15.0	162.8	6.41	148.3	5.84	112.0	4.41	185 to 447	7.3 to 17.6	170 to 433	6.7 to 17.1	9.7	0.38	16.0	0.63
209	6.0	20.0	194.6	7.66	148.3	5.84	112.0	4.41	216 to 480	8.5 to 18.9	170 to 433	6.7 to 17.1	9.7	0.38	16.0	0.63

## General Information for ATEX Certified Models

Range Designators	Adjustable Range		Overrange		Max. Process Pres.	
	°F	°C	°F	°C	psi	bar
135	-50 to 70	-45 to 21	190	88	2300	158
125	40 to 225	5 to 107	360*	182*	2300	158
115	150 to 375	66 to 190	520	270	2300	158
105**	300 to 1000	150 to 540	1100	590	1000	70

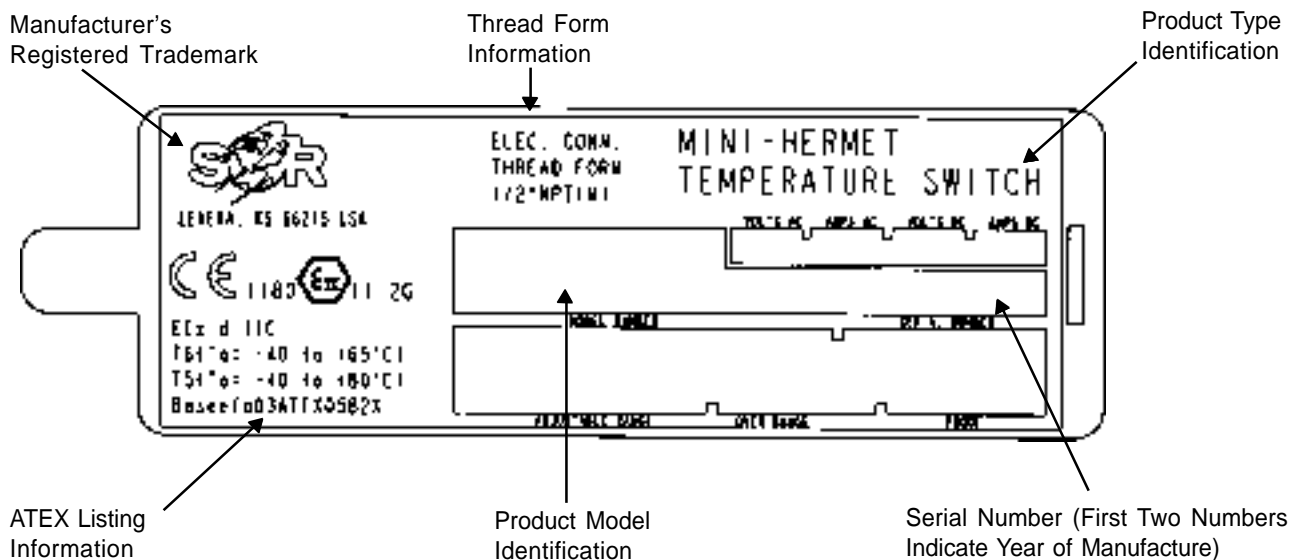
\* Overrange temperature decreases to 250°F (120°C) when NB option is specified.  
See accessories on page 12.

\*\* Remote mount only.

Designator	AC Rating		DC Rating			
	Volts	Amps	Volts	Amps	Volts	Amps
AF & AG	250	11	125	0.5	30	5
EF & EG	250	5	125	0.5	30	5
JF & JG	125	1	---	---	30	1

## ATEX Marking Materials

For ATEX Certified Models



# Shock/Vibration Control Switches Installation Instructions

**Models: VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94**



Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

## GENERAL INFORMATION

### WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.



Model VS2EX

### Description

The Murphy shock and vibration switches are available in a variety of models for applications on machinery or equipment where excessive vibration or shock can damage the equipment or otherwise poses a threat to safe operation. A set of contacts is held in a latched position through a mechanical latch and magnet mechanism. As the level of vibration or shock increases an inertia mass exerts force against the latch arm and forces it away from the magnetic latch causing the latch arm to operate the contacts. Sensitivity is obtained by adjusting the amount of the air gap between the magnet and the latch arm plate.

Applications include all types of rotating or reciprocating machinery such as cooling fans, engines, pumps, compressors, pump jacks, etc.

### Models

**VS2:** Base mount; non hazardous locations.

**VS2C:** C-clamp mount; non hazardous locations.

**VS2EX:** Explosion-proof; Class I, Div. 1, Groups C and D\*.

**VS2EXR:** Explosion-proof with remote reset.

**VS2EXRB:** Explosion-proof; Class I, Div. 1, Group B\* ; with remote reset.

**VS94:** Base mount; non hazardous locations, NEMA 4X/IP66.

### Remote Reset Option (VS2EXR, VS2EXRB and VS94 only)

Includes built-in electric solenoid which allows reset of tripped unit from a remote location. Standard on VS2EXR and VS2EXRB. Optional on VS94 (options listed below).

**-R15:** Remote reset for 115 VAC

**-R24:** Remote reset for 24 VDC

### Time Delay Option (VS94 only)

Overrides trip operation on start-up. For VS94 series models, the delay time is field-adjustable from 5 seconds up to 6-1/2 minutes with a 20-turn potentiometer (15 seconds per turn approximately). Options listed below:

**-T15:** Time delay for 115 VAC

**-T24:** Time delay for 24 VDC

### Space Heater Options (VS94 only)

This optional space heater board prevents moisture from condensing inside the VS94 Series case. Options listed below:

**-H15:** Space heater for 115 VAC

**-H24:** Space heater for 24 VDC

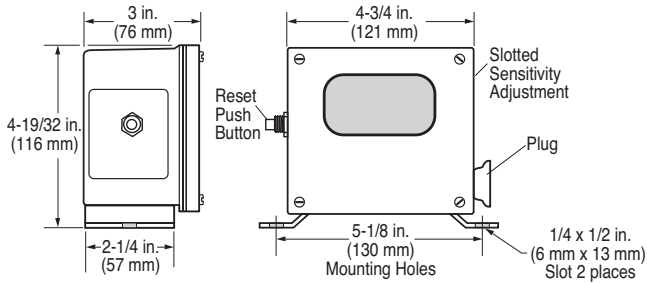
### Warranty

A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to [www.fwmurphy.com/support/warranty.htm](http://www.fwmurphy.com/support/warranty.htm)

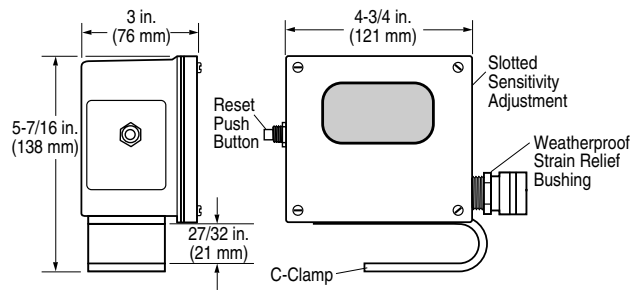


# DIMENSIONS

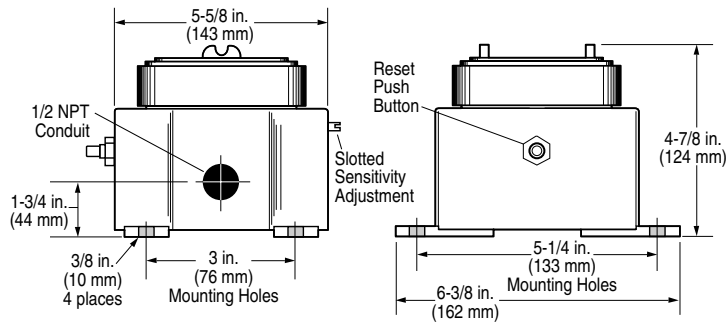
## VS2



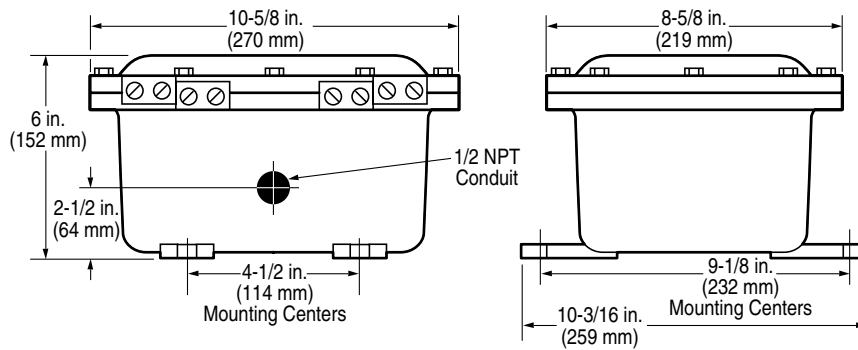
## VS2C



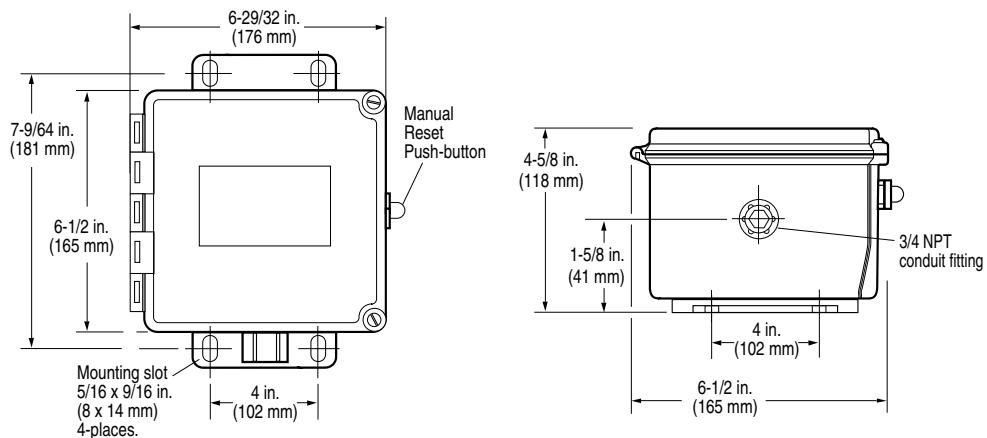
## VS2EX and VS2EXR



## VS2EXRB



## VS94



## SPECIFICATIONS

### VS2 and VS2C

- **Case:** Weatherproof (equal to NEMA 3R) suitable for non-hazardous areas.  
VS2: *Base mount*  
VS2C: *C-clamp mount. Includes 45 feet (13.7 meters), 2-conductor 16 AWG, 30 strands/0.25 mm strand dia. (1.5 mm<sup>2</sup>) cable, and five cable hold down clamps.*
- **Contacts:** SPDT double make leaf contacts, 5A @ 480 VAC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

### VS2EX

- **Case:** Explosion-proof and weatherproof aluminum alloy housing; meets NEMA 7/IP50 specifications; Class I, Division 1, Groups C & D; UL and CSA listed.\*  
VS2EX: *base mount.*
- **Snap-switches:** 2-SPDT snap-switches; 5A @ 480 VAC;\* 2A resistive, 1A inductive, up to 30 VDC.
  - **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

### VS2EXR

- **Case:** Same as VS2EX.
- **Snap-switch:** 1-SPDT snap-switch and reset coil; 5A @ 480 VAC;\* 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset (optional):**

<i>Option</i>	<i>Operating Current</i>
-R15:	350 mA @ 115 VAC
-R24:	350 mA @ 24 VDC
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

### VS2EXRB

- **Case:** Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.
- **Snap-switch:** 1-SPDT snap-switch with reset coil (option available for

additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.

### • Remote Reset (optional):

*Option Operating Current*

-R15: 350 mA @ 115 VAC

-R24: 350 mA @ 24 VDC

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

### VS94

- **Case:** Polyester fiberglass reinforced; NEMA type 4 and 4X; IP66; CSA types 4 and 12.
- **Conduit Fitting:** 3/4 NPT conduit fitting connection.
- **Normal Operating Ambient Temperature:** 0 to 140°F (-18 to 60°C).
- **Snap-switches:** 2-SPDT snap acting switches; 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Heater (optional):**

<i>Option</i>	<i>Operating Current</i>
H15	.023 A @ 115 VAC
H24	.12 A @ 24 VDC
- **Remote Reset (optional):**

<i>Option</i>	<i>Operating Current</i>
R15	.17 A @ 115 VAC
R24	.36 A @ 24 VDC
- **Time Delay (optional):**

<i>Option</i>	<i>Operating Current</i>	<i>Standby Current</i>
T15	.360 A @ 115 VAC	.01 A @ 115 VAC
T24	1.15 A @ 24 VDC	.01 A @ 24 VDC
- **Time Delay/Remote Reset:** Adjustable 20-turn potentiometer from 5 seconds to 6-1/2 minutes (15 seconds per turn approximately).

\*CSA and UL listed with 480 VAC rating.

## INSTALLATION



**WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.**

The VS2 and VS94 series shock switches are sensitive to shock and vibration in all three planes of motion - up/down, front/back and side/side. Front/back is the most sensitive (The reset pushbutton is located on the "front" of the unit). For maximum sensitivity mount the unit so that the front faces into the direction of rotation of the machine. (See Dimensions on page 2 for sensitivity adjustment location).

The VS2 and VS94 Series must be firmly attached/mounted to the machine so that all mounting surfaces are in rigid contact with the mounting surface of the machine. For best results, mount the instrument in-line with the direction of rotating shafts and/or near bearings. In other words, the reset push button should be mounted pointing into the direction of shaft rotation (see page 5). It may be necessary to provide a mounting plate or bracket to attach the VS2 and VS94 Series to the machine. The mounting bracket should be thick enough to prevent induced acceleration/vibration upon the VS2 or VS94 Series. Typically 1/2 in. (13mm) thick plate is sufficient. See illustrations on page 5 for typical mounting locations.



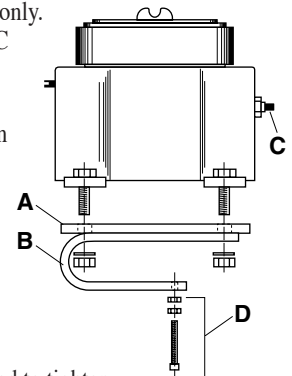
**CAUTION:** A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting

orientation should be on a horizontal plane or with the sensitivity adjustment pointing down. Sensitivity adjustment for model VS2 is covered by a plug. The plug must be in place and tight to prevent moisture or dust intrusion.

### C-Clamp Installation (VS2C model only)

A C-Clamp is supplied with the VS2C model only. The C-Clamp is shipped installed on the VS2C but must be installed on the VS2EX and VS2EXR switches.

1. The C-Clamp (B) will already be installed on a 1/4 in. (6 mm) thick steel mounting plate (A). Bolt the VS2 switch to the mounting plate as illustrated — with four 5/16 in. bolts, nuts, and washers.
2. The mounting location should provide convenient access to the TATTLETALE® push button (C).
3. The hardened set screw and nuts (D) are used to tighten the switch to an I-Beam or cross member such as a Sampson post of an oilwell pumpjack.



*Continued on next page.*

**All Models**



**WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.**

1. Firmly secure the unit to the equipment using the base foot mount or C-Clamp if applicable. See *C-Clamp Installation* page 3.  
For oilwell pumpjacks attach the VS2 and VS94 Series to the Sampson post or walking beam. See *Typical Mounting Locations* page 5.
2. Make the necessary electrical connections to the vibration switch. See *Internal Switches*, page 6 for electrical terminal locations and page 7 for typical wiring diagrams. **DO NOT EXCEED VOLTAGE OR CURRENT RATINGS OF THE CONTACTS.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

*NOTE: If the electrical cable crosses a pivot point such as at the pivot of the walking beam, be sure to allow enough slack in the cable so that no stress is placed on the cable when the beam moves.*

If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc. or as otherwise required by applicable electrical codes. If conduit is not attached directly to the VS2 and VS94 Series switch, use a strain relief bushing and a weatherproof cap on the exposed end of the conduit. A “drip loop” should be provided in the cable to prevent moisture from draining down the cable into the conduit should the weathercap fail.

**Sensitivity Adjustment**



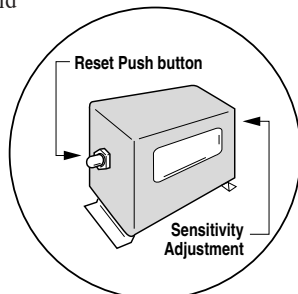
**WARNING: REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.**

All models of the VS2 and VS94 Series cover a wide range of sensitivity. Each model is adjusted to the specific piece of machinery on which it is installed. After the switch has been installed in a satisfactory location (see page 5) the sensitivity adjustment will be increased or decreased so that the switch does not trip during start-up or under normal operating conditions. This is typically done as follows:

**1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.**

2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL “A”). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.

**DETAIL “A”**



3. Start the machine.
4. If the instrument trips on start-up,

allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL “B”).

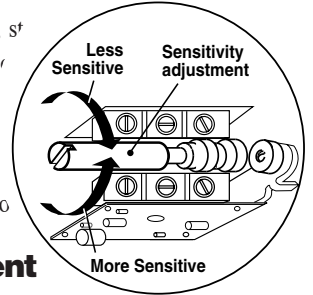


**WARNING: MAKE THE AREA NON-HAZARDOUS BEFORE OPENING THE EXPLOSION-PROOF (-EX) ENCLOSURES.**

Depress the reset button and restart the machine. Repeat this process until the unit does not trip on start-up.

**DETAIL “B”**

5. If the instrument does NOT trip on start-up, sensitivity adjustment 1/4 turn counter-clockwise/stop process until the instrument trips on adjustment 1/4 turn clockwise (less sensitive verify that the instrument will not trip on start
6. Verify that the unit will trip when abnormal shock



**VS94 Time Delay Adjustment**

1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking noise is heard.



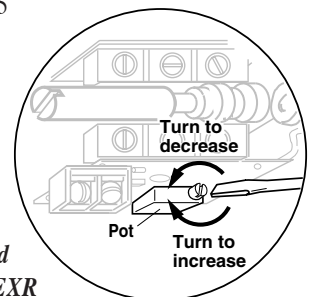
**WARNING: REMOVE ALL POWER BEFORE OPENING ACCESS DOOR. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES.**

**3. TURN THE POWER OFF TO RESET THE TIME DELAY CIRCUIT.**

*NOTE: Allow 30 seconds bleed-time between turning the power “OFF” and “ON”.*

4. Locate the time adjustment pot (DETAIL “C”). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (15 seconds per turn approximately).
5. Repeat the above steps as necessary to obtain desired time delay.

**DETAIL “C”**

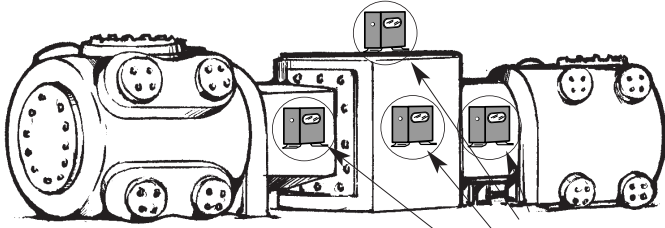


*NOTE: An external time delay can be used with the remote reset feature of the VS2EXR series to provide a remote reset and override of the trip operation on start-up. Time delay must automatically disconnect after equipment start-up.*

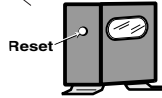
## TYPICAL MOUNTING LOCATIONS

**NOTE:** These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

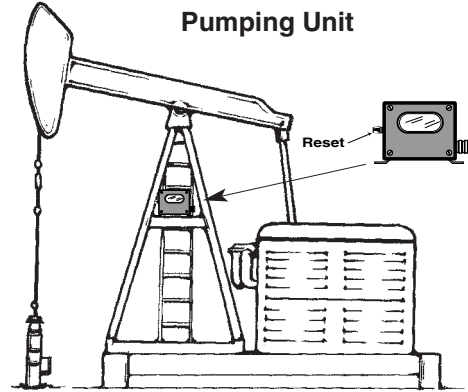
### 2-Throw Balance-Opposed Compressor



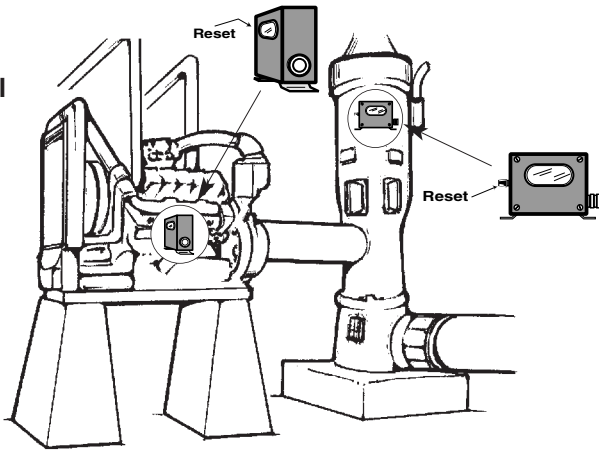
**NOTE:** If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



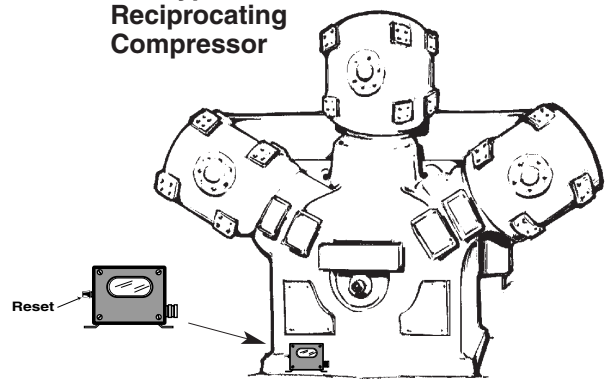
### Pumping Unit



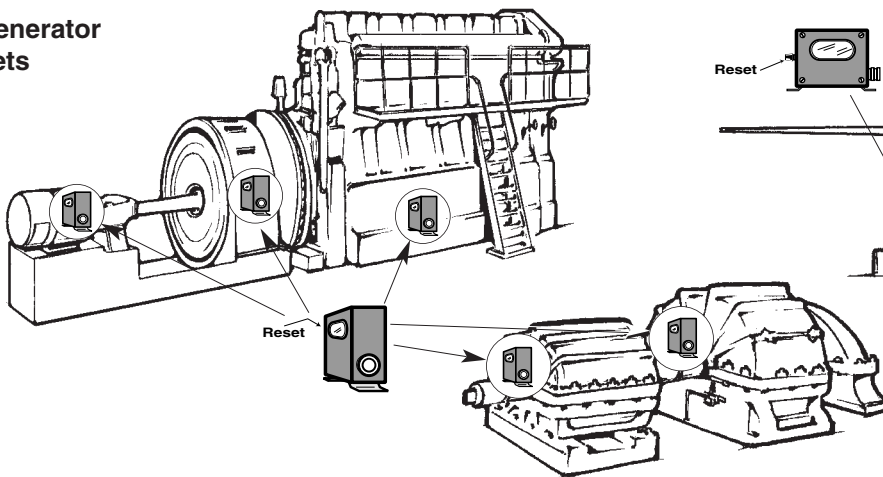
### Engine and Vertical Shaft Pump



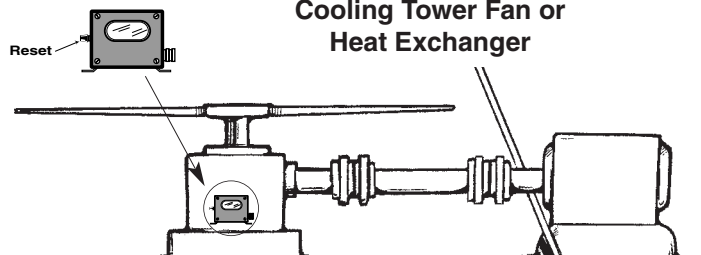
### "Y" Type Reciprocating Compressor



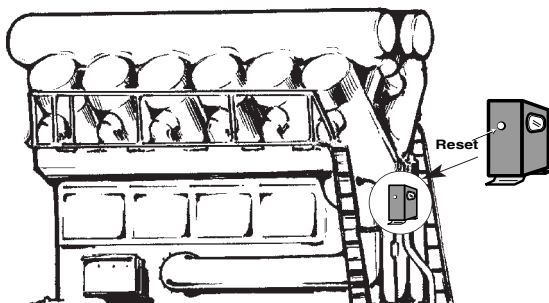
### Generator Sets



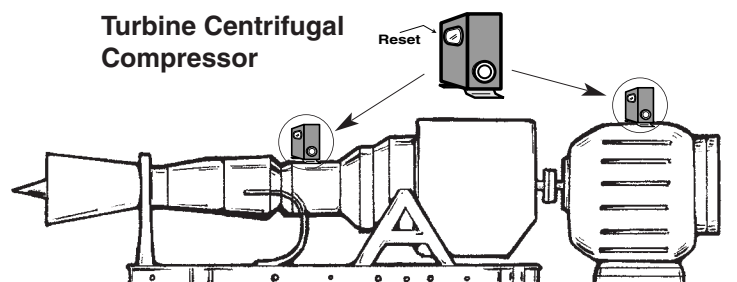
### Cooling Tower Fan or Heat Exchanger



### Engine Compressor

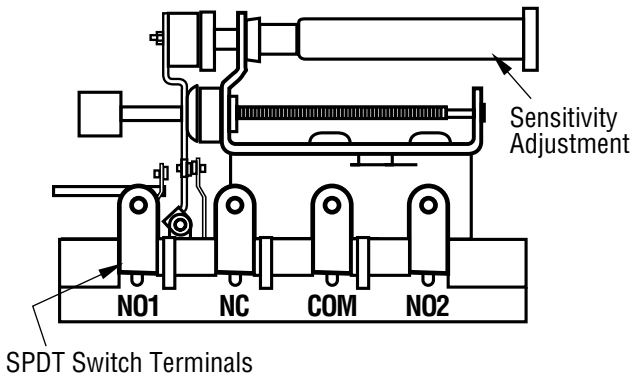


### Turbine Centrifugal Compressor

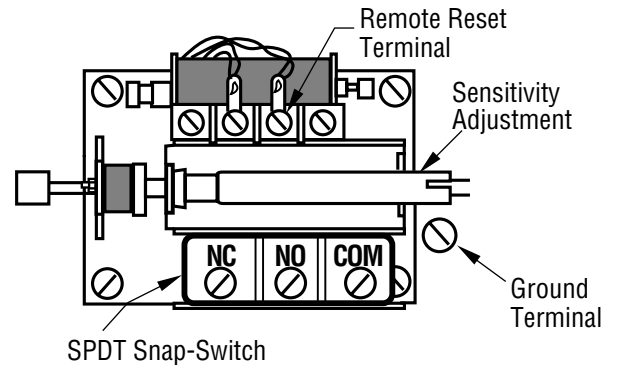


# INTERNAL SWITCHES

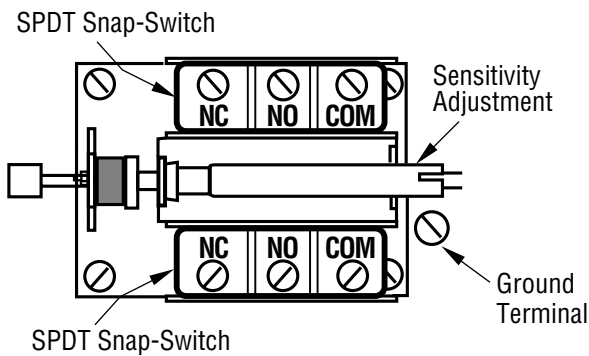
## VS2 and VS2C



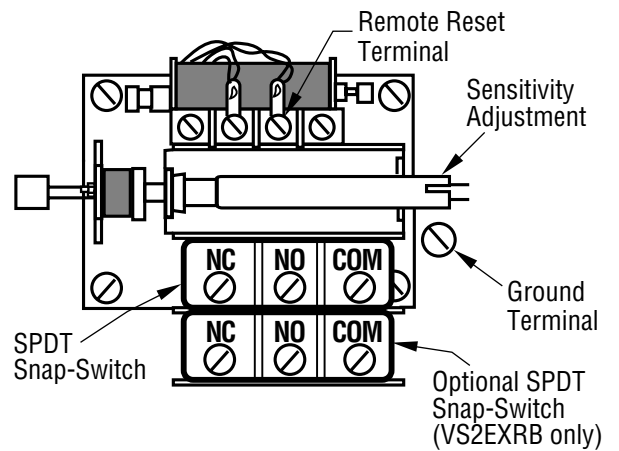
## VS2EXR



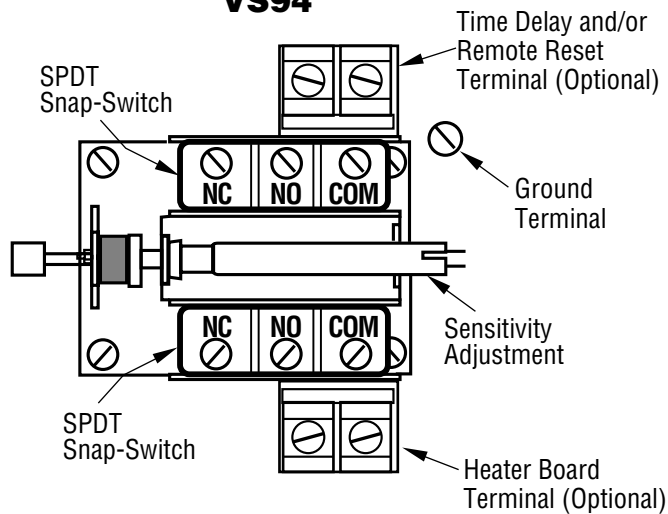
## VS2EX



## VS2EXB and VS2EXRB



## VS94

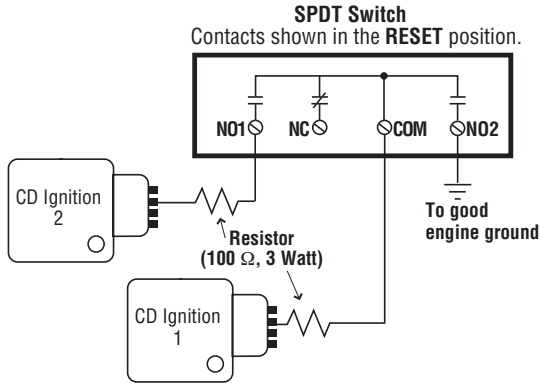


# ELECTRICAL

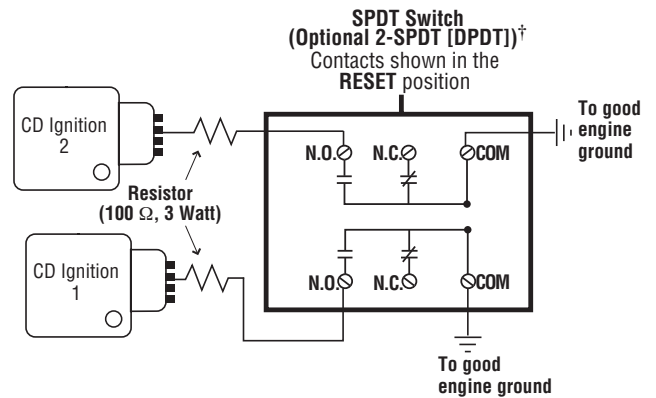


**WARNING:** REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

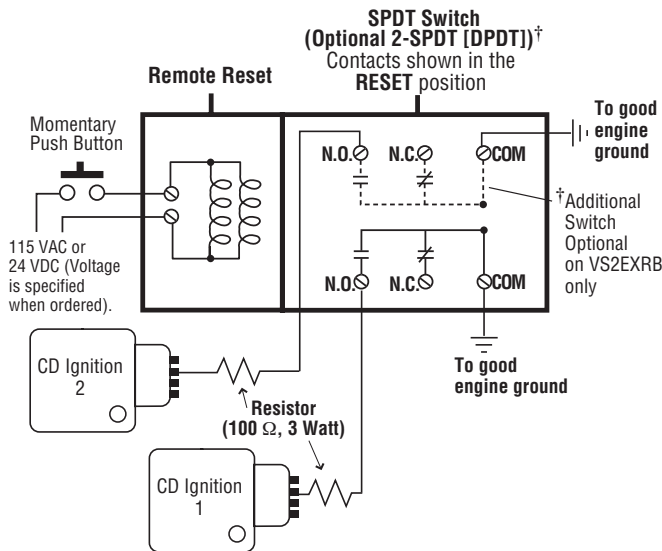
### VS2 and VS2C Typical Wiring Diagram for Single or Dual CD Ignition



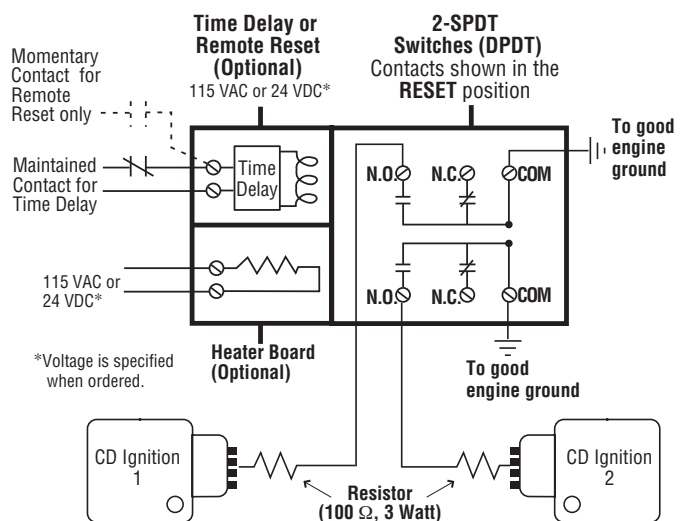
### VS2EX Typical Wiring Diagram for Single or Dual CD Ignitions



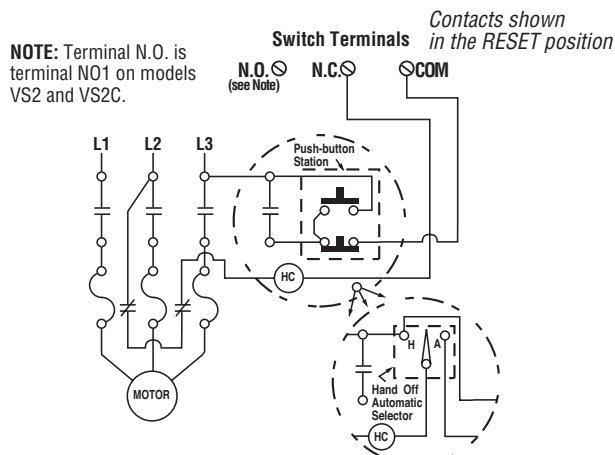
### VS2EXR and VS2EXRB Typical Wiring Diagram for Single or Dual CD Ignitions



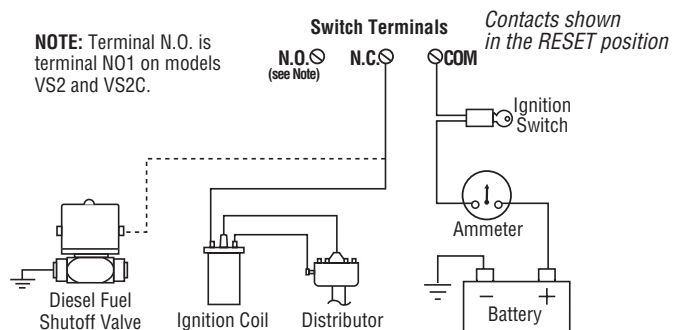
### VS94 Typical Wiring Diagram for Single or Dual CD Ignitions



### VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94 Typical Wiring Diagram for Electric Motors



### VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94 Typical Wiring Diagram for Distributor Ignition or Diesel





## SERVICE PARTS

**PART NO. DESCRIPTION**

**VS2**

20000030 Movement assembly  
 20000031 Glass and gasket assembly  
 20000032 Reset push button assembly

**VS2C**

20000030 Movement assembly  
 20000031 Glass and gasket assembly  
 20000032 Reset push button assembly  
 20050021 Mounting clamp  
 20000185 VS2C 5-clamp hardware package assembly.  
 20050465 2-Conductor electrical cable, 45 feet (13.7 meters)

**VS2EX**

20010091 Movement assembly  
 20050087 Cover  
 00000309 Cover gasket  
 20010090 Snap-switch and insulator kit (1 switch per kit)  
**prior to September 1, 1995.\***  
**20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.\***  
 20000289 C-clamp conversion mounting kit

**VS2EXR**

20000262 Movement assembly  
 20050087 Cover  
 00000309 Cover gasket  
 20010090 Snap-switch and insulator kit (1 switch per kit)  
**prior to September 1, 1995.\***  
**20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.\***  
 20000049 Reset solenoid assembly (115 VAC)  
 20000234 Reset solenoid assembly (24 VDC)  
 20000289 C-clamp conversion mounting kit

**PART NO. DESCRIPTION**

**VS2EXRB**

20010090 Snap-switch and insulator kit (1 switch per kit)  
**prior to September 1, 1995.\***  
**20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.\***  
 20000057 *Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.\***  
 20000058 *Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.\***  
**20000287 Inside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.\***  
**20000290 Outside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.\***  
 20050077 Adjustment shaft  
 20000262 Movement assembly  
 20000049 Reset solenoid assembly (115 VAC)  
 20000234 Reset solenoid assembly (24 VDC)

**VS94 Series**

25050506 Dust boot  
 00000232 Conduit fitting  
 20010090 Snap-switch and insulator kit (1 switch per assembly)  
**prior to September 1, 1995.\*\***  
**20000288 Snap-switch and insulator kit (1 switch per assembly) for models manufactured on September 1, 1995 or later.\*\*\***

\* If no date code is found, refer to the old switch. Models with date 0895 and before use old switch. Dated 0995 after, use straight snap-switch arm, no rollers.  
 \*\* Models dated Q1 thru Q8 (formed snap-switch arm and rollers).  
 \*\*\*Models date coded Q9 thru Q12 and R1 thru R12 (straight snap-switch arm, no rollers).



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*In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.*



## *Installation Instructions*

# SLC 500™ Modular Chassis

(Catalog Numbers 1746-A4, -A7, -A10, and -A13 Series B)

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## ***Installation Instructions***

# **SLC 500™ Modular Chassis**

(Catalog Numbers 1746-A4, -A7, -A10, and -A13 Series B)

## **English Section**

### **What's in this Publication**

Use this publication as a guide when installing an SLC 500 modular chassis.

### **Installation**

<b>To .....</b>	<b>See page</b>
prepare for installation .....	5
allow sufficient mounting space .....	6
install your chassis .....	7
ground your chassis .....	9
install the chassis interconnect cable (optional).....	12
install your I/O modules and attach your power supply.....	12

### **Reference**

<b>For this information.....</b>	<b>See page</b>
specifications .....	13
CSA hazardous location approval .....	14
mounting dimensions.....	75

For additional installation information, see the *SLC 500 Modular Style Installation and Operation Manual*, publication 1747-6.2.

## Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout these installation instructions we use notes to make you aware of safety considerations:

---

### ATTENTION



Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

---

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

---

### IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

---

## Prepare for Installation

Make sure you have these items.

### M4 or M5 (#10 or #12) Hardware

- phillips screw and star washer (or SEM screw — phillips screw with attached star washer) for chassis mounting tabs

<b>This chassis:</b>	<b>Has:</b>
1746-A4	4 mounting tabs
1746-A7	4 mounting tabs
1746-A10	6 mounting tabs
1746-A13	8 mounting tabs

- phillips screwdriver
- drill

### Documentation

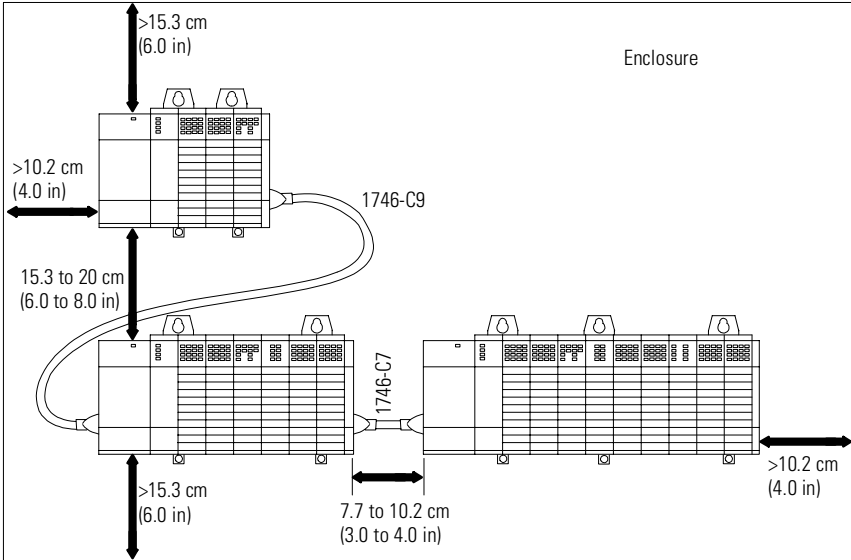
For your:

- processor or I/O adapter module
- power supply
- communication modules and/or I/O modules

## Allow Sufficient Mounting Space

**IMPORTANT**

Make sure you meet these minimum spacing requirements. Up to three SLC chassis can be connected (for a maximum of 30 I/O slots).



**IMPORTANT**

When vertically connecting two 1746-A13 chassis with a 1746-C9 cable, the space cannot be greater than 15.3 cm (6.0 in) for the cable to reach from chassis to chassis.

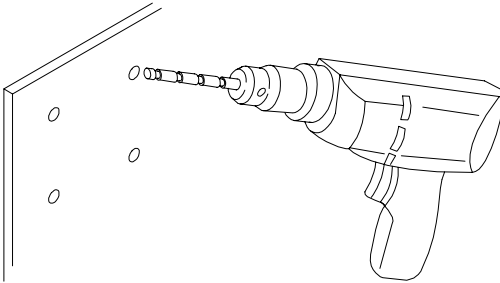
For dimensions of:	See page:
left side of all chassis	75
1746-A4, -A7	75
1746-A10, -A13	76

# Install Your Chassis

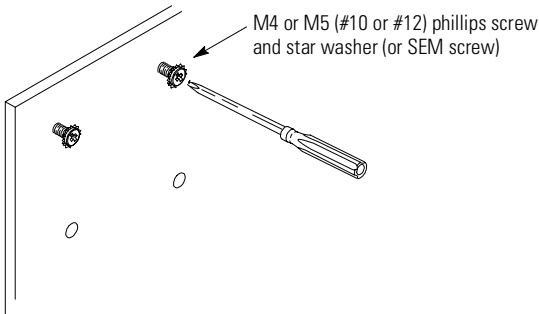
**1****ATTENTION**

Be careful of metal chips when drilling mounting holes for the SLC chassis. Do not drill holes above an SLC chassis if a processor and I/O modules are installed.

Drill holes in the back panel of the enclosure for chassis mounting tabs.

**2**

Install the hardware for the top mounting tabs.

**NOTE**

Scrape paint off the back panel for an electrical connection between the chassis and back panel.

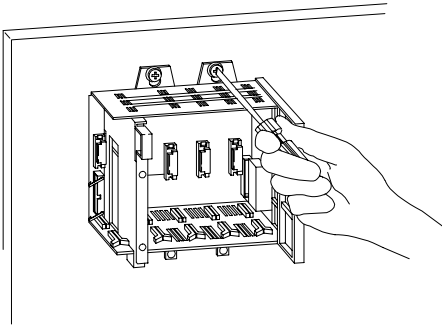
3

**ATTENTION**



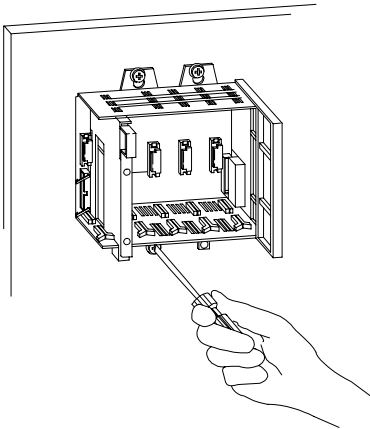
If the chassis mounting tabs do not lay flat before the screws are tightened, use additional washers as shims so that the chassis will not be warped by tightening the screws. Warping a chassis could damage the backplane and cause poor connections.

Slide the chassis over the installed hardware and tighten the screws.



4

Leaving far-left and far-right tabs open for grounding, install the remaining tab hardware (for a four-slot chassis, leave both tabs open).

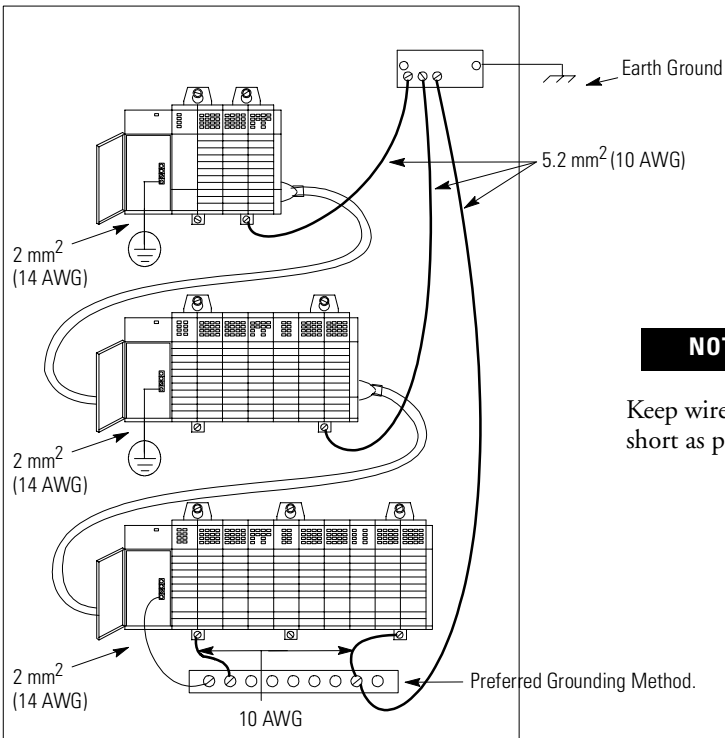


# Ground Your Chassis

To properly ground your I/O chassis:	See page:
verify grounding configuration	9
install a central ground bus	10
connect equipment grounding conductor	10
connect equipment grounding conductor to ground bus	11
connect ground bus to grounding-electrode system	11

## Verify Grounding Configuration

This figure shows you how to run ground connections from the chassis to the ground bus. Two acceptable grounding methods are shown; we recommend using a ground bus because it reduces the electrical resistance at the connection.



### NOTE

Keep wire length as short as possible.



## Install a Central Ground Bus

Each enclosure must contain a central ground bus. The ground bus is the common connection for each chassis within the enclosure and the enclosure itself. If you have not already installed a central ground bus, see the *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1.

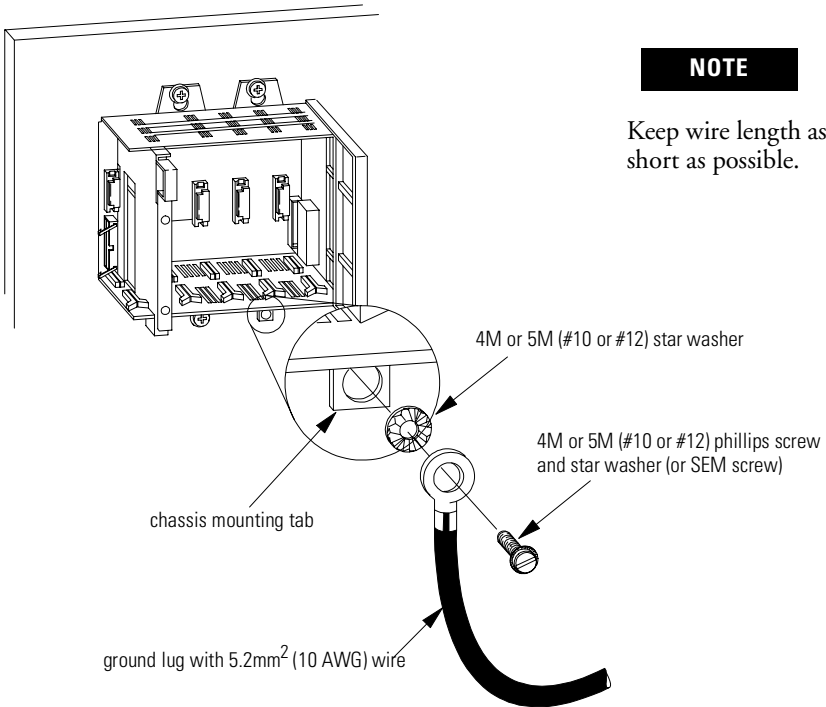
## Connect Equipment Grounding Conductor

### IMPORTANT

Use the following information, along with the installation manual for your programmable controller, to ground the chassis and your I/O modules.

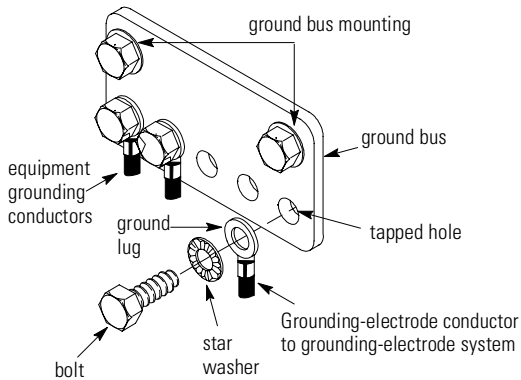
### NOTE

Keep wire length as short as possible.



## Connect Equipment Grounding Conductor to Ground Bus

Connect an equipment grounding conductor directly from each chassis to an individual bolt on the ground bus.



- use 2.54 cm (1in) copper braid or **5.2 mm<sup>2</sup> (10 AWG)** copper wire to connect each chassis, the enclosure, and a central ground bus mounted on the back-panel
- use a steel enclosure to guard against electromagnetic interference (EMI)
- make sure the enclosure door viewing window is a laminated screen or a conductive optical substrate (to block EMI)
- install a bonding wire for electrical contact between the door and the enclosure; do not rely on the hinge

### IMPORTANT

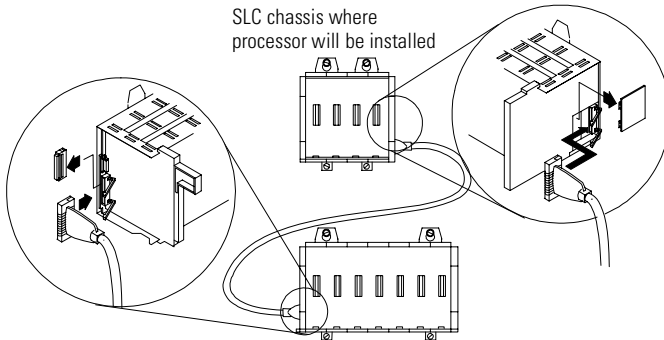
Do not lay one ground lug directly on top of the other; this type of connection can become loose **due to compression** of the metal lugs. Place the first lug between a star washer and a nut with a captive star washer. After tightening the nut, place the second lug between the first nut and a second nut with a captive star washer.

## Connect Ground Bus to Grounding-Electrode System

The grounding-electrode system is at earth-ground potential and is the central ground for all electrical equipment and ac power within any facility. Use a grounding-electrode conductor to connect the ground bus to the grounding-electrode system. Use at **minimum 8.3 mm<sup>2</sup> (8 AWG)** copper wire for the grounding-electrode conductor to guard against EMI. The National Electrical Code specifies safety requirements for the grounding-electrode conductor.

## Install the Chassis Interconnect Cable (optional)

To connect up to three chassis together (for a maximum of 30 I/O slots), install the chassis interconnect cable before attaching your power supply.



## Install Your I/O Modules and Attach Your Power Supply

Use the installation instructions/user manuals for your modules to install them into the chassis. Use the installation instructions for your power supply to attach it to your chassis.

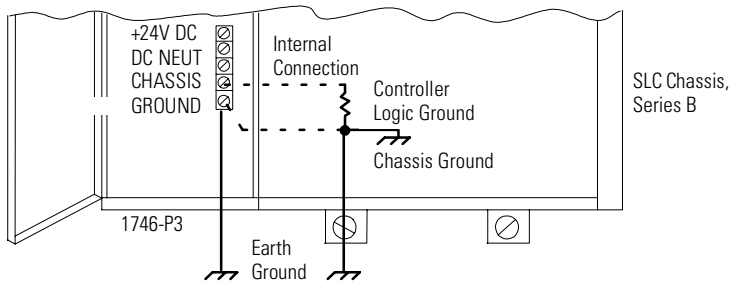
### ATTENTION



- Keep the connector plug on the left side-connector of the chassis if you are not connecting chassis together.
- Remove the protective label from the top of the power supply before applying power.

### IMPORTANT

Series B chassis have a 1M  $\Omega$  resistor between logic ground and chassis ground. When using a 1746-P3 power supply, follow the grounding instructions provided with the power supply to avoid unwanted potentials across the logic ground of the SLC processor.



## Specifications

### SLC Chassis, Series B

#### 1746-A4

#### 1746-A7

#### 1746-A10

#### 1746-A13

#### *dimensions (with tabs)-W x H x D*

17.7 x 17.1 x 14.5 cm  
(7.1 x 6.8 x 5.8 in)

28.2 x 17.1 x 14.5 cm  
(11.3 x 6.8 x 5.8 in)

39.7 x 17.1 x 14.5 cm  
(15.9 x 6.8 x 5.8 in)

50.2 x 17.1 x 14.5 cm  
(20.1 x 6.8 x 5.8 in)

#### *approximate weight (without modules)*

0.75 kg (1.7 lbs)

1.1 kg (2.4 lbs)

1.45 kg (3.2 lbs)

1.9 kg (4.2 lbs)

#### *maximum backplane current*

5.1V dc @ 10A;  
24V dc @ 2.88A

5.1V dc @ 10A;  
24V dc @ 2.88A

5.1V dc @ 10A;  
24V dc @ 2.88A

5.1V dc @ 10A;  
24V dc @ 2.88A

#### *module slots*

4

7

10

13

#### *type of mount*

panel mount

panel mount

panel mount

panel mount

#### *operating conditions*

operating temperature: 0°C to +60°C (+32°F to +140°F)

storage temperature: -40°C to +85°C (-40°F to +185°F)

relative humidity: 5 to 95% (without condensation)

#### *certification*



LISTED IND.  
CONT. EQ. FOR  
HAZ. LOC A196



OPERATING  
TEMPERATURE  
CODE T3C



CE compliant for  
all applicable  
directives

**CLASS I  
GROUPS A, B, C, AND D  
DIV. 2**

## CSA Hazardous Location Approval

CSA certifies products for general use as well as for use in hazardous locations. Actual CSA certification is indicated by the CSA certification product label, and not by any statements in any user documentation.

To comply with CSA certification for use in hazardous locations, the following information becomes a part of the product literature for this CSA-certified industrial control product:

- This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D, or non-hazardous locations only.
- The products having the appropriate CSA markings (that is, Class I, Division 2, Groups A, B, C, D) are certified for use in other equipment where the suitability of combination (that is, application or use) is determined by the CSA or the location inspection office having jurisdiction.

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**IMPORTANT**

Due to the modular nature of a programmable control system, the product with the highest temperature rating determines the overall temperature code rating of a programmable control system in a Class I, Division 2 location. The temperature code rating is marked on the product label.

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**WARNING****EXPLOSION HAZARD**

- Substitution of components may impair suitability for Class I, Division 2.
  - Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
  - Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
  - All wiring must comply with N.E.C. article 501-4(b).
-



**Allen-Bradley**

*Technical Data*

## SLC 500™ Modular Chassis and Power Supplies

Chassis Catalog Numbers 1746-A4, -A7, -A10 and  
-A13

Power Supply Catalog Numbers 1746-P1, -P2, -P3,  
-P4, -P5, -P6 and -P7



SLC 500 modular chassis and power supplies provide flexibility in system configuration. By selecting the appropriate chassis, power supply, processor, and I/O modules you can create a controller system specifically designed for your application.

Four chassis sizes are available to suit your application needs. Choose from 4-slot, 7-slot, 10-slot, and 13-slot chassis based on your modular hardware component requirements.

Seven power supplies are available to meet your system power requirements. There are three different ac power supplies and four dc power supplies.

## Table of Contents

Hardware Overview.....	3
System Layout Recommendations .....	6
Heat Dissipation.....	8
Dimension Drawings.....	12
Reference Table and Graphs.....	14
Power Supply Specifications.....	18
Allen-Bradley Support .....	21
Worksheets .....	22

## Features and Benefits

### Chassis

The SLC 1746 modular chassis houses the processor and the I/O modules. Features and benefits of the modular chassis series include:

Modules easily slide into chassis slots. No tools are required for module installation.

Up to three chassis can be interconnected. Locally, the processor can address up to 30 slots.

Four chassis sizes are available from which to choose. Selection can be suited to your system I/O requirements.

### Power Supplies

Each chassis requires a power supply to provide power to the processor and each I/O slot. You should consider future system expansion when selecting a power supply. Power supply features and benefits include:

All power supplies have an LED that indicates proper supply power. Monitoring this LED can tell you at a glance whether your supply is operating properly.

Supplies have a hold-up time (the time the system is operational during a brief power loss) typically between 20 milliseconds and 3 seconds. This eliminates nuisance-type shutdowns due to momentary power interruptions.

On ac power supplies, you can select either 120V or 240V operation by setting a jumper. No special wiring is required.

This technical data supplies you with information you need to consider when setting up your control application. It provides specifications and dimension drawings for the SLC 1746 modular chassis and power supplies. It also provides worksheets that you can use to calculate the power supply best suited to your application and the amount of heat you can expect the components in your system to generate under normal operating conditions.

## Hardware Overview

## Chassis Sizes

SLC modular chassis are available in the following slot sizes:

Description	Catalog Number	See Page
4-slot chassis	1746-A4	12
7-slot chassis	1746-A7	12
10-slot chassis	1746-A10	13
13-slot chassis	1746-A13	13

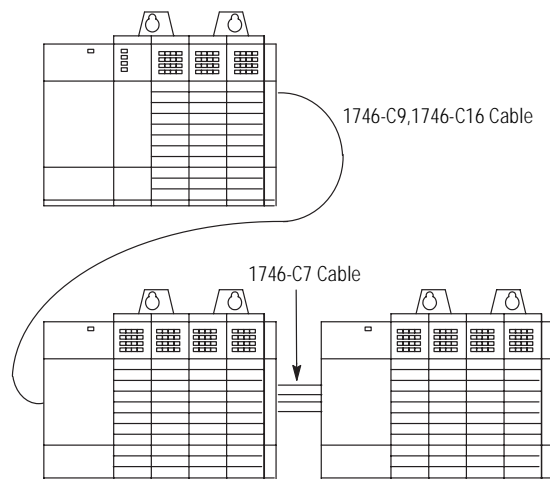
## Chassis Interconnect Cables

You can connect up to three chassis using chassis interconnect cables. Chassis do not include interconnect cables. Below is a description of available cables:

Description	Catalog Number
152.4 mm (6 in.) Chassis Interconnect Cable - Use this ribbon cable when linking modular chassis up to 152.4 mm (6 in.) apart in an enclosure.	1746-C7
914.4 mm (36 in.) Chassis Interconnect Cable - Use this cable when linking modular chassis from 152.4 mm (6 in.) up to 914.4 mm (36 in.) apart in an enclosure.	1746-C9
1270.0 mm (50 in.) Chassis Interconnect Cable - Use this cable when linking modular chassis from 914.4 mm (36 in.) up to 1270.0 mm (50 in.) apart in an enclosure	1746-C16

### *Chassis Interconnect Cable Installation*

Cables must exit the right side of the first chassis and enter the left side of the second chassis. Cables are keyed for proper installation.

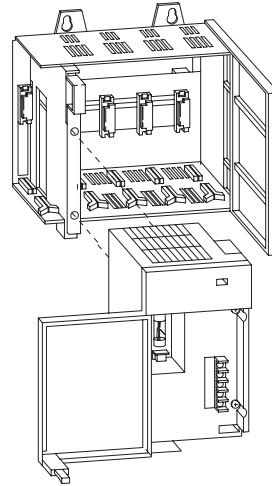


The 1746-C16 cable should be used when connecting two 1746-A13 chassis (one above the other) with 1746-P4 power supplies.



## Power Supply Selection and Installation

When configuring a modular system, you must have an individual power supply for each chassis. The power supply provides power to the processor and each I/O card. Careful system configuration results in the best performance. Excessive loading of the power supply can cause reduced power supply life or a power supply shutdown. The following pages can help you select the power supply best suited for each chassis in your modular SLC control system.



### NOTE

The power supply does not occupy a slot in the chassis. It mounts on the left side with two screws.

## Wiring, Input Voltage Selection and Fuse Location

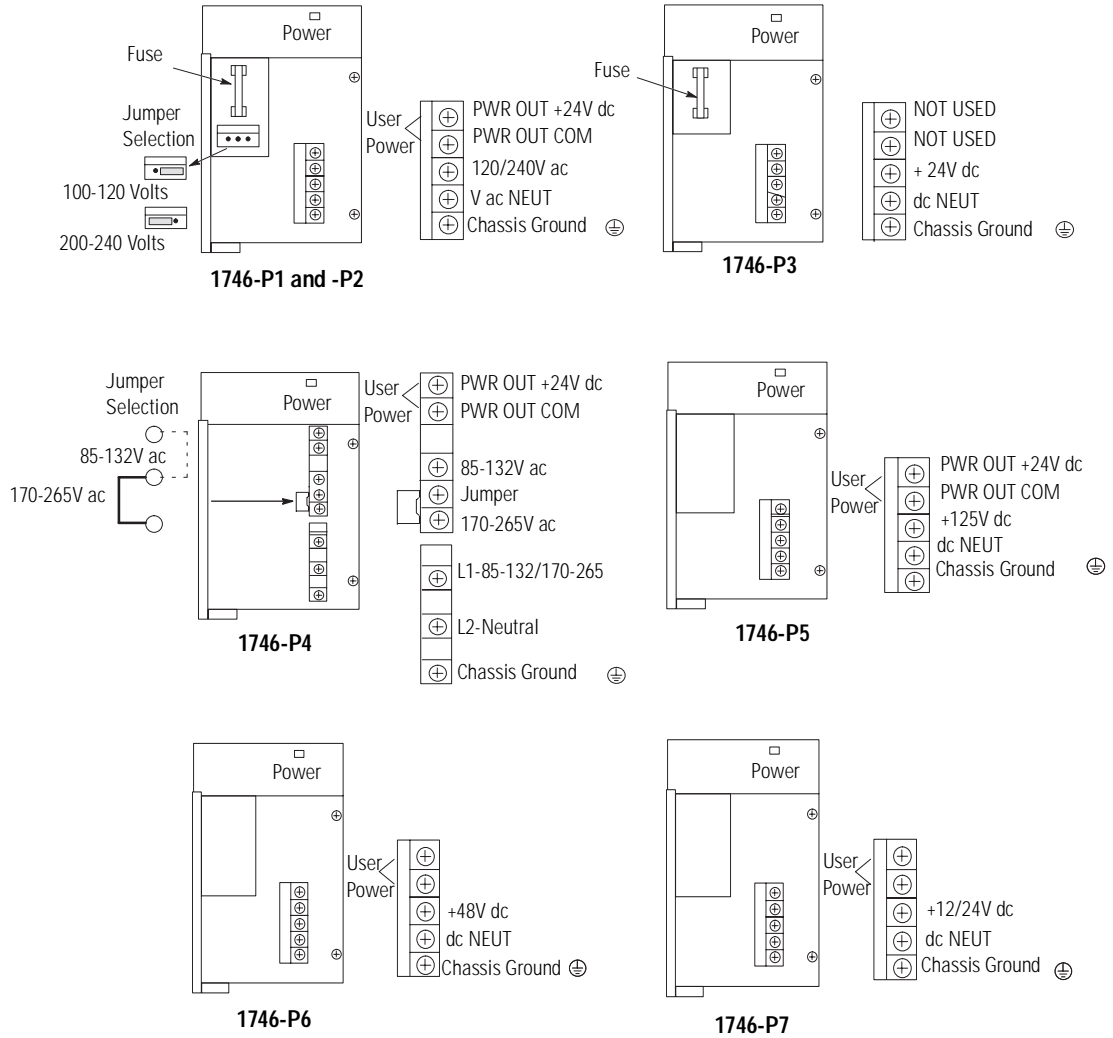
The power supply terminals accept two #14 AWG wires and are marked as shown in the figures on the following page. On ac power supplies, a jumper is provided to make the 120/240V selection. Place the jumper to match the input voltage. Note that the jumper location on the 1746-P4 supply is different from the jumper location on the P1 and P2 power supplies.

Fuse placement for 1746-P1, P2, and P3 supplies is also shown on the next page. Refer to the *Power Supply Specification* table on page 18 for fuse replacement information. Note that the 1746-P4, -P5, -P6 and -P7 power supplies fuse is non-replaceable.

### ATTENTION



Make jumper selection before applying power. Hazardous voltage is present on exposed pins when power is applied.



### Power Supply Undervoltage Operation

SLC 500 controllers continue to operate (hold-up) for a short period of time if the input voltage to the power supply drops below the recommended operating voltage range. The controller continues to scan the user program and control I/O during this time.

SLC 500 controllers turn OFF (stop scanning and disable outputs) if input voltage to the power supply is removed or drops below the recommended operating range for a period exceeding the CPU hold-up time. The controller resumes operation automatically when the input voltage is restored to normal.

If the input voltage to the 1746-P7 power supply falls into a range of 4 to 9V for a period exceeding the CPU hold-up time, the controller turns OFF and will not turn back ON until:

- input voltage is increased to 11V dc.
- power is cycled and the input voltage returns to a valid range.

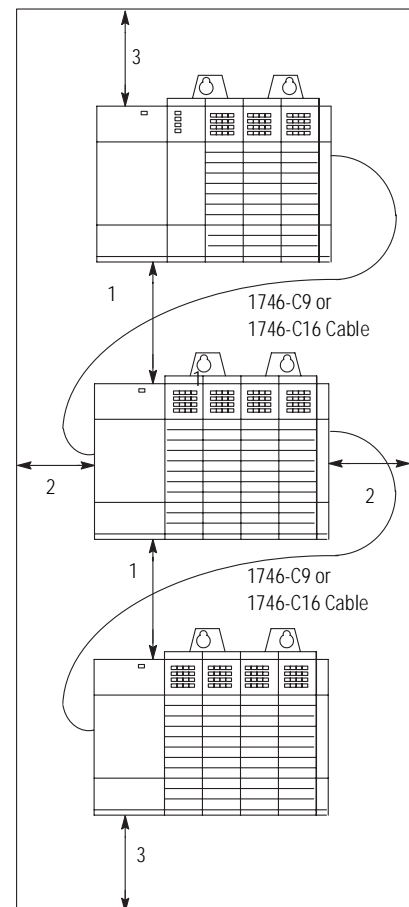
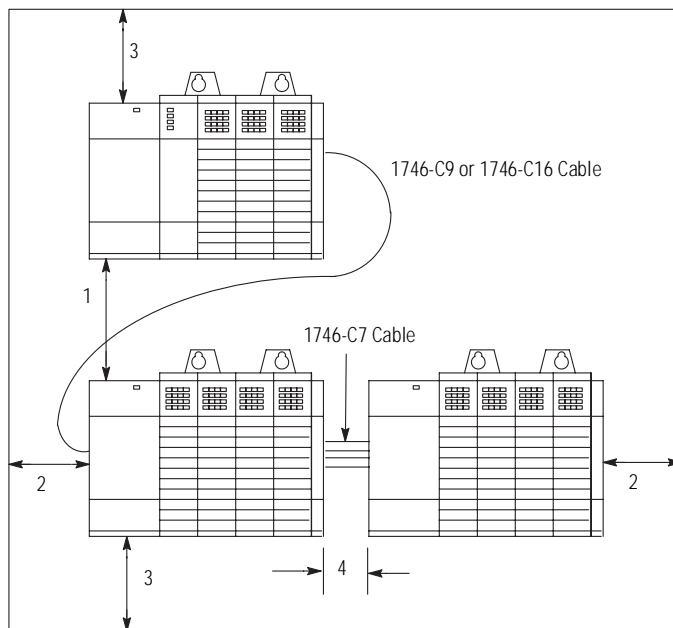
## System Layout Recommendations

## Selecting Enclosures

The enclosure protects the equipment from atmospheric contamination. Standards established by the National Electrical Manufacturer's Association (NEMA) and International Electrotechnical Commission (IEC) define enclosure types based on the degree of protection an enclosure provides. Select a NEMA- or IEC-rated enclosure that suits your application and environment. The enclosure should be equipped with a disconnect device. To calculate the heat dissipation of your controller, refer to *Calculating Heat Dissipation* on page 9.

## Spacing Considerations

Follow the recommended minimum spacing shown below to allow for convection cooling within the enclosure. Cooling air in the enclosure must be kept within a range of 0°C to +60°C (+32°F to +140°F).



### Recommended Spacing

1. 15.3 to 20 cm (6 to 8 inches) when using the 1746-C9 cable

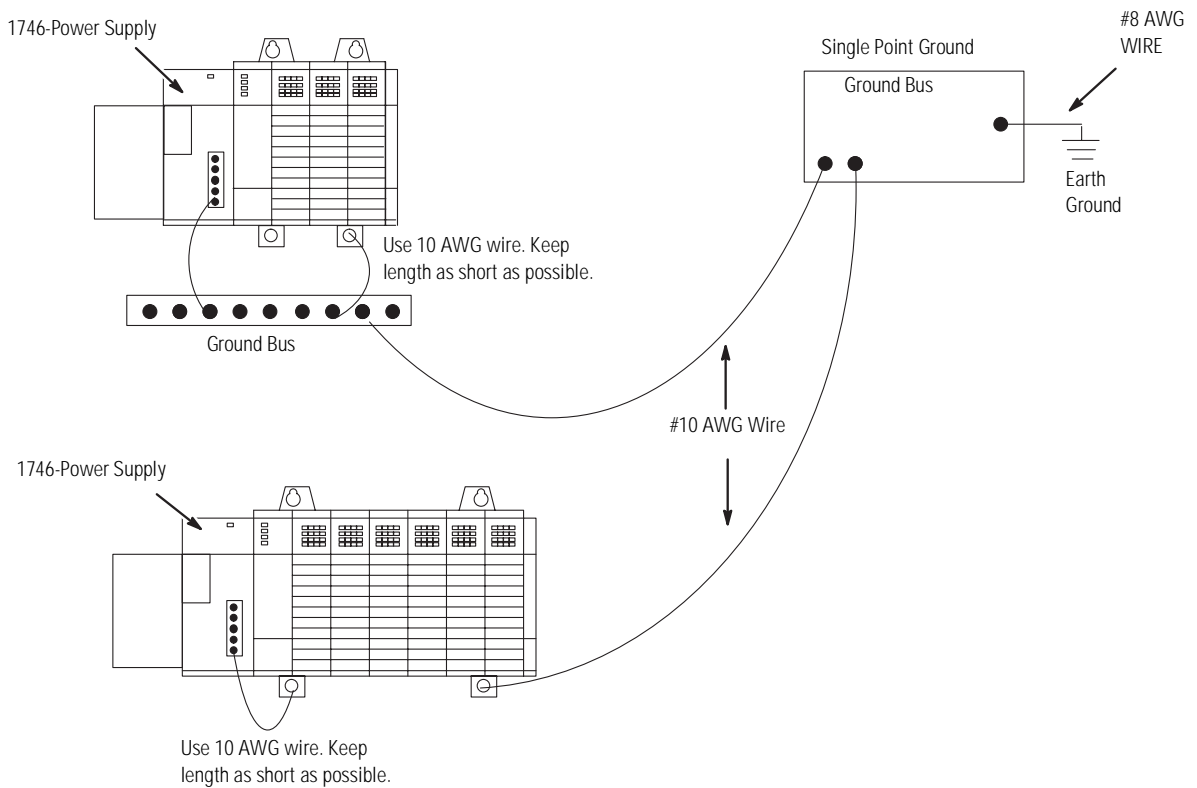
**Note:** When making a vertical connection between two A13 chassis:

- You must limit the space to 15.3 cm (6 inches) for the -C7 cable to reach from chassis to chassis.
  - You must limit the space to 92 cm (36 inches) for the -C9 cable to reach from chassis to chassis.
  - You must limit the space to 127 cm (50 inches) for the -C16 cable to reach from chassis to chassis.
2. Greater than 10.2 cm (4 inches)
  3. Greater than 15.3 cm (6 inches)
  4. 7.7 to 10.2 cm (3 to 4 inches) when using the 1746-C7 cable

## Grounding

In solid-state control systems, grounding helps limit the effects of noise due to electromagnetic interference (EMI). Ground connections should run from the chassis and power supply on each controller and expansion unit to the ground bus. Exact connections differ between applications. An authoritative source on grounding requirements for most installations is the National Electrical Code. Also, refer to *Allen-Bradley Industrial Automation Grounding and Wiring Guidelines*, Publication Number 1770-4.1.

The figure below shows you how to run ground connections from the chassis to the ground bus. Each chassis in the figure uses a different grounding method. Both methods are acceptable, but we recommend use of the ground bus because it reduces the electrical resistance at the connection.



### ATTENTION



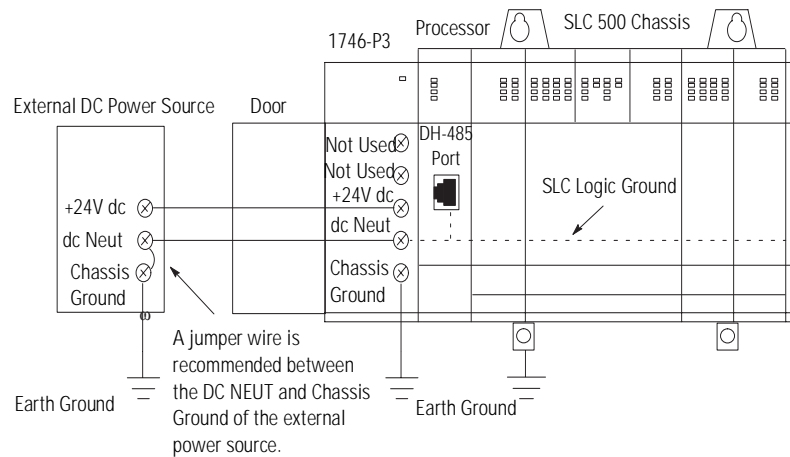
Your SLC 500 power supply can be damaged by voltage surges when switching inductive loads such as motors, motor starters, solenoids, and relays. To avoid damage to your SLC 500 power supply in these applications, it is strongly recommended that an isolation transformer be used to isolate the power supply from harmful voltage surges.

## Special Considerations in dc Applications

### ATTENTION



Any voltage applied to the 1746-P3 dc NEUT terminal will be present at the SLC logic ground and the processor DH-485 port. To prevent unwanted potentials across the logic ground of the controller and/or damage to the SLC chassis, the dc NEUTRAL of the external dc power source must be either isolated from the SLC chassis ground, or connected to earth ground. See the figure below.



## Heat Dissipation

### Preventing Excessive Heat

For most applications, normal convection cooling keeps the controller components within the specified operating range (0-60°C). Proper spacing of components within the enclosure is usually sufficient for heat dissipation.

In some applications, a substantial amount of heat is produced by other equipment inside or outside the enclosure. In this case, place blower fans inside the enclosure to assist in air circulation and to reduce “hot spots” near the controller.

Additional cooling provisions might be necessary when high ambient temperatures are encountered.

### IMPORTANT

Do not bring unfiltered outside air into the enclosure. It may introduce harmful contaminants that could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to protect against heat build-up within the enclosure.

If you suspect heat build-up may be a problem, you can calculate the heat dissipation of your SLC control system. The following information can help you to make this calculation.

## Calculation Heat Dissipation

To calculate the heat dissipation of your SLC controller you must consider two things:

- the maximum heat dissipated (with field power applied) by the processor, all I/O and specialty modules, and any peripheral devices for each chassis.
- the heat dissipated by the power supply. This is determined by the maximum load on the power supply of the processor, each I/O and specialty module, peripheral device, and device drawing power directly off the power supply via the “POWER OUT” terminals.

You calculate maximum heat dissipation by using one of these methods:

- calculated watts method
- total watts method

Use calculated watts if you know exactly how many outputs and inputs on each card are active at any given time. This method will give you a lower, more accurate heat dissipation calculation than the total watts method. With this method, use the formula below for calculating the heat dissipation of each module. Then use these values in step 1 of the *Example Worksheet for Calculating Heat Dissipation* on page 11.

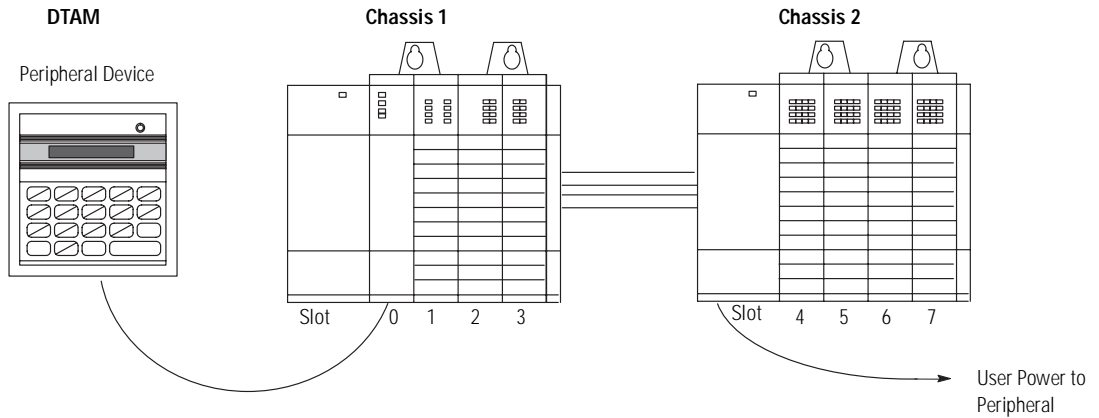
*(points energized x watts per point) + minimum watts = heat dissipation of module*

Use total watts if you are not sure how many points on a module are energized at any time. Total watts is the watts per point (with all points energized) plus the minimum watts. Total watts generated by each module are provided in the table on page 14.

Once you have determined which method you will use to calculate the heat dissipation of your modules, see the *Example Worksheet for Calculating Heat Dissipation* on page 11. This worksheet shows you how to calculate the heat dissipation for the example SLC control system on page 10.

## Example Heat Dissipation Calculation

If your controller consisted of the following hardware components, you would calculate heat dissipation as shown in the worksheet on page 11.



The following table details the total watts dissipated by the modules and peripheral devices in the above SLC 500 controller. The numbers were taken from the tables on page 14.

Chassis 1				Chassis 2			
Slot Number	Catalog Number	Min. Watts	Max. Watts	Slot Number	Catalog Number	Min. Watts	Max. Watts
0	1747-L511	1.75	1.75	4	1746-IA16	0.425	4.800
1	1746-BAS	3.750	3.80	5	1746-IA16	0.425	4.800
2	1746-IA8	0.250	2.40	6	1746-OW16	5.170	5.500 <sup>(2)</sup>
3	1746-OV8	0.675	6.90	7	1746-OW16	5.170	5.700
Peripheral Device	1747-DTAM	2.500	2.50	NA	NA	NA	NA
User Power to Peripheral	NA	NA	NA	NA	NA	2.400 <sup>(1)</sup>	NA

<sup>(1)</sup> The user power on the 1746-P1 power supply for Chassis 2 is being used to power a peripheral (100 mA at 24V dc).

<sup>(2)</sup> This output card uses 5.5 Watts because only 10 points are on at any one time. Using the calculated watts formula - (number of points energized x watts per point) + minimum watts = heat dissipation of module - the calculated watts for the 1746-OW16 module is 5.5W: (10 points x .33) + 5.17 = 5.5W.

## Example Worksheet for Calculating Heat Dissipation

**Procedure:**

1. Calculate the heat dissipation for each chassis without the power supply.
  - a. Write in the watts (calculated watts or total watts, see page 12) dissipated by the processor, I/O and specialty modules, and any peripheral devices attached to the processor. Then, for each chassis, add these values together.

Chassis 1		Chassis 2		Chassis 3		Chassis 1	Chassis 2	Chassis 3	Heat Dissipation
Cat No	Ht Dis	Cat No	Ht Dis	Cat No	Ht Dis				
<b>L511</b>	<b>1.75</b>	<b>IA16</b>	<b>4.8</b>						
<b>BAS</b>	<b>3.8</b>	<b>IA16</b>	<b>4.8</b>						
<b>IA8</b>	<b>2.4</b>	<b>OW16</b>	<b>5.5</b>						
<b>OV8</b>	<b>6.9</b>	<b>OW16</b>	<b>5.7</b>						
peripheral device:	<b>DTAM</b> 2.5								
peripheral device:									
<b>Total:</b>	<b>17.35</b>	<b>20.8</b>				17.35	20.8	—	

- b. Place the heat dissipation for each chassis into the appropriate columns.

2. Calculate the heat dissipation for each power supply.
  - a. Calculate the power supply loading for each chassis (write in the minimum watts) for each device (see page 14) add these values together.

**Important:** If you have a device connected to user power, multiply 24V by the current used. Include user power in the total power supply loading

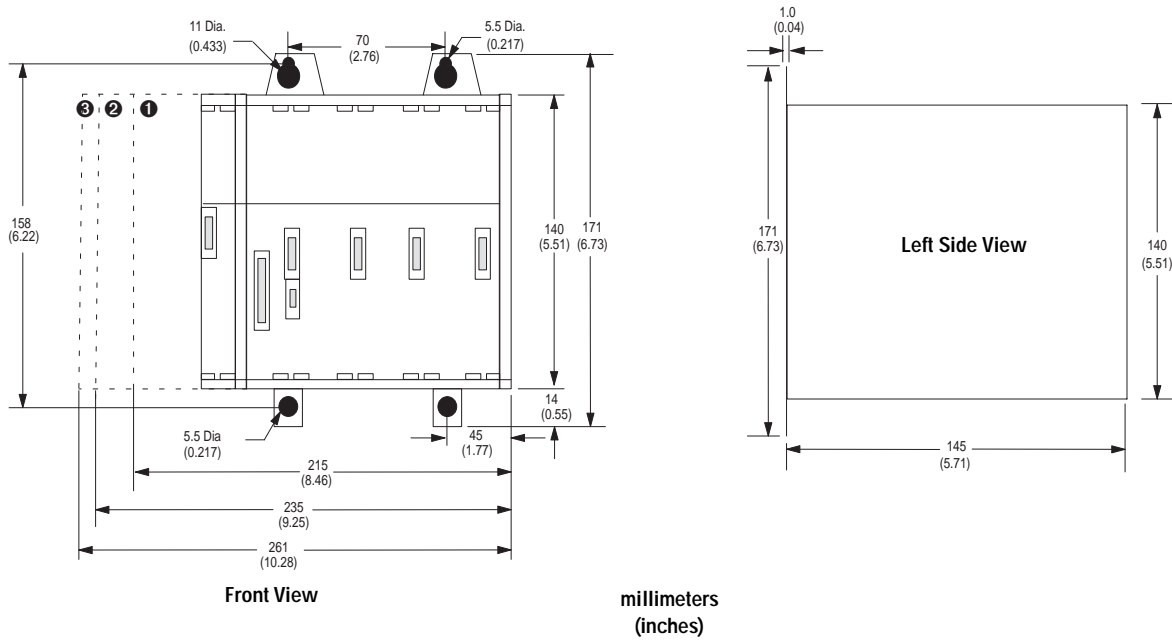
Chassis 1		Chassis 2		Chassis 3		Chassis 1	Chassis 2	Chassis 3	Heat Dissipation
Cat No	Min Ht Dis	Cat No	Min Ht Dis	Cat No	Min Ht Dis				
<b>L511</b>	<b>1.75</b>	<b>IA16</b>	<b>0.425</b>						
<b>BAS</b>	<b>3.750</b>	<b>IA16</b>	<b>0.425</b>						
<b>IA8</b>	<b>0.250</b>	<b>OW16</b>	<b>5.17</b>						
<b>OV8</b>	<b>0.675</b>	<b>OW16</b>	<b>5.17</b>						
user power			<b>2.4</b>						
peripheral device:	<b>DTAM</b> 2.5								
peripheral device:									
<b>Total:</b>	<b>8.925</b>	<b>13.59</b>				13.0	15.0	—	

- b. Use the power supply loading for each chassis and the graphs on page 17 to determine the power supply dissipation. Place the power supply dissipations into the appropriate columns.

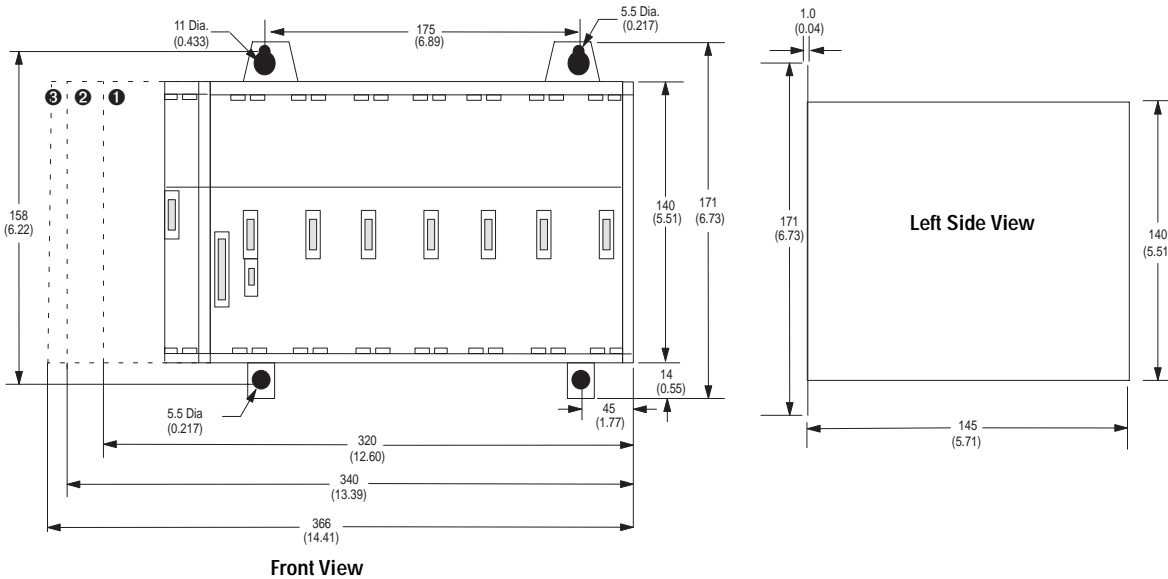
3. Add the chassis dissipation to the power supply dissipation.



## Dimension Drawings 4-Slot Modular Chassis

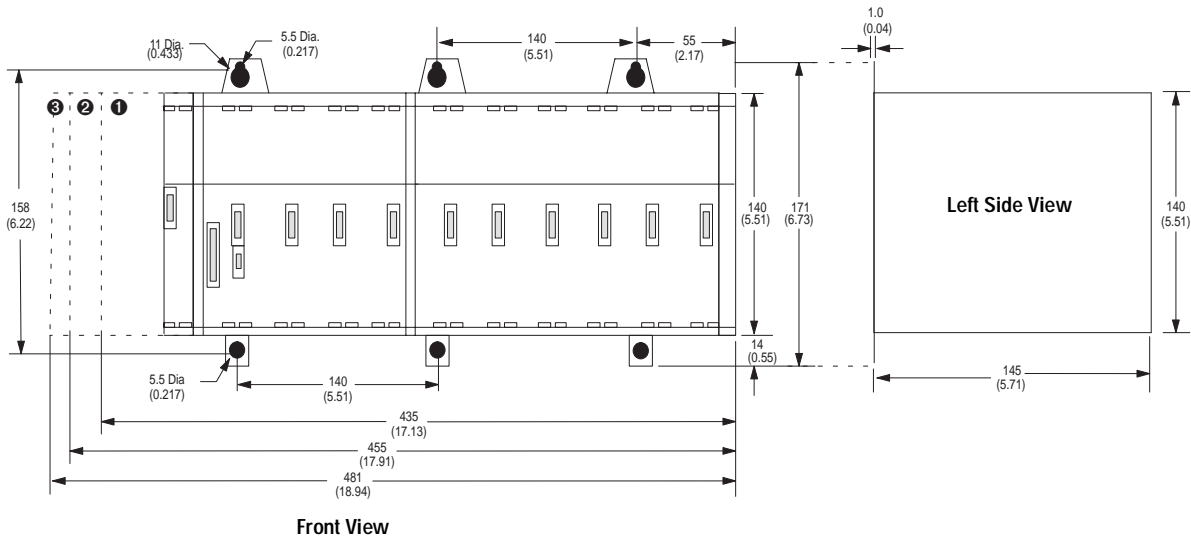


## 7-Slot Modular Chassis

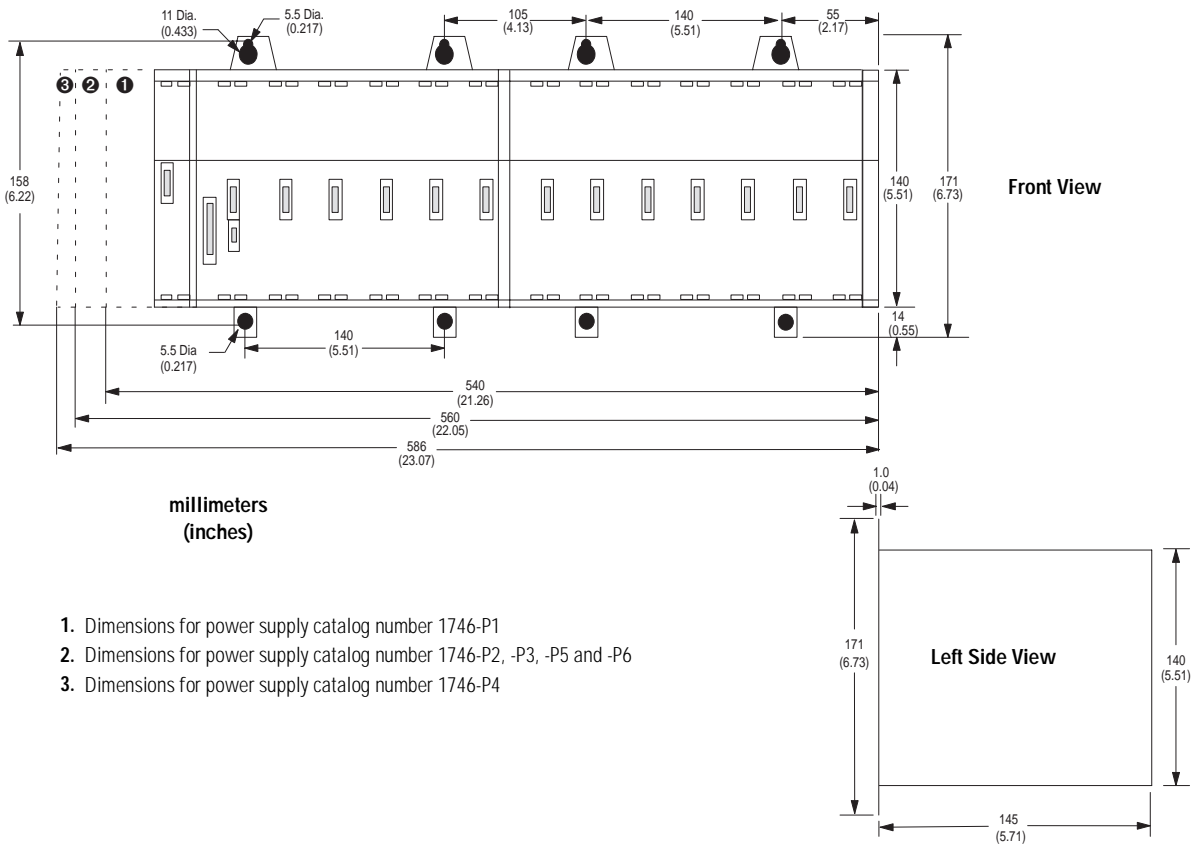


1. Dimensions for power supply catalog number 1746-P1
2. Dimensions for power supply catalog number 1746-P2, -P3, -P5 and -P6
3. Dimensions for power supply catalog number 1746-P4

### 10-Slot Modular Chassis



### 13-Slot Modular Chassis



- 1. Dimensions for power supply catalog number 1746-P1
- 2. Dimensions for power supply catalog number 1746-P2, -P3, -P5 and -P6
- 3. Dimensions for power supply catalog number 1746-P4

## Reference Table and Graphs

## Power Supply Loading Reference Table

Use the table below to calculate the power supply loading and heat dissipation for each chassis in your SLC modular application. Definitions of some of the terms used in the table are provided on page 16.

Hardware Component	Catalog Numbers	Maximum Current (A)		Watts per Point	Minimum Watts	Total Watts
		at 5V dc	at 24V dc			
Processors	1747-L511	0.350	0.105	NA	1.75	1.75
	1747-L514	0.350	0.105	NA	1.75	1.75
	1747-L524	0.350	0.105	NA	1.75	1.75
	1747-L531	0.500	0.175	NA	1.75	1.75
	1747-L532	0.500	0.175	NA	2.90	2.90
	1747-L541	1.000	0.200	NA	4.00	4.00
	1747-L542	1.000	0.200	NA	4.00	4.00
	1747-L543	1.000	0.200	NA	4.00	4.00
	1747-L551	1.000	0.200	NA	4.00	4.00
	1747-L552	1.000	0.200	NA	4.00	4.00
	1747-L553	1.000	0.200	NA	4.00	4.00
Input Modules  (continued on Page 15)	1746-IA4	0.035	-	0.270	0.175	1.30
	1746-IA8	0.050	-	0.270	0.250	2.40
	1746-IA16	0.085	-	0.270	0.425	4.80
	1746-IB8	0.050	-	0.200	0.250	1.90
	1746-IB16	0.085	-	0.200	0.425	3.60
	1746-IB32 <sup>(1)</sup>	0.050	-	0.200	0.530	6.90
	1746-IC16	0.085	-	0.220	0.425	3.95
	1746-IG16	0.140	-	0.020	0.700	1.00
	1746-IH16	0.085	-	0.320	0.675	3.08
	1746-IM4	0.035	-	0.350	0.175	1.60
	1746-IM8	0.050	-	0.350	0.250	3.10
	1746-IM16	0.085	-	0.350	0.425	6.00
	1746-IN16	0.085	-	0.350	0.425	6.00
	1746-ITB16	0.085	-	0.200	0.425	3.625
	1746-ITV16	0.085	-	0.200	0.425	3.625
	1746-IV8	0.050	-	0.200	0.250	1.90
	1746-IV16	0.085	-	0.200	0.425	3.60
1746-IV32 <sup>(1)</sup>	0.050	-	0.200	0.530	6.90	

Hardware Component	Catalog Numbers	Maximum Current (A)		Watts per Point	Minimum Watts	Total Watts
		at 5V dc	at 24V dc			
Output Modules (continued from Page 14)	<b>1746-OA8</b>	0.185	-	1.000	0.925	9.00
	<b>1746-OA16</b>	0.370	-	0.462	1.850	9.30
	<b>1746-OAP12</b>	0.370	-	1.000	1.850	10.85
	<b>1746-OB8</b>	0.135	-	0.775	0.675	6.90
	<b>1746-OB16</b>	0.280	-	0.338	1.400	7.60
	<b>1746-OB32<sup>(1)</sup></b>	0.190	-	0.078	2.260	4.80
	<b>1746-OBP8</b>	0.135	-	0.300	0.675	3.08
	<b>1746-OBP16</b>	0.250	-	0.310	1.250	6.21
	<b>1746-OB16E</b>	0.280	-	0.338	1.400	7.60
	<b>1746-OB32E</b>	0.452	-	0.078	2.260	4.80
Output Modules	<b>1746-OG16</b>	0.180	-	0.033	0.900	1.50
	<b>1746-OV8</b>	0.135	-	0.775	0.675	6.90
	<b>1746-OV16</b>	0.270	-	0.388	1.400	7.60
	<b>1746-OV32<sup>(1)</sup></b>	0.190	-	0.078	2.260	4.80
	<b>1746-OVP16</b>	0.250	-	0.310	1.250	6.21
	<b>1746-OW4</b>	0.045	0.045	0.133	1.310	1.90
	<b>1746-OW8</b>	0.085	0.090	0.138	2.590	3.70
	<b>1746-OW16</b>	0.170	0.180	0.033	5.170	5.70
	<b>1746-OX8</b>	0.085	0.090	0.825	2.590	8.60
Input and Output Modules	<b>1746-IO4</b>	0.030	0.025	0.270 per input pt. 0.133 per output pt.	0.750	1.60
	<b>1746-IO8</b>	0.060	0.045	0.270 per input pt. 0.133 per output pt.	1.380	3.00
	<b>1746-IO12</b>	0.090	0.070	0.270 per input pt. 0.133 per output pt.	2.130	4.60
	<b>1746-IO12DC</b>	0.080	0.060	0.200 per input pt. 0.133 per output pt.	1.840	3.90
Specialty Modules	<b>1746-BAS</b>	0.150	0.040 <sup>(2)</sup>	NA	3.750	3.800
	<b>1746-BLM</b>	0.110	0.085	NA		
	<b>1746-BTM</b>	0.110	0.085	NA		
	<b>1746-FIO4I</b>	0.055	0.150	NA	3.760	3.800
	<b>1746-FIO4V</b>	0.055	0.120	NA	3.040	3.100
	<b>1746-HSCE</b>	0.320	-	NA	1.600	1.600
	<b>1746-HSCE2</b>	0.250	-	NA		
	<b>1746-HSRV</b>	0.300	-	NA		
	<b>1746-HSTP1</b>	0.300	-	NA		
	<b>1746-INT4</b>	0.060	0.040	NA		
	<b>1746-MPM</b>	0.110	0.085	NA		
	<b>1746-NI4</b>	0.025	0.085	NA	2.170	2.20
	<b>1746-NI8</b>	0.200	0.100	NA		
	<b>1746-NI16</b>	0.200	0.100	NA		
	<b>1746-NIO4I</b>	0.055	0.145	NA	3.760	3.80

Hardware Component	Catalog Numbers	Maximum Current (A)		Watts per Point	Minimum Watts	Total Watts
		at 5V dc	at 24V dc			
	<b>1746-NIO4V</b>	0.055	0.115	NA	3.040	3.10
(continued from Page 15)	<b>1746-NO4I</b>	0.055	0.195	NA	4.960	5.00
	<b>1746-NO4V</b>	0.055	0.145	NA	3.780	3.80
	<b>1746-NR4</b>	0.050	0.050	NA	1.500	1.500
	<b>1746-NT4</b>	0.060	0.040	NA	0.800	0.800
	<b>1746-NT8</b>	0.120	0.070	NA		
	<b>1746-QS</b>	1.000	0.200	NA		
	<b>1746-QV</b>	0.215	-	NA		
Communication Modules	<b>1747-ACN15</b>	0.900	-	NA		
	<b>1747-ACNR15</b>	0.900	-	NA		
	<b>1747-ASB</b>	0.375	-	NA	1.875	1.875
	<b>1747-BSN</b>	0.800	0			
	<b>1747-DCM</b>	0.360	-	NA	1.800	1.800
	<b>1747-KE</b>	0.150	0.040 <sup>(2)</sup>	NA	3.750	3.800
	<b>1747-KFC15</b>	0.640	0	NA	3.200	3.200
	<b>1747-SCNR</b>	0.800	0.090	NA		
	<b>1747-SDN</b>	1.200	-	NA		
	<b>1747-SN</b>	0.900	-	NA	4.500	4.500
Peripheral Devices	<b>1747-AIC</b>	0	0.085	NA	2.000	2.000
	<b>1747-DTAM</b>	0	(3)	NA	2.500	2.500
	<b>1747-PIC</b>	0	(3)	NA	2.000	2.000
	<b>1747-PSD</b>	NA	NA	NA	NA	NA
	<b>1747-PT1 Series A and B</b>	0	(3)	NA	2.500	2.500
	<b>1761-NET-AIC<sup>(4)</sup></b>	0.350	0			

<sup>(1)</sup> Power supply loading for Series D and later modules.

<sup>(2)</sup> When using the BAS or KE modules to supply power to an AIC draws its power through the module. Add 0.085A (the current loading for the AIC) to the BAS or KE module's power supply loading value at 24V dc.

<sup>(3)</sup> The 24V dc loading values of the HHT, PIC, and DTAM are included in the 24V dc loading value of the processor.

<sup>(4)</sup> Current for the 1761-NET-AIC may be supplied from the controller communications port or from an external 24V dc source. No current is consumed from the controller when an external source is used.

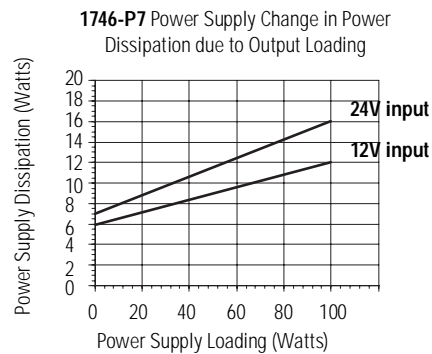
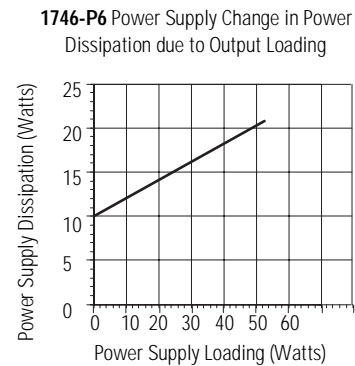
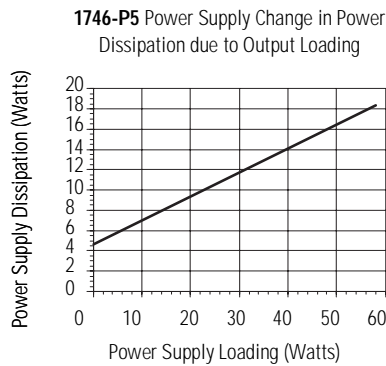
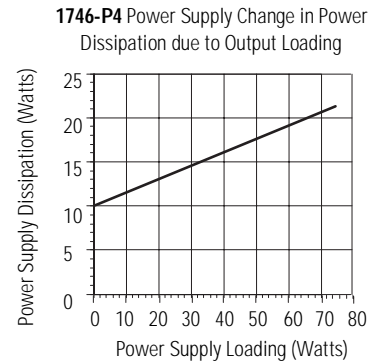
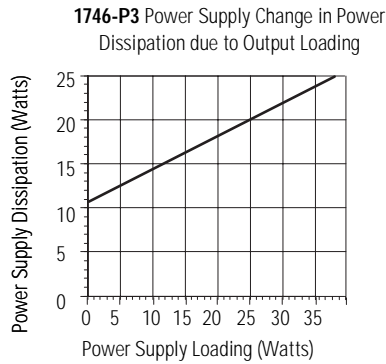
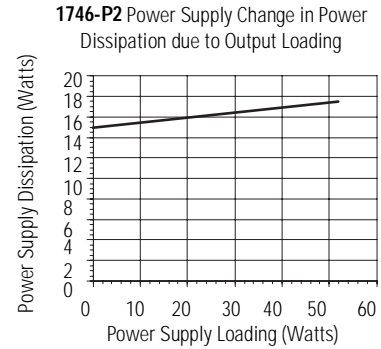
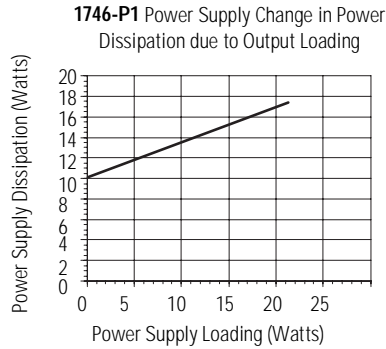
**Watts per point** — the heat dissipation that can occur in each field wiring point when energized at nominal voltage.

**Minimum watts** — the amount of heat dissipation that can occur when there is no field power present.

**Total watts** — the watts per point plus the minimum watts (with all points energized)

## Power Supply Heat Dissipation Graphs

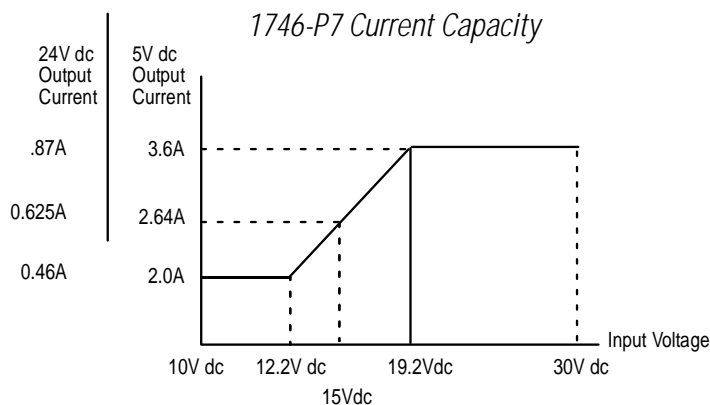
Use the graphs below for determining the power supply dissipation in step 2 of the *Example Worksheet for Calculating Heat Dissipation*.



## Power Supply Specifications

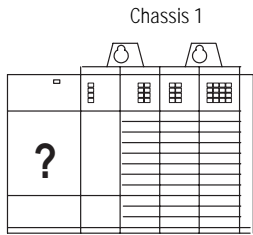
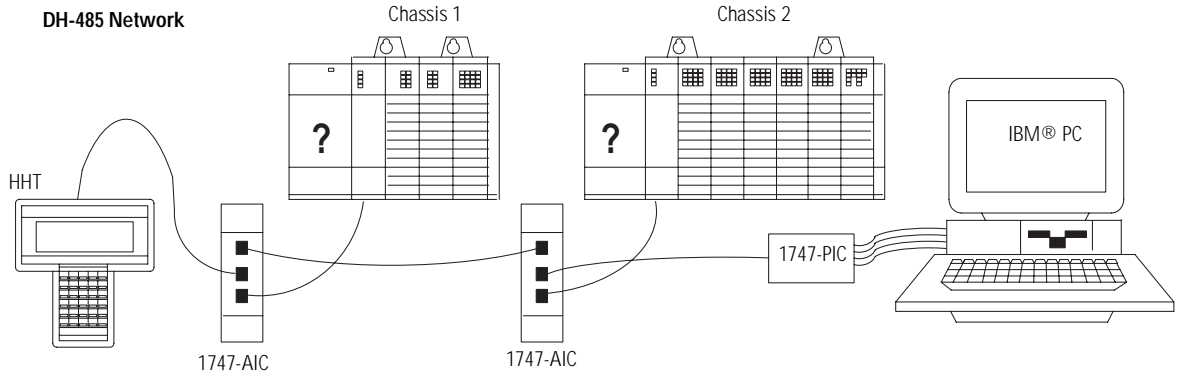
Description:	Specification: 1746-							
	P1	P2	P3	P4	P5	P6	P7	
Line Voltage	85-132/170-265V ac 47-63 Hz		19.2-28.8V dc	85-132/ 170-265V ac 47-63 Hz	90-146V dc	30-60V dc	10-30V dc <sup>(1)</sup>	
Typical Line Power Reqmnt.	135 VA	180 VA	90 VA	240 VA	85VA	100VA	12V dc input: 50 VA	24V dc input: 75 VA
Maximum Inrush Current	20A			45A	20A		20A (required for turn-on)	
Internal Current Capacity	2A at 5V dc 0.46A at 24V dc	5A at 5V dc 0.96A at 24V dc	3.6A at 5V dc 0.87A at 24V dc	10.0A at 5V dc 2.88A at 24V dc <sup>(2)</sup>	5A at 5V dc 0.96A at 24V dc		12V dc input: 2.0A at 5V dc 0.46A at 24V dc	24V dc input: 3.6A at 5V dc 0.87A at 24V dc
Fuse Protection <sup>(3)</sup>	1746-F1 or equivalent <sup>(4)</sup>	1746-F2 or equivalent <sup>(5)</sup>	1746-F3 or equivalent <sup>(6)</sup>	Fuse is soldered in place.				
24V dc User Power Current Capacity	200 mA		Not Applicable	1A <sup>(2)</sup>	200 mA		Not Applicable	
24V dc User Power Volt. Range	18-30V dc			20.4-27.6V dc	18-30V dc			
Ambient Operating Temperature	0°C to +60°C (+32°F to +140°F) Current capacity is derated 5% above +55°C.			0°C to +60°C (+32°F to +140°F) no derating	0°C to +60°C (+32°F to +140°F) Current capacity is derated 5% above +55°C.			
Isolation <sup>(7)</sup>	1800V ac RMS for 1 s		None <sup>(8)</sup>	2600V dc for 1 s	1800V ac RMS for 1 s		600V ac RMS for 1 s	
CPU Hold-up Time <sup>(9)</sup>	20 ms (full load) 3000 ms (no load)		5 ms (full load) 1000 ms (no load)	20 ms (full load) 3000 ms (no load)	20 ms (full load) 3000 ms (no load)	5 ms (full load) 1500 ms (no load)	12V dc input: 1.37 ms at 0V dc (full load) 895 ms at 0V dc (no load) 10 ms at 9V dc (full load) continuous at 9V dc (no load)	24V dc input: 40 ms at 0V dc (full load) 1860 ms at 0V dc (no load) 790 ms at 11V dc (full load) continuous at 11V dc (no load)
Certification	UL listed C-UL or CSA certified (as indicated by product or packaging markings) CE compliant for all applicable directives							
Hazardous Environmt. Cert.	Class I Division 2							

- (1) See page 5 for information on power supply under voltage operation.
- (2) The combination of all output power (5 volt backplane, 24 volt backplane, and 24 volt user source) cannot exceed 70 watts.
- (3) Power supply fuse is intended to guard against fire hazard due to short-circuit conditions. This fuse may not protect the supply from miswiring or excessive transient in the power line.
- (5) Equivalent fuse: 250V-3A fuse, SANO SOC SD4, or BUSSMAN AGC 3
- (6) Equivalent fuse: 125V-3A fuse, Nagasawa ULCS-61ML-5, or BUSSMAN AGC 5
- (7) Isolation is between input terminals and backplane.
- (8) No isolation between input terminals and backplane. However, dielectric withstand between input terminals and chassis ground terminal is 600V ac RMS for 1 s.
- (9) CPU hold-up time is for 0V unless specified. Hold-up time is dependent on power supply loading.



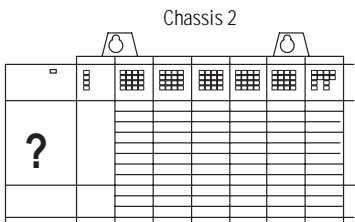
## Power Supply Selection Example

Select a power supply for chassis 1 and chassis 2 in the control system below. (The worksheet for this example is on page 20.)



Slot Numbers	Description	Catalog Number	Power Supply at 5V dc (Amps)	Power Supply at 24V (Amps)
0	Processor Unit	1747-L511	0.35	0.105
1	Input Module	1747-IV8	0.05	NA
2	Transistor Output Module	1746-OB8	0.135	NA
3	Triac Output Module	1746-OA16	0.37	NA
Peripheral Device	Hand-Held Terminal	1747-PT1	NA	NA
Peripheral Device	Isolated Link Coupler	1747-AIC	NA	NA
<b>Total Current:</b>			0.905	0.190 <sup>(1)</sup>

<sup>(1)</sup> Power Supply 1746-P1 is sufficient for Chassis #1. The "Internal Current Capacity" for this power supply is 2 Amps at 5V dc; 0.46 Amps at 24V dc.



Slot Numbers	Description	Catalog Number	Power Supply at 5V dc (Amps)	Power Supply at 24V (Amps)
0	Processor Unit	1747-L514	0.35	0.105
1	Output Module	1746-OW16	0.17	0.180
2	Combination Module	1746-IO12	0.09	.07
3,4,5,6	Analog Output Modules	1746-NO4I	0.22 (4 x 0.055)	0.780 (4 x 0.195)
Peripheral Device	Isolated Link Coupler	1747-AIC	NA	0.085
Peripheral Device	Interface Converter	1746-PIC	NA	NA
<b>Total Current:</b>			0.83	1.22 <sup>(1)</sup>

<sup>(1)</sup> Power Supply 1746-P4 is sufficient for Chassis #2. The "Internal Current Capacity" for this power supply is 10 Amps at 5V dc; not to exceed 70 Watts. (This configuration = 33.43 Watts, i.e., [5V x 0.083] + [24V x 1.22A] = 33.43W)



## Example Worksheet for Selecting 1746 Power Supplies for the Example System

If you have a multiple chassis system, make copies of the Worksheet for Selecting a Power Supply found on page 22. For a detailed list of device load currents, see page 14. Remember to consider future system expansion when selecting a power supply.

Procedure															
1. For each slot of the chassis that contains a module, list the slot number, the catalog number of the module, and its 5V and 24V maximum currents. Also include the power consumption of any peripheral devices that may be connected to the processor other than a DTAM, HHT, or PIC—the power consumption of these devices is accounted for in the power consumption of the processor.															
Chassis Number		1			Maximum Currents		Chassis Number		2		Maximum Currents				
Slot Number		Catalog Number		at 5V dc	at 24V dc	Slot Number		Catalog Number		at 5V dc	at 24V dc				
Slot	0	1747-L511		0.350A	0.105A	Slot	0	1747-L514		0.350A	0.105A				
Slot	1	1746-IV8		0.050A	-	Slot	1	1746-OW16		0.170A	0.180A				
Slot	2	1746-OB8		0.135A	-	Slot	2	1746-NO4I		0.055A	0.195A				
Slot	3	1746-OA16		0.370A	-	Slot	3	1746-NO4I		0.055A	0.195A				
Slot						Slot	4	1746-NO4I		0.055A	0.195A				
Slot						Slot	5	1746-NO4I		0.055A	0.195A				
Slot						Slot	6	1746-IO12		0.090A	0.070A				
Slot						Slot									
Peripheral Device		A/C		-	0.085A	Peripheral Device		A/C		-	0.085A				
Peripheral Device						Peripheral Device									
2. Add the loading currents of all the system devices at 5 and 24V dc to determine the <b>Total Current</b> .				<b>0.905A</b>	<b>0.190A</b>	2. Add the loading currents of all the system devices at 5 and 24V dc to determine the <b>Total Current</b> .				<b>0.830A</b>	<b>1.220A</b>				
3. For 1746-P4 power supplies, calculate the total power consumption of all system devices. If you are not using a 1746-P4, go to step 4.															
Current		Multiply by		= Watts		Current		Multiply by		= Watts					
Total Current at 5V dc		0.905A		5V		4.525W		Total Current at 5V dc		0.830A		5V		4.15W	
Total Current at 24V dc		0.190A		24V		4.56W		Total Current at 24V dc		1.220A		24V		29.28W	
User Current at 24V dc		0.500A		24V		12.00W		User Current at 24V dc		0.500A		24V		12.00W	
<b>Add the Watts values to determine Total Power (cannot exceed 70 Watts)</b>				<b>21.085W</b>		<b>Add the Watts values to determine Total Power (cannot exceed 70 Watts)</b>				<b>45.43W</b>					
4. Choose the power supply from the list of catalog numbers shown below. Compare the Total Current required for the chassis with the Internal Current capacity of the power supplies. Be sure that the Total Current consumption for the chassis is less than the Internal Current Capacity for the power supply, for both 5V and 24V loads.															
Catalog Number		Internal Current Capacity		Catalog Number		Internal Current Capacity									
		at 5V dc	at 24V dc			at 5V dc	at 24V dc								
1746-P1		2.0A	0.46A	1746-P1		2.0A	0.46A								
1746-P2		5.0A	0.96A	1746-P2		5.0A	0.96A								
1746-P3		3.6A	0.87A	1746-P3		3.6A	0.87A								
1746-P4 (see step 3)		10.0A	2.88A	1746-P4 (see step 3)		10.0A	2.88A								
1746-P5		5.0A	0.96A	1746-P5		5.0A	0.96A								
1746-P6				1746-P6											
1746-P7				1746-P7											
<b>Required Power Supply</b>		<b>1746-P1</b>		<b>Required Power Supply</b>		<b>1746-P4</b>									

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# Worksheets

## Blank Worksheets for Selecting a 1746 Power Supply

(For a detailed list of device load currents, see page 14.) Remember to consider future system expansion when selecting a power supply.

Procedure							
1. For each slot of the chassis that contains a module, list the slot number, the catalog number of the module, and its 5V and 24V maximum currents. Also include the power consumption of any peripheral devices that may be connected to the processor other than a DTAM, HHT, or PIC—the power consumption of these devices is accounted for in the power consumption of the processor.							
Chassis Number		Maximum Currents		Chassis Number		Maximum Currents	
Slot Number	Catalog Number	at 5V dc	at 24V dc	Slot Number	Catalog Number	at 5V dc	at 24V dc
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Slot				Slot			
Peripheral Device				Peripheral Device			
Peripheral Device				Peripheral Device			
2. Add the loading currents of all the system devices at 5 and 24V dc to determine the <b>Total Current</b> .				2. Add the loading currents of all the system devices at 5 and 24V dc to determine the <b>Total Current</b> .			
3. For 1746-P4 power supplies, calculate the total power consumption of all system devices. If you are not using a 1746-P4, go to step 4.							
Current		Multiply by = Watts		Current		Multiply by = Watts	
Total Current at 5V dc		5V		Total Current at 5V dc		5V	
Total Current at 24V dc		24V		Total Current at 24V dc		24V	
User Current at 24V dc		24V		User Current at 24V dc		24V	
<b>Add the Watts values to determine Total Power (cannot exceed 70 Watts)</b>				<b>Add the Watts values to determine Total Power (cannot exceed 70 Watts)</b>			
4. Choose the power supply from the list of catalog numbers shown below. Compare the Total Current required for the chassis with the Internal Current capacity of the power supplies. Be sure that the Total Current consumption for the chassis is less than the Internal Current Capacity for the power supply, for both 5V and 24V loads.							
Catalog Number		Internal Current Capacity		Catalog Number		Internal Current Capacity	
		at 5V dc	at 24V dc			at 5V dc	at 24V dc
1746-P1		2.0A	0.46A	1746-P1		2.0A	0.46A
1746-P2		5.0A	0.96A	1746-P2		5.0A	0.96A
1746-P3		3.6A	0.87A	1746-P3		3.6A	0.87A
1746-P4 (see step 3)		10.0A	2.88A	1746-P4 (see step 3)		10.0A	2.88A
1746-P5		5.0A	0.96A	1746-P5		5.0A	0.96A
1746-P6				1746-P6			
1746-P7				1746-P7			
<b>Required Power Supply</b>				<b>Required Power Supply</b>			



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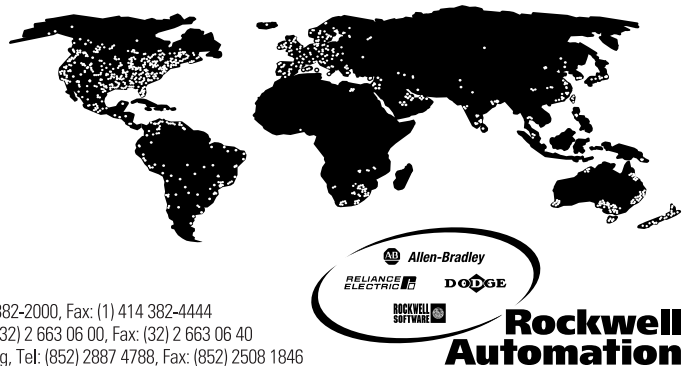
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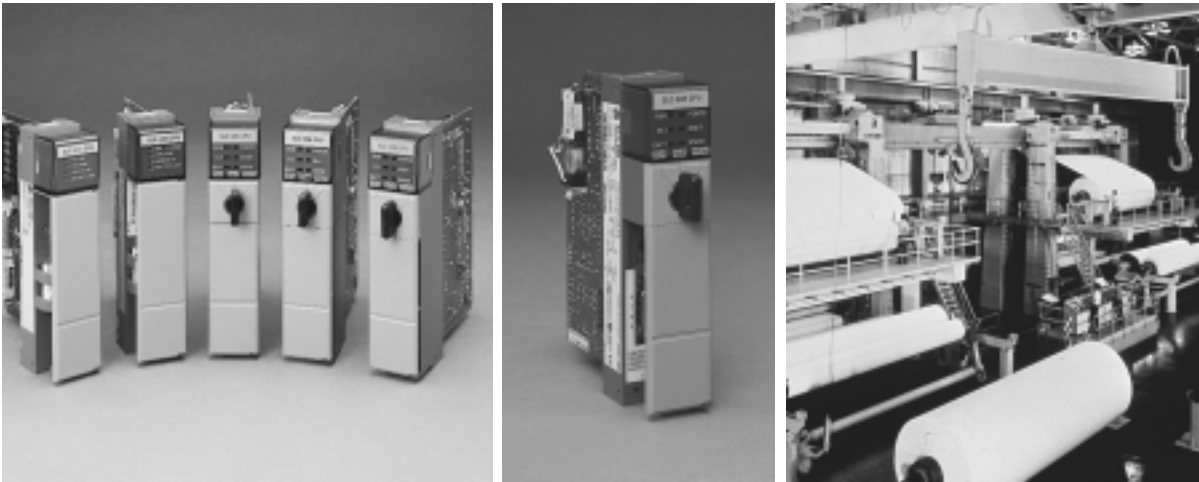
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## SLC 500™ Chassis-Based Processors

(Catalog Numbers 1747-L511, -L514, -L524, -L531, -L532, -L541, -L542, -L543, -L551, -L552, -L553)

### Product Data



The SLC 500 product line allows you to build just the right control system to meet your needs. We offer four chassis sizes, five power supplies, eleven processors, and a wide variety of I/O modules. Additionally, we offer flexible communication options and programming and operator interface options.

The SLC 500 family of programmable controllers have expanded to meet a broader range of applications. From high-speed packaging and material handling applications to advanced process control applications, Allen-Bradley offers the right processor for your job.

The SLC 5/03™, SLC 5/04™ and SLC 5/05™ processors offer features previously found only on high-level Plus. The SLC 500 processors provide a broad range of communication options, including DH-485, RS-232, DH+™, and Ethernet™. Increased instruction support with ASCII, floating point math, and indirect addressing allows you to expand your application's capabilities.

## Features and Benefits

**Supports user memory sizes from 1K to 64K.** By offering a wide range of user memory, SLC 500 modular processors can be used in a wide variety of applications.

**Supports a variety of input and output modules.** The 1746 modular I/O system offers over 60 types of modules, allowing you to customize your control solution to meet your application needs.

**Supports I/O configurations of up to 3 chassis (30 local I/O slots).** Provides you with the flexibility to expand I/O capacity as required.

**Supports remote I/O and DeviceNet.** The SLC 5/02 and above processors support up to 4096 discrete inputs and 4096 discrete outputs which may be a mix of local or remote I/O as well as I/O on DeviceNet.

**Provides superior system throughput.** SLC 500 modular processors deliver fast overall system throughput times, providing fast response in high-speed applications.

**Supports Ethernet communication.** The SLC 5/05 processors support 10 Mbps Ethernet communication and use the TCP/IP protocol. The 10Base-T Ethernet channel provides an economical connection to your Ethernet network.

**Supports Data Highway Plus™ (DH+) communication.** The SLC 5/04 processor provides communication and seamless integration into the larger Allen-Bradley PLC-5® network.

**Supports DH-485 communication.** Communication via the DH-485 network is available in every processor we ship, reducing your system cost for processor communication.

**Provides a second channel for RS-232 communication for the SLC 5/03, SLC 5/04, and SLC 5/05 processors.** This allows:

- dial up for remote monitoring and programming
- networking over modems for SCADA master/slave RTU applications
- an alternate connection for operator interfaces freeing up peer-to-peer network
- direct communication to ASCII devices such as bar code decoders and serial printers via a complete set of ASCII ladder instructions which simplify programming.

**Provides user-selectable program security.** The wide range of system protection capabilities allow you to secure user data and program files from changes.

Supports a host of third-party products through the Allen-Bradley Encompass Program. The Encompass Program provides access to products and services that increase your application capabilities.

## Overview of the Processors

The SLC 500 processor product line offers five types of chassis-based processors.

### SLC 5/01™ Processor (Catalog # 1747-L511 or 1747-L514)

The SLC 5/01 processor offers the instruction set of the SLC 500 fixed controller in a modular hardware configuration. The SLC 5/01 processor provides:

- two choices of program memory size - 1K or 4K instructions
- control of up to 3840 input and output points
- powerful ladder logic programming instruction set
- subroutines
- a DH-485 communication channel (peer-to-peer communication response to message commands only)
- capacitor backup for the -L511; battery backup for the -L514



### SLC 5/02™ Processor (Catalog # 1747-L524)

The SLC 5/02 processor offers additional instructions, increased diagnostics, faster throughput, and additional peer-to-peer communication options; building on what the SLC 5/01 processors offer. The SLC 5/02 processor provides:

- program memory size of 4K instructions
- control of up to 4096 input and output points
- PID - used to provide closed loop process control
- indexed addressing
- interrupt capability
- user fault routines
- ability to handle 32-bit signed math functions
- built-in DH-485 communication channel (initiation of peer-to-peer communication)
- battery-backed RAM





### SLC 5/03™ Processor (Catalog # 1747-L531 and 1747-L532)



The SLC 5/03 processor significantly increases performance by supplying system throughput times of 1 ms for a typical 1K user program. Now applications such as high-speed packaging, sorting, and material handling become more affordable. With the addition of online editing, the SLC 5/03 processor presents a positive solution for your continuous process application. A built-in RS-232 channel gives you the flexibility to connect to external intelligent devices without the need for additional modules. The SLC 5/03 processor provides:

- program memory size of 8K or 16K
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in DH-485 channel
- built-in RS-232 channel, supporting:
  - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3 cable for direct connection.)
  - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
  - DH-485 (Serves as a second DH-485 channel. Use a 1761-NET-AIC with a 1747-CP3 cable to connect to the DH-485 network.)
  - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- remote I/O passthru
- built-in real-time clock/calendar
- 2 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- indirect addressing
- flash PROM provides firmware upgrades without physically changing EPROMS
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM

## SLC 5/04™ Processor (Catalog # 1747-L541, -L542, or -L543)



The SLC 5/04 processor provides the baseline functionality of the SLC 5/03 processor plus DH+ communication. Communication via DH+ takes place 3 to 12 times faster than DH-485, providing you with increased performance levels. In addition, the SLC 5/04 processor runs approximately 15% faster than the SLC 5/03 processor. The SLC 5/04 processor provides:

- program memory sizes of 16K, 32K, or 64K
- high-speed performance - 0.90 ms/K typical
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in DH+ channel, supporting:
  - high-speed communication (57.6K, 115.2K, and 230.4K baud)
  - messaging capabilities with SLC 500, PLC-2<sup>®</sup>, PLC-5<sup>®</sup>, and PLC-5/250 processors
- built-in RS-232 channel, supporting:
  - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3 cable for direct connection.)
  - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
  - DH-485 (Use a 1761-NET-AIC with a 1747-CP3 cable to connect to the DH-485 network.)
  - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- channel-to-channel (DH+ to DH-485) passthru capability to operator interface devices
- channel-to-channel (DF1 Full-Duplex to DH+) passthru (OS401 and later only)
- remote I/O passthru
- built-in real-time clock/calendar
- 1 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- indirect addressing
- flash PROM provides firmware upgrades without physically changing EPROMS
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM

### SLC 5/05™ Processor (Catalog # 1747-L551, -L552, or -L553)

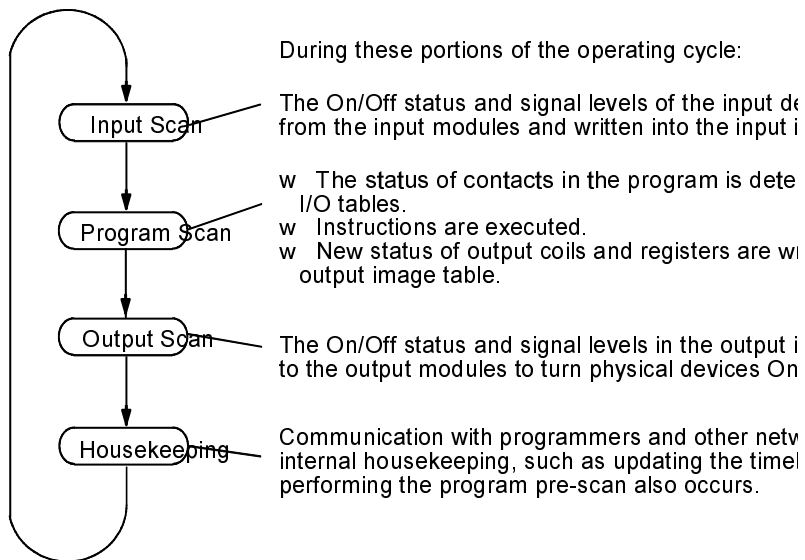


The SLC 5/05 processor provides identical functionality as the SLC 5/04 processor using standard Ethernet communications. Ethernet communication takes place at 10 Mbps, providing you with a high performance network for program upload/download, on-line editing, and peer-to-peer messaging. The variety of memory sizes allows you to closely match your application needs. The SLC 5/05 provides:

- program memory sizes of 16K, 32K, or 64K
- high-speed performance - 0.90 ms/K typical
- control of up to 4096 input and output points
- online programming (includes runtime editing)
- built-in 10Base-T Ethernet channel, supporting:
  - high-speed computer communication using TCP/IP
  - messaging capabilities with SLC 5/05, PLC-5, and PLC-5/250 processors, 1785-ENET Ethernet interface module, and 1756-ENET Ethernet bridge
  - SNMP for standard Ethernet network management
  - BOOTP for optional dynamic IP address assignment
- built-in RS-232 channel, supporting:
  - DF1 Full-Duplex for point-to-point communication; remotely via a modem, or direct connection to programming or operator interface devices. (Use a 1747-CP3 cable for direct connection.)
  - DF1 Half-Duplex Master/Slave for SCADA type (point-to-multipoint) communication
  - DH-485 (Use a 1761-NET-AIC with a 1747-CP3 cable to connect to the DH-485 network.)
  - ASCII I/O for connection to other ASCII devices, such as bar code readers, serial printers, and weigh scales
- remote I/O passthru
- built-in real-time clock/calendar
- 1 ms Selectable Timed Interrupt (STI)
- 0.50 ms Discrete Input Interrupt (DII)
- advanced math features - trigonometric, PID, exponential, floating point, and the compute instruction
- indirect addressing
- logical ASCII addressing
- flash PROM provides firmware upgrades without physically changing EPROMS
- optional flash EPROM memory module available
- keyswitch - RUN, REMote, PROGram (clear faults)
- battery-backed RAM

## System Throughput

When your application requires high-speed processing it requires more than just fast instruction or program scan times. It requires speed from the time an input is read until the time an output is turned on. The SLC 500 processors improve performance in every phase of system throughput, from input and output scans, to program scans and housekeeping functions.



## Interrupt Subroutines

The following interrupt subroutines allow you to provide predetermined responses to special events in an application.

### Selectable Timed Interrupt

This function allows you to interrupt the scan of the processor automatically, on a periodic basis, in order to scan a specified subroutine file. When using an SLC 5/02 processor, the Selectable Timed Interrupt (STI) timebase can be adjusted in 10 ms increments. The timebase for the SLC 5/03, SLC 5/04, and SLC 5/05 processors can be adjusted in 1 ms increments. The SLC 5/03 processor begins at 2 ms STI, and the SLC 5/04 and SLC 5/05 processors begin at 1 ms STI.

### Discrete Input Interrupt

Use the Discrete Input Interrupt (DII) for high-speed processing applications or any application that needs to respond to an event quickly. This function allows the processor to execute a ladder subroutine when the input bit pattern of a discrete I/O card matches a compare value that you programmed. The discrete input interrupt is examined every 100  $\mu$ s asynchronous to the ladder program scan. You may also specify the number of counts (matches) to occur before subroutine execution.

### I/O Event Interrupt

This function allows the 1746-BAS (BASIC) module to interrupt the normal processor operating cycle in order to scan a specified subroutine file. Use this interrupt with SLC 5/02, SLC 5/03, SLC 5/04, and SLC 5/05 processors.

## Communication Options

The SLC 500 processors support different types of communication options. The following sections describe the physical connections and protocol options used by the processors.

### Physical Connection Options

#### Ethernet (10Base-T) channel offers:

- 10 Mbps communication rate
- ISO/IEC 8802-3STD 802.3 (RJ45) connector for 10Base-T media
- TCP/IP communication protocol
- built-in isolation

#### Data Highway Plus (DH+) channel offers:

- communication rates of 57.6K, 115.2K, and 230.4K baud
- maximum network length of 3,048 m (10,000 ft.) at 57.6K baud
- Belden 9463 (blue hose) cable connection between nodes (daisy chain connection)
- built-in isolation

#### DH-485 channel offers:

- configurable communication rates up to 19.2K baud
- electrical isolation via the 1747-AIC or 1761-NET-AIC
- maximum network length of 1219m (4,000 ft.)
- RS-485 electrical specifications
- Belden 9842 or Belden 3106A cable connection between nodes (daisy chain connection)

#### RS-232 channel offers:

- communication rates up to 19.2K baud (38.4K baud SLC 5/05)
- maximum distance between devices is 15.24 m (50 ft.)
- RS-232C (EIA-232) electrical specifications
- modem support
- built-in isolation

The table below summarizes the SLC 500 processor channel connections.

Processor		Physical Communication Channel			
		DH-485	RS-232 <sup>a</sup>	DH+	Ethernet
SLC 5/01		DH-485 protocol			
SLC 5/02		DH-485 protocol			
SLC 5/03	Channel 0		DH-485, DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols		
	Channel 1	DH-485 protocol			
SLC 5/04	Channel 0		DH-485, DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols		
	Channel 1			DH+ protocol	
SLC 5/05	Channel 0		DH-485, DF1 Full-Duplex, DF1 Half-Duplex Master/Slave, and ASCII protocols		
	Channel 1				Ethernet TCP/IP protocol

a.A 1761-NET-AIC (or 1747-AIC) is required when connecting to a DH-485 network.

## Protocol Options

### Ethernet TCP/IP Protocol

Standard Ethernet, utilizing the TCP/IP protocol, is used as the backbone network in many office and industrial buildings. Ethernet is a local area network that provides communication between various devices at 10 Mbps. This network provides the same capabilities as DH+ or DH-485 networks, plus:

- SNMP support for Ethernet network management
- optional dynamic configuration of IP addresses using a BOOTP utility
- SLC 5/05 Ethernet data rate up to 40 times faster than SLC 5/04 DH+ messaging
- ability to message entire SLC 5/05 data files
- much greater number of nodes on a single network possible compared to DH-485 (32) and DH+ (64)

### **Data Highway Plus (DH+) Protocol**

The Data Highway Plus protocol is used by the PLC-5 family of processors and the SLC 5/04 processor. This protocol is similar to DH-485, except that it can support up to 64 devices (nodes) and runs at faster communication (baud) rates.

### **DH-485 Protocol**

The SLC 500 processors have a DH-485 channel that supports the DH-485 communication network. This network is a multi-master, token-passing network protocol capable of supporting up to 32 devices (nodes). This protocol allows:

- monitoring of data and processor status, along with program uploading and downloading of any device on the network from one location
- SLC processors to pass data to each other (peer-to-peer communication)
- operator interface devices on the network to access data from any SLC processor on the network

### **DF1 Full-Duplex Protocol**

DF1 Full-Duplex protocol (also referred to as DF1 point-to-point protocol) allows two devices to communicate with each other at the same time. This protocol allows:

- transmission of information across modems (dial-up, leased line, radio, or direct cable connections)
- communication to occur between Allen-Bradley products and third-party products

### **DF1 Half-Duplex Protocol (Master and Slave)**

DF1 Half-Duplex protocol provides a multi-drop single master/multiple slave network capable of supporting up to 255 devices (nodes). This protocol also provides modem support and is ideal for SCADA (Supervisory Control and Data Acquisition) applications because of the network capability.

### **ASCII Protocol**

The ASCII protocol provides connection to other ASCII devices, such as bar code readers, weigh scales, serial printers, and other intelligent devices.



## System Protection Options

The SLC 500 family of processors offer a number of hardware and software security features that allow you to protect your system from unauthorized changes to program or data files. The different types of protection are:

Types of Protection	SLC 5/01	SLC 5/02	SLC 5/03 SLC 5/04 SLC 5/05
Password	•	•	•
Future Access (OEM Lock)	•	•	•
Program Owner	•	•	•
Program Files			•
Data Table Files	•	•	•
Memory Module Data File Overwrite			•
Memory Module Program Compare			•
Memory Module Write Protection			•
Force Protection			•
Keyswitch			•
Communication Channel Protection			

## I/O Usages

The SLC 500 family of processors support a variety of I/O modules, allowing you to exactly match your application. The following table lists the various types of I/O modules and their compatibility with the SLC 500 processors.

I/O Module	SLC 5/01	SLC 5/02	SLC 5/03 SLC 5/04 SLC 5/05
1746–Discrete Input/Output AC/DC	•	•	•
1746sc–Isolated Discrete Input/Output AC/DC <sup>a</sup>	•	•	•
1746–Analog Modules	•	•	•
1746sc–Isolated Analog Modules	•	•	•
1746–NT4 and 1746–INT4 Thermocouple Modules and 1746sc–NT8 Isolated Thermocouple Module	•	•	•
1746–NR4 RTD Input Module	•	•	•
1747–SN Remote I/O Scanner Module		•	•
1746–SDN DeviceNet Scanner Module		•	•
1746–BAS Basic Module	•	•	•
1747–KE DH–485/RS232 KE Module	•	•	•
1746–HSCE High–Speed Counter Encoder Module		•	•
1746–HSTP1 Stepper Controller Module		•	•
1746–HS IMC 110 Servo Controller Module	•	•	•
1746–HSRV Servo Control Module			•
1746–QV Open–Loop Velocity Control Module		•	•
1746–BTM Barrel Temperature Module		•	•
1746–QS Synchronized Axes Module		•	•

a. Sold and supported by Spectrum Controls, Inc., Bellevue, WA. For additional information, contact Spectrum at (206) 746-9481.

## Programming Instructions

The following programming instructions are used with the SLC 500 processors. Included are instruction execution times ( $\mu\text{s}$ ) for the processors when the instruction is True and when floating point math is used and the instruction is True.

### Basic Instructions

Instruction Mnemonic and Name	Execution Times ( $\mu\text{s}$ )				Function - Conditional Instructions Input or Output
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>XIC</b> Examine if Closed	4	2.4	0.44	0.37	Conditional instruction. True when bit is on (1).
<b>XIO</b> Examine if Open	4	2.4	0.44	0.37	Conditional instruction. True when bit is off (0).
<b>OTE</b> Output Energize	18	11	0.63	0.56	Output instruction. True (1) when conditions preceding it are true. False when conditions preceding it go false.
<b>OTL</b> Output Latch	19	11	0.63	0.56	Output instruction. Addressed bit goes true (1) when conditions preceding the OTL instruction are true. When conditions go false, OTL remains true until the rung containing an OTU instruction with the same address goes true.
<b>OTU</b> Output Unlatch	19	11	0.63	0.56	Output instruction. Addressed bit goes false (0) when conditions preceding the OTU instruction are true. Remains false until the rung containing an OTL instruction with the same address goes true.
<b>OSR</b> One-Shot Rising	34	20	10.80	9.10	Conditional instruction. Makes rung true for one scan upon each false-to-true transition of conditions preceding it in the rung.
<b>TON</b> Timer On-Delay	135	83	1.40	1.31	Counts time intervals when conditions preceding it in the rung are true. Produces an output when accumulated value (count) reaches preset value.
<b>TOF</b> Timer Off-Delay	140	86	1.40	1.31	Counts time intervals when conditions preceding it in the rung are false. Produces an output when accumulated value (count) reaches preset value.
<b>RTO</b> Retentive Timer	140	86	1.40	1.31	This is an On-Delay timer that retains its accumulated value when: <ul style="list-style-type: none"> <li>• Rung conditions go false.</li> <li>• The mode changes to program from run or test.</li> <li>• The processor loses power.</li> <li>• A fault occurs.</li> </ul>
<b>CTU</b> Count Up	111	69	1.40	1.31	Counts up for each false-to-true transition of conditions preceding it in the rung. Produces an output when accumulated value (count) reaches the preset value.
<b>CTD</b> Count Down	111	69	1.40	1.31	Counts down for each false-to-true transition of conditions preceding it in the rung. Produces an output when accumulated value (count) reaches preset value.
<b>RES</b> Reset	40	26	1.40	1.31	Used with timers and counters. When conditions preceding it in the rung are true, the RES instruction resets the accumulated value and control bits of the timer or counter.

## Comparison Instructions

Instruction Mnemonic and Name	Execution Times (μs) Floating Point (μs) <sup>a b</sup>				Function - Conditional (Input) Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>EQU</b> Equal	60	38	1.25/12.94	1.12 / 12.5	Instruction is true when source A = source B.
<b>NEQ</b> Not Equal	60	38	1.25 / 13.25	1.12 / 12.18	Instruction is true when source A $\neq$ source B.
<b>LES</b> Less Than	60	38	1.25 / 13.19	1.12 / 13.94	Instruction is true when source A < source B.
<b>LEQ</b> Less Than or Equal	60	38	1.25 / 13.19	1.12 / 13.93	Instruction is true when source A $\leq$ source B.
<b>GRT</b> Greater Than	60	38	1.25 / 14.82	1.12 / 12.62	Instruction is true when source A > source B.
<b>GEQ</b> Greater Than or Equal	60	38	1.25 / 14.81	1.12 / 14.31	Instruction is true when source A $\geq$ source B.
<b>MEQ</b> Masked Comparison for Equal	75	47	38	22.75	Compares 16-bit data of a source address to 16-bit data at a reference address through a mask. If the values match, the instruction is true.
<b>LIM</b> Limit Test	-	45	1.95 / 22.81	1.68 / 20.19	True/false status of the instruction depends on how a test value compares to specified low and high limits.

a. Floating point times do not apply to SLC 5/03 OS300 processors.

b. When only one Execution Time is listed for an instruction, Floating Point does not apply.

## Math Instructions

Instruction Mnemonic and Name <sup>a</sup>	Execution Times (μs) Floating Point (μs) <sup>b c</sup>				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>ADD</b> Add	122	76	1.70 / 38.44	1.50 / 18.22	When rung conditions are true, the ADD instruction adds source A to source B and stores the result in the destination.
<b>SUB</b> Subtract	125	77	1.70 / 38.19	1.50 / 19.50	When rung conditions are true, the SUB instruction subtracts source B from source A and stores the result in the destination.
<b>MUL</b> Multiply	230	140	20 / 39.05	17.75 / 21.94	When rung conditions are true, the MUL instruction multiplies source A by source B and stores the result in the destination.
<b>DIV</b> Divide	400	242	23 / 57.56	25.9 / 23.27	When rung conditions are true, the DIV instruction divides source A by source B and stores the result in the destination and the math register.
<b>DDV</b> Double Divide	650	392	33	29.6	When rung conditions are true, the DDV instruction divides the contents of the math register by the source and stores the result in the destination and the math register.
<b>NEG</b> Negate	110	68	1.70 / 12.38	1.5 / 11.87	When rung conditions are true, the NEG instruction changes the sign of the source and places it in the destination.
<b>CLR</b> Clear	40	26	1.70 / 6.62	1.5 / 5.94	When rung conditions are true, the CLR instruction clears the destination to zero.
<b>SQR</b> Square Root	—	162	32.00 / 70.00	28.8 / 18.87	When rung conditions are true, the SQR instruction calculates the square root of the source and places the result in the destination.
<b>SCL</b> Scale	—	480	<sup>d</sup> / 32.00	<sup>d</sup> / 33.06	When rung conditions are true, the SCL instruction multiplies the source by a specified rate. The result is added to an offset value and placed in the destination.
<b>SCP</b> Scale with Parameters	—	—	33.10 / 196.10	29.85 / 94.15	Produces a scaled output value that has a linear relationship between the input and scaled values.
<b>CPT</b> Compute	—	—	<sup>d</sup> / 8.8	<sup>d</sup> / 7.7	Evaluates an expression and stores the result in the destination. To get the total execution time for a CPT instruction, take the CPT execution time plus each additional math instruction execution time, plus the number of math instructions times 3.01. For example if an SLC 5/03 CPT instruction calls one ADD and one SUB instruction, the calculation is: $8.8 + 1.70 + 1.70 + 2(3.01) = 18.22$

<b>SWP</b> Swap	—	—	24 + 13.09 per word	22.6 + 12.13 per word	Swaps the low and high bytes of a specified number of words in a bit integer, ASCII, or string file.
<b>ABS</b> Absolute Value	—	—	9.95 / 5.20	8.60 / 4.35	Calculates the absolute value of the source and places the result in the destination.
<b>XPY</b> X to the Power of Y Register/Data	—	—	<sup>d</sup> / 699.30	<sup>d</sup> / 335.10	Raises a value to a power and stores the result in the destination.
<b>LOG</b> Log to the Base 10	—	—	<sup>d</sup> / 390.80	<sup>d</sup> / 54.55	Takes the log base 10 of the value in the source and stores the result in the destination.
<b>LN</b> Natural Log	—	—	<sup>d</sup> / 392.00	<sup>d</sup> / 51.35	Takes the natural log of the value in the source and stores it in the destination.
<b>SIN</b> Sine	—	—	<sup>d</sup> / 311.95	<sup>d</sup> / 38.05	Takes the sine of a number and stores the result in the destination.
<b>COS</b> Cosine	—	—	<sup>d</sup> / 310.90	<sup>d</sup> / 37.20	Takes the cosine of a number and stores the result in the destination.
<b>TAN</b> Tangent	—	—	<sup>d</sup> / 406.35	<sup>d</sup> / 43.00	Takes the tangent of a number and stores the result in the destination.
<b>ASN</b> Arc Sine	—	—	<sup>d</sup> / 483.05	<sup>d</sup> / 41.45	Takes the arc sine of a number and stores the result (in radians) in the destination.
<b>ACS</b> Arc Cosine	—	—	<sup>d</sup> / 510.85	<sup>d</sup> / 51.90	Takes the arc cosine of a number and stores the result (in radians) in the destination.
<b>ATN</b> Arc Tangent	—	—	<sup>d</sup> / 387.05	<sup>d</sup> / 40.15	Takes the arc tangent of a number and stores the result (in radians) in the destination.

a. Applies to SLC 5/03 OS302, SLC 5/04 OS401 and SLC 5/05 OS500 processors.

b. Floating point times do not apply to SLC 5/03 OS300 processors.

c. When only one Execution time is listed for an instruction, Floating Point does not apply.

d. The execution times assume floating point data. If signed integer data is used, add 15 microseconds per instruction execution time.

## Data Handling Instructions

Instruction Mnemonic and Name	Execution Times (μs) Floating Point (μs) <sup>b c</sup>				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>TOD</b> Convert to BCD	200	122	38	34.06	When rung conditions are true, the TOD instruction converts the source value to BCD and stores it in the math register or the destination.
<b>FRD</b> Convert from BCD	223	136	31	23.88	When rung conditions are true, the FRD instruction converts a BCD value in the math register or the source to an integer and stores it in the destination.
<b>RAD</b> Degrees to Radians <sup>a</sup>	—	—	<sup>d</sup> / 31.80	<sup>d</sup> / 24.65	When rung conditions are true, RAD converts degrees (source) to radians and stores the result in the destination.
<b>DEG</b> Radians to Degrees <sup>a</sup>	—	—	<sup>d</sup> / 32.80	<sup>d</sup> / 24.70	When rung conditions are true, DEG converts radians (source) to degrees and stores the result in the destination.
<b>DCD</b> Decode	80	50	10	8.88	When rung conditions are true, the DCD instruction decodes 4-bit value (0 to 16), turning on the corresponding bit in 16-bit destination.
<b>COP</b> File Copy	45 + 21 per word	29 + 13 per word	30 + 2.20 per word	20.2 + 2.0 per word	When rung conditions are true, the COP instruction copies a user-defined source file to the destination file.
<b>FLL</b> File Fill	37 + 14 per word	25 + 8 per word	28 + 2 per word	21.9 + 2.5 per word	When rung conditions are true, the FLL instruction loads a source value into specified elements in a user-defined file.
<b>MOV</b> Move	20	14	1.25 / 12.19	1.12 / 11.44	When rung conditions are true, the MOV instruction moves a copy of the source to the destination.
<b>MVM</b> Masked Move	115	71	19	17.40	When rung conditions are true, the MVM instruction moves a copy of the source through a mask to the destination.
<b>AND</b> And	87	55	1.70	1.5	When rung conditions are true, sources A and B of the AND instruction are ANDed and stored in the destination.
<b>OR</b> Inclusive Or	87	55	1.70	1.5	When rung conditions are true, sources A and B of the OR instruction are ORed bit by bit and stored in the destination.
<b>XOR</b> Exclusive Or	87	55	1.70	1.5	When rung conditions are true, sources A and B of the XOR instruction are Exclusive ORed and stored in destination.
<b>NOT</b> Not	66	42	1.70	1.5	When rung conditions are true, the source of the NOT instruction is NOTed bit by bit and stored in the destination.
<b>FFL</b> Load	—	150	58	40.75	First In First Out (FIFO). The FFL instruction loads a word into a FIFO stack on successive false-to-true transitions. The FFU unloads a word from the stack on successive false-to-true transitions. The first word loaded is the first to be unloaded.
<b>FFU</b> Unload	—	150 + 11 per word	79 + 2.20 per word	60 + 2 per word	
<b>LFL</b> Load	—	150	58	40.70	Last In First Out (LIFO). The LFL instruction loads a word into a LIFO stack on successive false-to-true transitions. The LFU unloads a word from the stack on successive false-to-true transitions. The last word loaded is the first to be unloaded.
<b>LFU</b> Unload	—	180	66	34.70	

a. Applies to SLC 5/03 OS302 and SLC 5/04 OS401 processors.

b. Floating point times do not apply to SLC 5/03 OS300 processors.

c. When only one Execution Time is listed for an instruction, Floating Point does not apply.

d. The execution times assume floating point data. If signed integer data is used, add 15 microseconds per instruction execution time.

## Program Flow Instructions

Instruction Mnemonic and Name	Execution Times (μs)				Function - Conditional or Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>JMP</b> Jump to Label	38	23	44.45	37.44	Output instruction. When rung conditions are true, the JMP instruction causes the program scan to jump forward or backward to the corresponding LBL instruction.
<b>LBL</b> Label	2	4	0.25	0.18	This is the target of the correspondingly numbered JMP instruction.
<b>JSR</b> Jump to Subroutine	46	28	131.0	112.0	Output instruction. When rung conditions are true, the JSR instruction causes the processor to jump to the targeted subroutine file.
<b>SBR</b> Subroutine	2	4	0.25	0.18	Placed as first instruction in a subroutine file. Identifies the subroutine file.
<b>RET</b> Return from Subroutine	34	20	23	20.0	Output instruction, placed in subroutine. When rung conditions are true, the RET instruction causes the processor to resume program execution in the main program file or the previous subroutine file.
<b>MCR</b> Master Control Reset	10	6	4	3.0	Output instruction. Used in pairs to inhibit or enable a zone within a ladder program.
<b>TND</b> Temporary End	32	22	12	13.05	Output instruction. When rung conditions are true, the TND instruction stops the program scan, updates I/O, and resumes scanning at rung 0 of the main program file.
<b>SUS</b> Suspend	12	7	12	10.31	Output instruction, used for troubleshooting. When rung conditions are true, the SUS instruction places the controller in the Suspend Idle mode. The suspend ID number is placed in word S:7 and the program file number is placed in S:8.
<b>IIM</b> Immediate Input with Mask	372	340	51.85	51.0	When conditions preceding it in the rung are true, the IIM instruction is enabled and interrupts the program scan to write a word of masked external input data to input data file.
<b>IOM</b> Immediate Output with Mask	475	465	70.90	75.74	When conditions preceding it in the rung are true, the IOM instruction is enabled and interrupts the program scan to read a word of data from the output data file and transfer the data through a mask to the corresponding external outputs.



### Application Specific Instructions

Instruction Mnemonic and Name	Execution Times (µs)				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>BSL</b> Bit Shift Left <b>BSR</b> Bit Shift Right	144 + 24 per word	89 + 14 per word	50 + 2.30 per word	31.5 + 2.31 per word	On each false-to-true transition, these instructions load a data bit into a bit array, shift the pattern of data through the array, and unload the end bit of data. The BSL shifts data to the left and the BSR shifts data to the right.
<b>SQO</b> Sequencer Output	225	137	70	44.1	On each false-to-true transition, these instructions load a data bit into a bit array, shift the pattern of data through the array, and unload the end bit of data. The BSL shifts data to the left and the BSR shifts data to the right.
<b>SQC</b> Sequencer Compare	225	137	60	33.2	On successive false-to-true transitions, the SQC moves a step through the programmed sequencer file, comparing the data through a mask to a source word or file for equality.
<b>SQL</b> Sequencer Load	—	135	56	33.2	On successive false-to-true transitions, the SQL moves a step through the sequencer file, loading a word of source data into the current element of the sequencer file.

### Communication Instructions

Instruction Mnemonic and Name	Execution Times (µs)				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>MSG</b> Message Read/Write	—	180	203	183	This instruction transfers data from one node to another on the communication network. When the instruction is enabled, message transfer is pending. Actual data transfer takes place at the end of the scan.
<b>SVC</b> Service Communications	—	240	240	200	When conditions preceding it in the rung are true, the SVC instruction interrupts the program scan to execute the service communication portion of the operating cycle.

### Proportional Integral Derivative Instruction

Instruction Mnemonic and Name	Execution Times (µs)				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>PID</b> Proportional Integral Derivative	—	3600	272	169.82	This instruction is used to control physical properties such as temperature, pressure, liquid level, or flow rate of process loops.

## ASCII Instructions

Instruction Mnemonic and Name <sup>a</sup>	Execution Times (μs)		Function - Output Instructions
	SLC 5/03	SLC 5/04 SLC 5/05	
<b>ABL</b> Test Buffer for Line	129.9	156.0	Determines the number of characters in the buffer, up to and including the end-of-line characters (termination).
<b>ACB</b> Number of Characters in Buffer	140.7	131.0	Determines the total characters in the buffer.
<b>ACI</b> String to Integer	86.62	56.0	Converts an ASCII string to an integer value.
<b>ACL</b> ASCII Clear Receive and/or Send Buffer	367.5	332.8	Clears the ASCII buffer.
<b>ACN</b> String Concatenate	69.4 + 2.1 per character	56 + 2.5 per character	Combines two strings using ASCII strings as operands.
<b>AEX</b> String Extract	56.2 + 4.7 per character	43.4 + 4.0 per character	Creates a new string by taking a portion of an existing string and linking it to a new string.
<b>AHL</b> ASCII Handshake Lines	138.7	115.1	Sets or resets the RS-232 Data Terminal Ready and Request to Sender handshake control lines for the modem.
<b>AIC</b> Integer to String	103.4	110.0	Converts an integer value to an ASCII string.
<b>ARD</b> ASCII Read Characters	181.8	151.0	Reads characters from the buffer and stores them in a string.
<b>ARL</b> ASCII Read Line	190.0	156.0	Reads characters from the buffer up to and including the end-of-line characters and stores them in a string.
<b>ASC</b> String Search	53.4 + 1.8 per character	43.5 + 2.5 per character	Searches an existing string for an occurrence of the source string.
<b>ASR</b> ASCII String Compare	49.69	43.5	Compares two ASCII strings.
<b>AWA</b> ASCII Write with Append	365.5	307.8	Adds the two appended characters set from the ASCII configuration menu.
<b>AWT</b> ASCII Write	263.8	217.3	Writes characters from a source string to a display device.

a. Only SLC 5/03 (OS301, OS302), SLC 5/04 and SLC 5/05 processors use these instructions.

## Interrupt Routine Instructions

Instruction Mnemonic and Name	Execution Times (μs)				Function - Output Instructions
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04 SLC 5/05	
<b>STD</b> Selectable Timed Disable	—	9	4	3.56	Associated with the Selectable Timed Interrupt function. STD and STE are used to prevent an STI from occurring during a portion of the program; STS initiates an STI.
<b>STE</b> Selectable Timed Enable	—	9	5	5.0	
<b>STS</b> Selectable Timed Start	—	72	58	44.38	
<b>IIE</b> I/O Interrupt Enable	—	42	16	10.44	The IIE, IID and RPI instructions are used with specialty I/O modules capable of generating an I/O interrupt.
<b>IID</b> I/O Interrupt Disable	—	39	6	5.81	
<b>RPI</b> Reset Pending I/O Interrupt	—	240	78 + 60 per added slot	91 + 56 per added slot	
<b>REF</b> I/O Refresh	—	240	240	200	When conditions preceding it in the rung are true, the REF instruction interrupts the program scan to execute the I/O scan (write outputs-service comms-read inputs). The program scan then resumes.
<b>INT</b> Interrupt Subroutine	—	0	0.25	0.18	Associated with STI interrupts and I/O event-driven interrupts.

## Indirect Addressing

The following sections describe how indirect addressing affects the execution time of instructions in the SLC 5/03 OS302, SLC 5/04 OS401, and SLC 5/05 processors. The timing for an indirect address is affected by:

- the form of the indirect address
- if the indirect address is a source or destination parameter
- whether indirect addressing is used in either a COP, FLL, FFL/FFU, LFL/LFU, BSR, BSL, or MVM instruction
- whether indirect addressing is used in either an XIC, XIO, OTU, OTL, OTE, or OSR instruction

For the address forms in the table on the next page, you can substitute the following file types:

For an Integer (N)	For a String (ST)
Input (I)	Control (R)
Output (O)	Counter (C)
Bit (B)	Timer (T)
Floating Point (F)	
ASCII (A)	

## Execution Times for Word-Level Indirect Addresses

For most types of instructions that contain an indirect address(es), look up the form of the indirect address in the table below and add that time to the execution time of the instruction.

Address Form <sup>a</sup>	Source Operand (μs)		Destination Operand (μs)		If used in a file type instruction	
	SLC 5/03	SLC 5/04 SLC 5/05	SLC 5/03	SLC 5/04 SLC 5/05	SLC 5/03	SLC 5/04 SLC 5/05
N7:[*]	65.1	56.15	63.10	54.20	76.35	66.75
ST12:[*],[*]	69.45	60.00	67.45	58.05	80.70	70.60
ST12:[*].0	74.65	59.60	72.65	57.65	85.90	70.20
ST12:0.[*]	74.65	59.60	72.65	57.65	85.90	70.20
N[*]:[:]	105.90	89.40	131.50	112.55	138.75	118.70
N[*]:0	111.10	89.00	136.70	112.15	143.95	118.30
N[*]:0	111.10	89.00	136.70	112.15	143.95	118.30
ST[*]:[*],[*]	110.25	93.25	135.85	116.40	143.10	122.55
ST[*]:[*].0	115.45	92.85	141.05	116.00	148.30	122.15
ST[*]:0.[*]	115.45	92.85	141.05	116.00	148.30	122.15
ST[*]:0.0	120.65	92.45	146.25	115.60	153.50	121.75
#N7:[*]	73.05	59.35	64.65	57.30	86.80	69.80
#ST12:[*],[*]	77.40	63.20	69.00	61.15	91.15	73.65
#ST12:[*].0	82.60	62.80	74.20	60.75	96.35	73.25
#ST12:0.[*]	82.60	62.80	74.20	60.75	96.35	73.25
#N[*]:[*]	110.95	92.95	133.40	114.40	146.65	121.35
#N[*]:0	116.15	92.55	138.60	114.00	151.85	120.95
#ST[*]:[*],[*]	115.30	96.80	137.75	118.25	151.00	125.20
#ST[*]:[*].0	120.50	96.40	142.95	117.85	156.20	124.80
#ST[*]:0.[*]	120.50	96.40	142.95	117.85	156.20	124.80
#ST[*]:0.0	125.70	96.00	148.15	117.45	161.40	124.40

a.[\*] indicates that an indirect reference is substituted.

### Execution Times for Bit-Level Indirect Addresses

Indirect bit addresses are based on the form of the indirect address and the type of bit instruction. Use the following two tables to calculate the execution time of a bit instruction.

Address Form	Additional Time (μs)	
	SLC 5/03	SLC 5/04 SLC 5/05
B3:[*]	96.70	77.80
B3:1/[*]	96.70	77.80
B3:[*=/]:[	91.50	72.80
ST12:[*].[*=/]:[	100.65	76.65
ST12:[*].[*]0	100.85	76.25
ST12:[*].0/[*]	100.85	76.25
ST12:[*].0/0	105.85	75.85
ST12:0.[*]/0	105.85	75.85
ST12:0.0/[*]	105.85	75.85
B[*=/]:[	171.50	141.40
B[*]:1/[*]	171.50	141.40
B[*]:[*=/]:[	166.30	141.80
ST[*]:[*].[*=/]:[	170.65	145.65
ST[*]:[*].[*]0	175.85	145.25
ST[*]:[*].0/[*]	175.85	145.25
ST[*]:[*].0/0	181.05	144.85
ST[*]:0.[*=/]:[	175.85	145.25
ST[*]:0.[*]0	181.05	144.85
ST[*]:0.0/[*]	181.05	144.85
ST[*]:0.0/0	186.25	144.45

### Execution Time Examples - Word Level and Bit Level Indirect Address

<pre> ADD ADD Source A      M7:[*] Source B      F4:[*].ACC Dest         M[*]:[*]                 </pre>	<table border="0"> <tr><td>Add</td><td>1.70</td></tr> <tr><td>Source A</td><td>65.10</td></tr> <tr><td>Source B</td><td>74.85</td></tr> <tr><td>Destination</td><td><u>131.50</u></td></tr> <tr><td></td><td>272.95μs</td></tr> </table>	Add	1.70	Source A	65.10	Source B	74.85	Destination	<u>131.50</u>		272.95μs
Add	1.70										
Source A	65.10										
Source B	74.85										
Destination	<u>131.50</u>										
	272.95μs										
<pre> BSL BIN SHIFF UNIT File          #B[*]:1 Control       RS:2 Bit Address   B3:[*] Length        32                 </pre>	<table border="0"> <tr><td>BSL</td><td>31.5 + (2)2.31 + 36.12</td></tr> <tr><td>File</td><td>120.85</td></tr> <tr><td>Bit Address</td><td><u>77.80</u></td></tr> <tr><td></td><td>234.87μs</td></tr> </table>	BSL	31.5 + (2)2.31 + 36.12	File	120.85	Bit Address	<u>77.80</u>		234.87μs		
BSL	31.5 + (2)2.31 + 36.12										
File	120.85										
Bit Address	<u>77.80</u>										
	234.87μs										

### Instruction Execution Times

Instruction	Execution Time (μs)	
	SLC 5/03	SLC 5/04 SLC 5/05
XIC	10.20	8.72
XIO	14.65	12.76
OTU	6.30	5.45
OTL	9.35	5.40
OTE	6.25	5.50
OSR	10.50	8.10

### Execution Time Example - Bit Instruction Using an Indirect Address

To calculate the execution time of an XIC at B3/[N7:0] using an SLC 5/03 processor add the following:

Execution Time for Bit-Level Indirect Address + Instruction Execution Time = 10.20 + 96.70 = 106.90

## Specifications

The following table summarizes the detailed specifications for the SLC 500 processor family:

Specification	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04	SLC 5/05
	1747-L511 1747-L514	1747-L524	1747-L531 1747-L532	1747-L541 1747-L542 1747-L543	1747-L551 1747-L552 1747-L553
Memory Size (words)	1K (1747-L511) 4K (1747-L514)	4K	8K (1747-L531) 16K (1747-L532)	16K (1747-L541) 32K (1747-L542) 64K (1747-L543)	16K (1747-L551) 32K (1747-L552) 64K (1747-L553)
Max. I/O Capacity	3940 Discrete	4096 Discrete	4096 Discrete	4096 Discrete	4096 Discrete
Max. Local Chassis/Slots	3/30	3/30	3/30	3/30	3/30
Programming	<ul style="list-style-type: none"> <li>•RSLogix 500 (V1.00 or later), SLC-500 A.I. Series</li> <li>•APS Programming Software</li> <li>•HHT</li> </ul>		<b>1747-L531:</b> <ul style="list-style-type: none"> <li>•RSLogix 500 (V1.26.03 or later)</li> <li>•SLC 500 A.I. Series (V8.15 or later)</li> </ul> <b>1747-L532:</b> <ul style="list-style-type: none"> <li>•RSLogix 500 (V1.24.04 or later)</li> <li>•SLC 500 A.I. Series (V8.10 or later)</li> <li>•APS (V6.0 or later)</li> </ul>	<ul style="list-style-type: none"> <li>•RSLogix 500 (V1.24.04 or later)</li> <li>•SLC 500 A.I. Series (V8.10 or later)</li> <li>•APS (V6.0 or later)</li> </ul>	<ul style="list-style-type: none"> <li>•RSLogix 500 (V2.10 or later)</li> </ul>
Programming Instructions	52	71	99	99	99
Typical Scan Time <sup>a</sup>	8 ms/K	4.8 ms/K	1 ms/K	0.9 ms/K	0.9 ms/K
Bit Execution (XIC)	4 μs	2.4 μs	0.44 μs	0.37 μs	0.37 μs

a. The scan times are typical for a 1K ladder logic program consisting of simple ladder logic and communication servicing. Actual scan times depend on your program size, instructions used and the communication protocol.

The following table summarizes the communication options for the SLC 500 processor family.

Communications Protocol	Processor				
	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04	SLC 5/05
DH485 peer-to-peer	receive only	receive and initiate	receive and initiate		
DH485 via RS232 port			receive and initiate <sup>c</sup>	receive and initiate <sup>c</sup>	receive and initiate <sup>c</sup>
DF1 via RS232 port (full-duplex or half-duplex master or slave)	receive only <sup>a</sup>	receive only <sup>a</sup>	receive and initiate	receive and initiate	receive and initiate
ASCII via RS232 port			receive and initiate	receive and initiate	receive and initiate
Data Highway Plus (DH+)	receive only <sup>b</sup>	receive only <sup>b</sup>	receive and initiate <sup>d</sup>	receive and initiate	receive and initiate
Ethernet					receive and initiate

a. A 1747-KE or 1770-KF3 is required to bridge from DF1 (full-duplex or half-duplex slave only) to DH485.

b. A 1785-KA5 is required to bridge from DH+ to DH485.

c. If using 1747-AIC for isolation, connect to DH-485 network using 1747-PIC; if using 1761-NET-AIC for isolation, directly connect to DH-485 network with 1747-CP3 serial cable (or equivalent RS-232 null-modem cable).

d. Either a 1785-KA5 is required to bridge from DH+ to DH485 or the SLC 5/04's channel-to-channel passthru feature may be used to bridge between DH+ and DH485 or between DH+ and DF1 Full-Duplex (DH+ to DF1 Full-Duplex passthru available starting with OS401). Another option is to use the 1785-KE to bridge between DH+ and DF1 Full-Duplex or DH+ and a DF1 Half-Duplex Master/Slave network.

**Note:** The 1785-KA5 and 1785-KE modules require use of a 1771-series chassis and power supply.

The following table summarizes the general specifications for the SLC 500 processor family:

Description		Specification
Power Supply Loading	SLC 5/01 and SLC 5/02	350mA at 5V dc. 105 mA at 24V dc
	SLC 5/03	500 mA at 5V dc. 175 mA at 24V dc
	SLC 5/04 and SLC 5/05	1.0 A at 5V dc 200 mA at 24V dc
Program Scan Hold-up time after Loss of Power		20 ms to 3 s (dependent on power supply loading)
Clock/Calendar Accuracy (Applicable only to SLC 5/03, SLC 5/04, and SLC 5/05 processors)		±54 sec/month at +25° C (77° F) ±81 sec/month @ +60° C (+140° F)
Noise Immunity		NEMA Standard ICS 2-230
Vibration	Displacement	0.015 inch, peak-to-peak at 5-57 Hz
	Acceleration	2.5Gs at 57-2000 Hz
Shock (operating)		30Gs
Ambient Temperature Rating	Operating Temperature	0 to +60°C (+32°F to +140°F)
	Storage Temperature	-40°C to +85°C (-40°F to 185°F)
Humidity		5 to 95% without condensation
Certification		UL listed CSA approved Class 1, Groups A, B, C or D, Division 2 CE compliant for all applicable directives

The following table summarizes the available memory back up options for the SLC 500 processors. EEPROM and UVPROM memory modules provide non-volatile memory backup. Flash EPROMs (Flash Erasable Programmable Read-Only Memory) combine the versatility of EEPROMs with the security of UVPROMs.

Specification	SLC 5/01	SLC 5/02	SLC 5/03	SLC 5/04	SLC 5/05
		1747-L511 1747-L514	1747-L524	1747-L531 1747-L532	1747-L541 1747-L542 1747-L543
EEPROM	1747-M1 1747-M2	1747-M2			
UVPROM	1747-M3 1747-M4	1747-M4			
Flash			1747-M11 1747-M12 (OS302 or later)	1747-M11 1747-M12 (OS401 or later)	1747-M11 1747-M12



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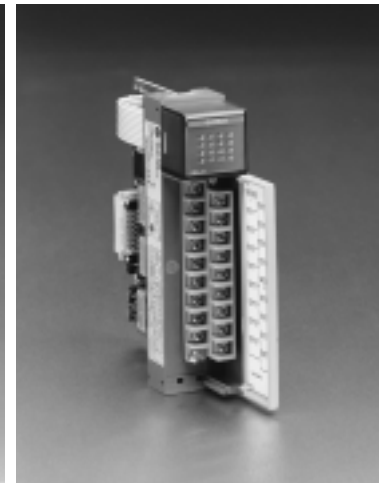
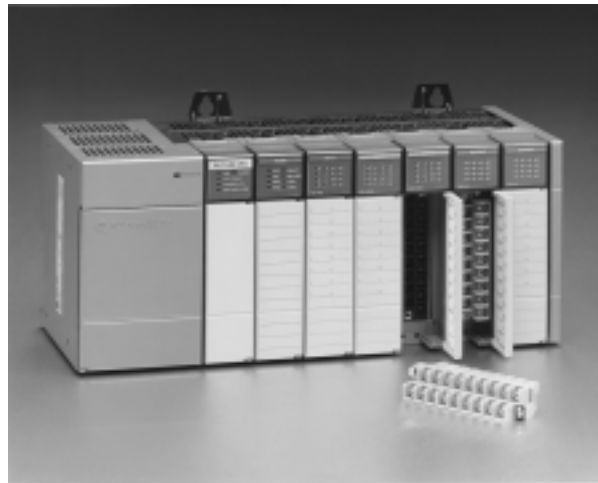
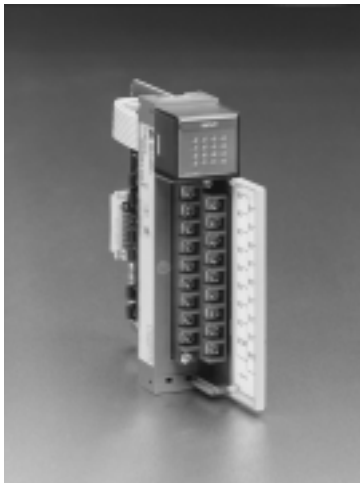
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# Discrete Input and Output Modules

(Catalog Numbers 1746-IA4, -IA8, -IA16, -IB8, -IB16, -IB32, -IC16, -IG16, -IH16, -IM4, -IM8, -IM16, -IN16, -ITB16, -ITV16, -IV8, -IV16, -IV32, -OA8, -OA16, -OAP12, -OB6EI, -OB8, -OB16, OB16E, -OB32, OB32E, -OBP8, -OBP16, -OG16, -OV8, -OV16, OV32, -OVP16, -OW4, -OW8, -OW16, -OX8, -IO4, -IO8, -IO12, -IO12DC)



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**Our wide variety of input, output, and combination modules makes the SLC 500™ family the smart choice for all of your small PLC applications.** I/O modules are available in a wide variety of densities including 4-, 8-, 16-, and 32-point and can interface to AC, DC, and TTL voltage levels. Output modules are available with solid state AC, solid state DC, and relay contact type outputs. For added flexibility, combination modules are also available in 2-input/2-output, 4-input/4-output, and 6-input/6-output versions.

**Designed and tested for industrial applications, our modules are of the highest quality.** The modules feature input filtering, optical isolation, and built-in surge protection to enhance the reliability of operation in noisy industrial environments.

**Class 1, Division 2 certified by UL and CSA. CE compliant.** All modules are UL 508 listed and CSA 22.2 142 approved and meet Class 1, Division 2 hazardous location requirements of both Underwriter’s Laboratory and the Canadian Standards Association (except for those noted in the module summary on page 2). For use within the European Union or EEA regions, most modules have been tested to meet Council Directive 89/336 Electromagnetic Compatibility (exceptions are listed on page 2).

## Discrete I/O Module Summary

	ID Code	Voltage Category	Catalog Number	Input/Output	I/O Points	Module Description	Page
AC Modules	100	100/120V ac	<b>1746-IA4</b>	Input	4	120V ac Input	15
	300	100/120V ac	<b>1746-IA8</b>	Input	8	120V ac Input	15
	500	100/120V ac	<b>1746-IA16</b>	Input	16	120V ac Input	15
	101	200/240V ac	<b>1746-IM4</b>	Input	4	240V ac Input	15
	301	200/240V ac	<b>1746-IM8</b>	Input	8	240V ac Input	15
	501	200/240V ac	<b>1746-IM16</b>	Input	16	240V ac Input	15
	2703	100/120V ac	<b>1746-OA8</b>	Output	8	120/240V ac Output	17
	2903	100/120V ac	<b>1746-OA16</b>	Output	16	120/240V ac Output	17
	2803	120/240V ac	<b>1746-OAP12<sup>(1)</sup></b>	Output	12	High Current 120/240V ac Output	17
DC Modules	306	24V dc	<b>1746-IB8</b>	Input	8	Current Sinking DC Input	19
	506	24V dc	<b>1746-IB16</b>	Input	16	Current Sinking DC Input	19
	706	24V dc	<b>1746-IB32<sup>(1)</sup></b>	Input	32	Current Sinking DC Input	19
	519	24V dc	<b>1746-ITB16</b>	Input	16	Fast Response DC Sinking Input	19
	509	48V dc	<b>1746-IC16</b>	Input	16	Current Sinking DC Input	22
	507	125V dc	<b>1746-IH16</b>	Input	16	Current Sinking DC Input	22
	320	24V dc	<b>1746-IV8</b>	Input	8	Current Sourcing DC Input	22
	520	24V dc	<b>1746-IV16</b>	Input	16	Current Sourcing DC Input	22
	720	24V dc	<b>1746-IV32<sup>(1)</sup></b>	Input	32	Current Sourcing DC Input	22
	518	24V dc	<b>1746-ITV16</b>	Input	16	Fast Response DC Sourcing Input	22
	515	5V dc/TTL	<b>1746-IG16<sup>(2)</sup></b>	Input	16	Current Sourcing TTL Input	27
	2619	24V dc	<b>1746-OB6EI</b>	Output	6	Isolated Sourcing DC Output	31
	2713	24V dc	<b>1746-OB8</b>	Output	8	Current Sourcing DC Output	28
	2913	24V dc	<b>1746-OB16</b>	Output	16	Current Sourcing DC Output	28
	2920	24V dc	<b>1746-OB16E<sup>(1)(3)</sup></b>	Output	16	Current Sourcing DC Output	31
	3113	24V dc	<b>1746-OB32<sup>(1)</sup></b>	Output	32	Current Sourcing DC Output	28
	3120	24V dc	<b>1746-OB32E<sup>(1)</sup></b>	Output	32	Current Sourcing DC Output	31
	2721	24V dc	<b>1746-OBP8<sup>(3)</sup></b>	Output	8	High Current Sourcing DC Output	31
	2921	24V dc	<b>1746-OBP16<sup>(1)</sup></b>	Output	16	High Current Sourcing DC Output	35
	2714	24V dc	<b>1746-OV8</b>	Output	8	Current Sinking DC Output	37
	2914	24V dc	<b>1746-OV16</b>	Output	16	Current Sinking DC Output	37
	3114	24V dc	<b>1746-OV32<sup>(1)</sup></b>	Output	32	Current Sinking DC Output	37
	2922	24V dc	<b>1746-OVP16<sup>(1)</sup></b>	Output	16	High Current Sinking DC Output	40
	2915	5V dc/TTL	<b>1746-OG16<sup>(2)</sup></b>	Output	16	Current Sinking TTL Output	41
AC/DC Modules	510	24V ac/dc	<b>1746-IN16</b>	Input	16	24V ac/dc Input	42
	2500	AC/DC Relay	<b>1746-OW4<sup>(1)</sup></b>	Output	4	Relay (Hard Contact) Output	43
	2700	AC/DC Relay	<b>1746-OW8<sup>(1)</sup></b>	Output	8	Relay (Hard Contact) Output	43
	2900	AC/DC Relay	<b>1746-OW16<sup>(1)</sup></b>	Output	16	Relay (Hard Contact) Output	43
	2701	AC/DC Relay	<b>1746-OX8<sup>(1)</sup></b>	Output	8	Isolated Relay Output	43
	800	In - 120V ac, Out - Relay	<b>1746-IO4<sup>(1)</sup></b>	Input/Output	2 In, 2 Out	Combination Input/Output	45
	1100	In - 120V ac, Out - Relay	<b>1746-IO8<sup>(1)</sup></b>	Input/Output	4 In, 4 Out	Combination Input/Output	45
	1500	In - 120V ac, Out - Relay	<b>1746-IO12<sup>(1)</sup></b>	Input/Output	6 In, 6 Out	Combination Input/Output	45
1512	In - 24V dc, Out - Relay	<b>1746-IO12DC<sup>(3)</sup></b>	Input/Output	6 In, 6 Out	Combination Input/Output	45	

(1) Certified for Class 1, Division 2 hazardous location by CSA only.

(2) Not CE marked.

(3) These modules carry the C-UL mark and are certified by UL per CSA only.

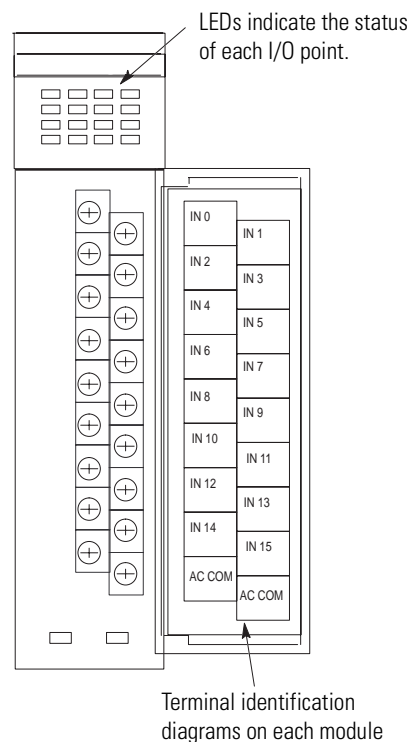
## Features and Benefits

**Select I/O modules to exactly match your application.** Combination modules allow you to have inputs and outputs in a single slot for efficient use of your chassis space.

**Expand the I/O capacity of your fixed controller system.** Two discrete I/O modules can be added to the fixed controller's 2-slot expansion chassis increasing the flexibility of the system.

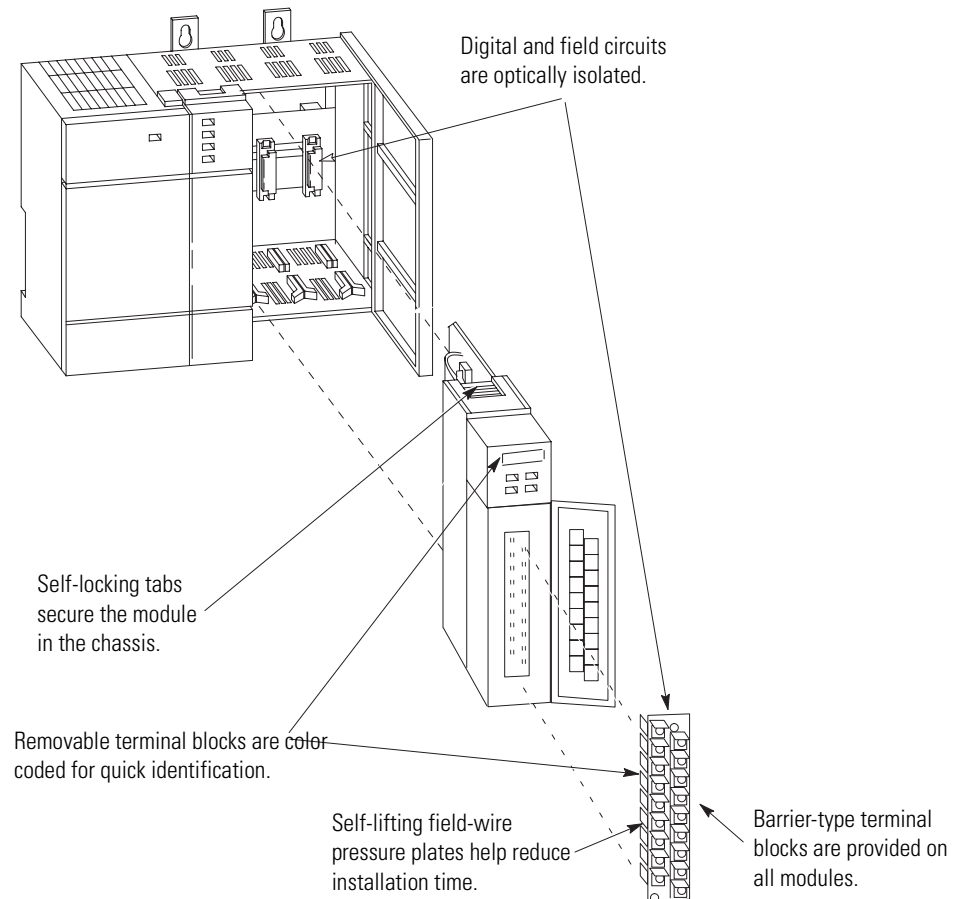
**All relay contacts are Silver Cadmium with Gold overlay.** Gold plating resists oxidation and tarnishing resulting from non-use. Silver Cadmium acts as an excellent conductor.

**High-density 32-Point DC I/O and fast response DC inputs are available.** These modules allow you to apply the SLC 500 processors in a broader spectrum of control applications.



**LEDs indicate the status of each I/O point.** LEDs illuminate to assist you in troubleshooting, when the proper signal is received at an input terminal, or when the processor applies power to an output terminal.

**Terminal identification diagrams on each module.** Terminal identification diagrams are located on each module, making terminal identification easier.



**Digital and field circuits are optically isolated.** All modules feature isolation between digital and field circuits, resulting in increased noise immunity and limited damage to your system due to an electrical malfunction of the field wiring.

**Self-lifting field-wire pressure plates cut installation time.** Wiring terminals have self-lifting pressure plates to secure two #14 AWG field wires.

**Removable terminal blocks help ease the wiring task.** Removable terminal blocks allow you to replace the module without rewiring it (not available on all modules).

**Removable terminal blocks are color coded for quick identification.** A matching color band is also provided on the front of the module to assist in matching the terminal block to the module.

**Barrier-type terminal blocks provided on all modules.** Each terminal block features a barrier on three sides of each terminal to help prevent accidental shorting of field wiring.

**Self-locking tabs secure the module in the chassis.** No tools are necessary to install or remove a module from the chassis. To install a module, you slide it into the chassis until it latches in place.

## I/O Module Operation

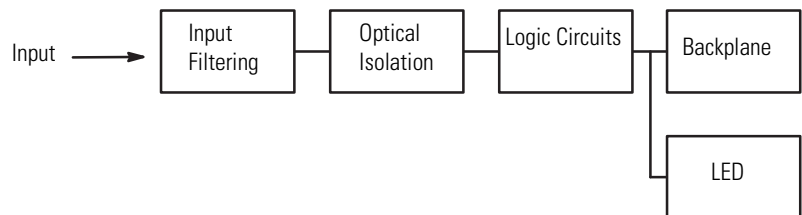
### Power Supply Requirements

Discrete modules receive power through the 1746 I/O chassis backplane from the associated chassis power supply. Refer to the individual module specifications for the current required from the power supply (in mA) to operate the module. You should total the current requirements for all the modules in the chassis to avoid overloading the power supply or the I/O chassis backplane.

### Input Modules

An input module responds to an input signal in the following manner:

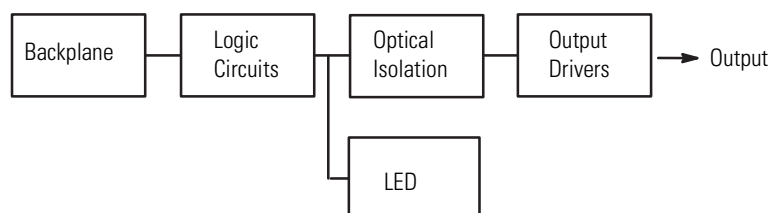
1. Input filtering limits the effect of voltage transients caused by contact bounce and/or electrical noise. If not filtered, voltage transients could produce false data. All input modules use input filtering.
2. Optical isolation shields backplane circuits and module logic circuits from possible damage due to electrical transients.
3. Logic circuits process the signal.
4. An input LED turns on or off indicating the status of the corresponding input device.



### Output Modules

An output module controls the output signal in the following manner:

1. Logic circuits determine the output status.
2. An output LED indicates the status of the output signal.
3. Optical isolation separates module logic and backplane circuits from the field signal.
4. The output driver turns the corresponding output on or off.



## Surge Suppression

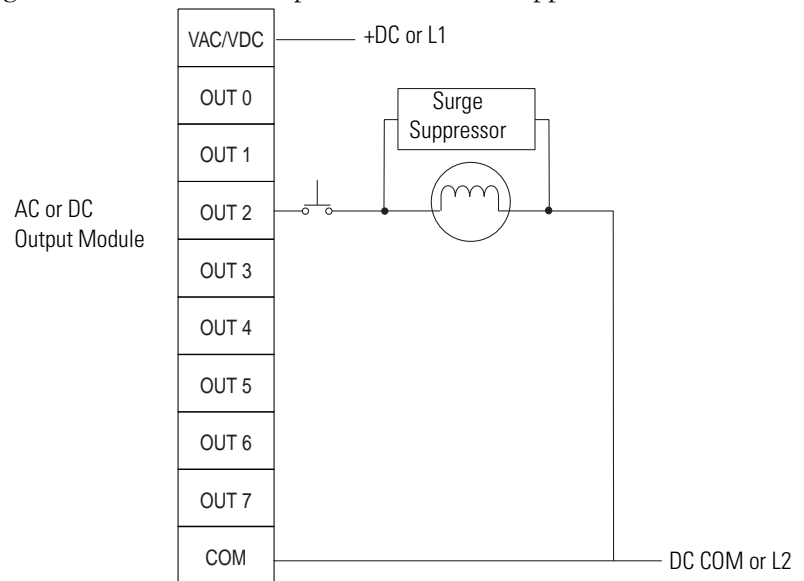
Most output modules have built-in surge suppression to reduce the effects of high-voltage transients. However, we recommend that you use an additional suppression device if an output module is being used to control an inductive device such as:

- relays
- motor starters
- solenoids
- motors

Additional suppression is especially important if your inductive device is in series with or parallel to a hard contact such as:

- push buttons
- selector switches

By adding a suppression device directly across the coil of an inductive device, you will reduce the effects of voltage transients caused by interrupting the current to that inductive device and prolong the life of the switch contacts. The diagram below shows an output module with a suppression device.



Recommended surge suppressors are provided in the specifications tables.

---

**Important:** Adding a suppression device across your load will defeat the fast turn-off feature of the 1746-OB6EI, -OB16E Series B and later, -OB32E, -OBP8 Series B and later, -OBP16, and -OVP16 DC output modules. Refer to pages 31, 35, and 40 for more information about suppression when using the 1746-OB6EI, -OB16E, -OB32E, -OBP8, -OBP16, and -OVP16, respectively.

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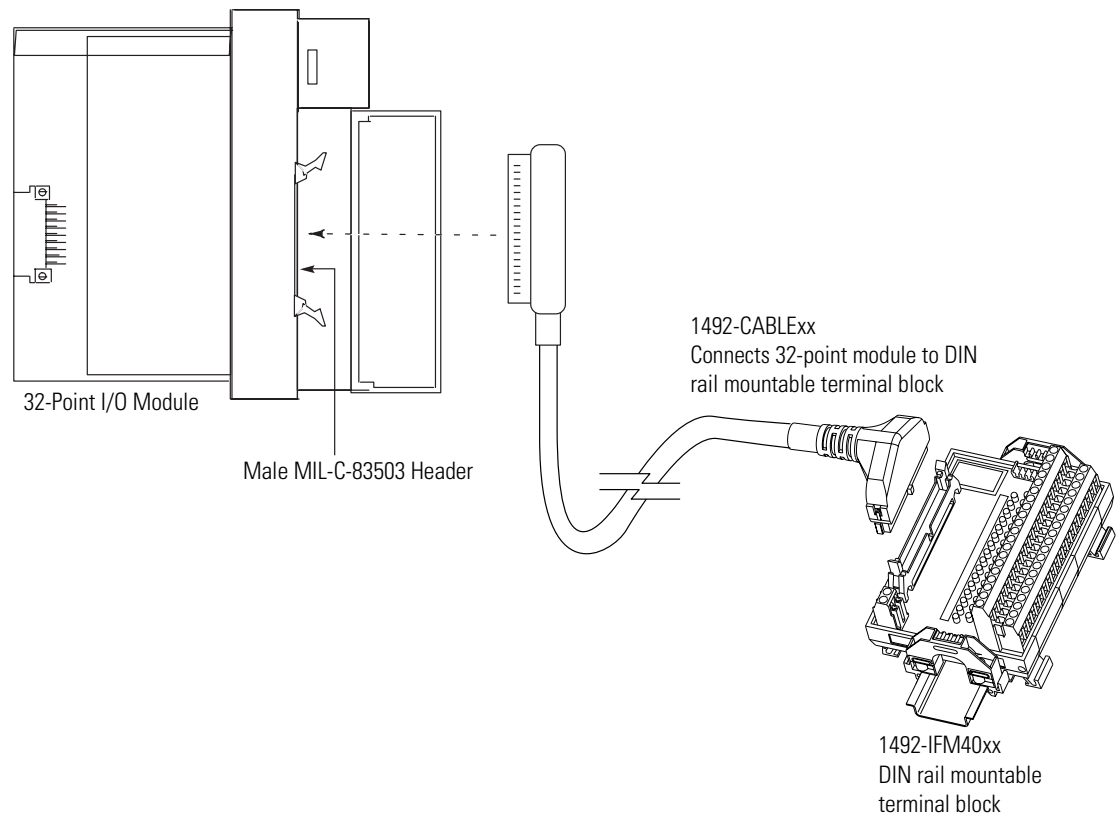
## Enhanced Discrete I/O Modules

### 32-Point Modules (1746-IB32, -IV32, -OB32, OB32E, -OV32)

The 32-point I/O modules allow you to reduce panel space requirements by wiring 32 DC input or 32 DC output devices to a module residing in one slot. These modules can be used with both modular chassis systems or fixed controllers.

The 32-point modules come equipped with a 40-pin male connector on the front instead of screw terminals. This connector is designed to accept your cable fitted with the 1746-N3 mating connector. One 1746-N3 connector and 45 crimp-type contacts are packaged with each module. The other end of the cable can be wired to a user-supplied terminal block.

As an alternative, 1492 prewired cables, purchased separately, can be used to connect the 32-point modules to 1492 interface modules. For more information, refer to the *Accessories* section on page 50.





## Fast Response Input Modules (1746-ITB16, -ITV16)

The fast-response DC input modules provide 16 input points and are designed for high-speed applications requiring fast response to input signals from DC sensing devices. When used with an SLC 5/03™ or higher processor and the Discrete Input Interrupt (DII) instruction (100 µsec polling), pulses can be read up to a frequency of 1K Hz. (It is 2K Hz if the input signals are from a gray code encoder.) Recommended wiring to an Allen-Bradley 845D Absolute Gray Code Encoder is provided on page 27.

Both sinking and sourcing versions of the fast response input module are available.

## High-Current Solid-State Output Modules (1746-OAP12, -OB6EI, -OBP8, -OBP16, -OVP16)

High-current solid-state output modules expand application coverage for the SLC 500 by providing the following enhanced functionality:

- increased current rating
- fuse protection and diagnostics
- high-speed switching
- excellent reliability

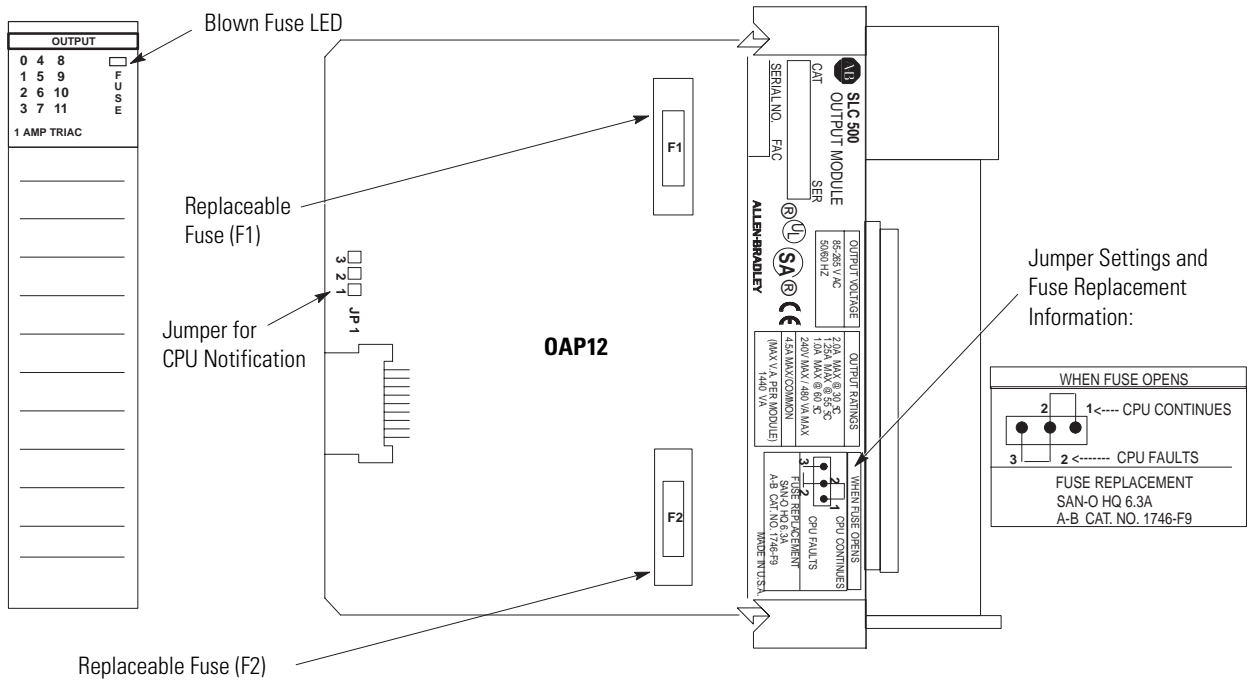
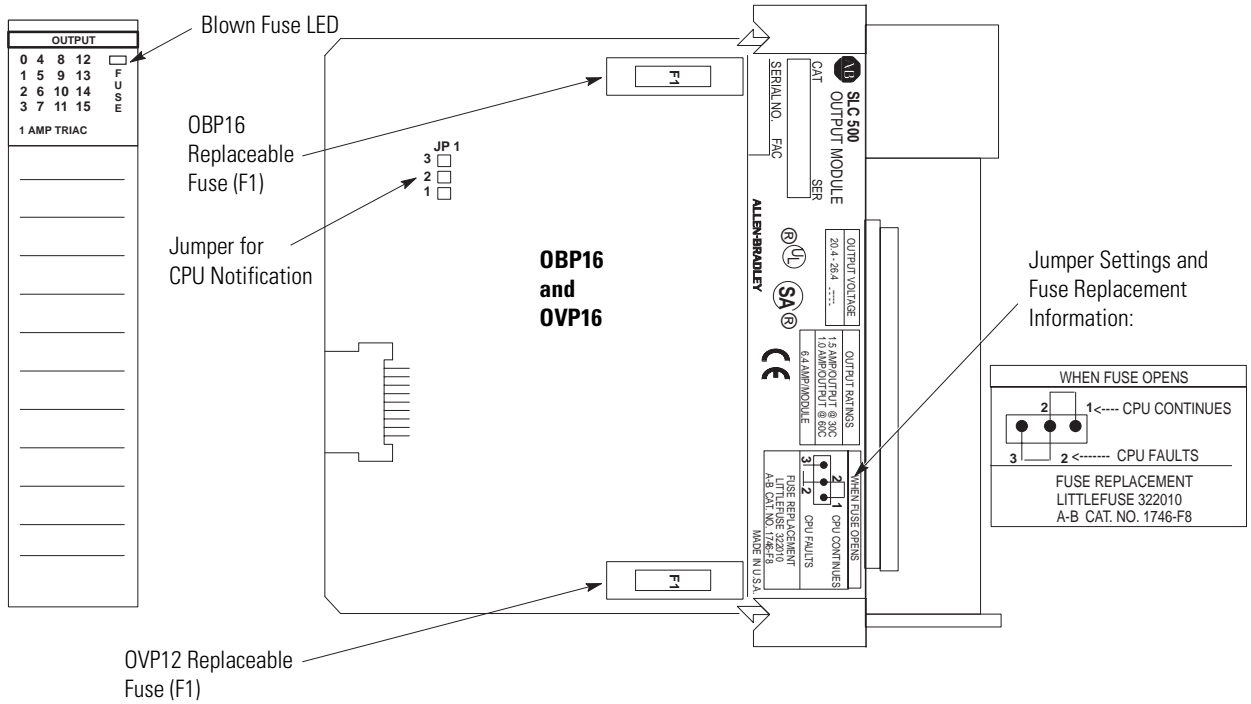
The high-current solid-state output modules expand application coverage in automotive, packaging, and material handling applications by allowing the SLC 500 processor to directly control solenoids, contactors, motors, and motor starter loads (up to size 5) with continuous current requirements of up to 1A at 60°C (1746-OAP12, -OBP16, -OVP16) and 2.0A at 60°C (1746-OB6EI, -OBP8).

1746-OAP12, -OBP16, and -OVP16 modules also provide fuse protection and blown fuse diagnostics for increased up-time. The ac output module includes two replaceable fuses (one per common), which protect the module in the event of short circuits.

1746-OBP16 and -OVP16 output modules include a replaceable fuse on the common providing short-circuit protection for wiring (16 AWG or larger) to external loads. A jumper can be set on these modules to provide CPU notification and system shutdown if the module fuse blows. The modules also include a blown fuse LED to assist I/O troubleshooting.

Inductive load turn-off time for 1746-OBP8 (Series B and later), -OBP16, and -OVP16 DC output modules is reduced by 70% over standard 1746 DC output modules, allowing fast application cycle times.

Innovative heat sink design for the OAP12 allows heat to be dissipated through the chassis frame metal, providing cool operation and excellent reliability.



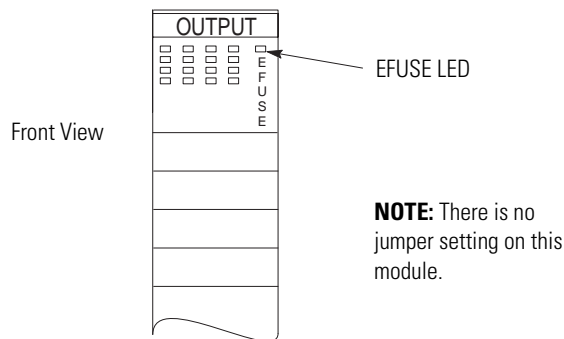
## Electronically Protected Output Modules (1746-OB6EI, -OB16E, and -OB32E)

The 1746-OB6EI, -OB16E, and OB32E are designed to electronically protect the module from a short-circuit or overload condition. The protection is based on a thermal cut-out principle. In the event of a short circuit or overload on an output channel, that channel limits the current within milliseconds after its thermal cut-out temperature is reached. All other channels continue to operate as directed by the processor.

These modules lower maintenance costs by eliminating the need to replace damaged modules and blown fuses. After the short-circuit or overload condition is corrected, restore power and the module automatically resets and resumes control of the output channel.

The modules provide a broad voltage range of 10 to 30V dc and a current rating of 2A at 60°C (1746-OB6EI), 0.5A at 60°C (1746-OB16E), and 0.5A at 30°C/ 0.25A at 60°C (1746-OB32E) making them the perfect solution for controlling 12V dc and 24V dc solenoid and lamp loads. The modules are also equipped with an LED indicator that illuminates when the short circuit or overload condition occurs to expedite the troubleshooting process.

Inductive load turn-off time for 1746-OB6EI and -OB16E (Series B and later), output modules is reduced by 70% over standard 1746 DC output modules, allowing fast application cycle times.




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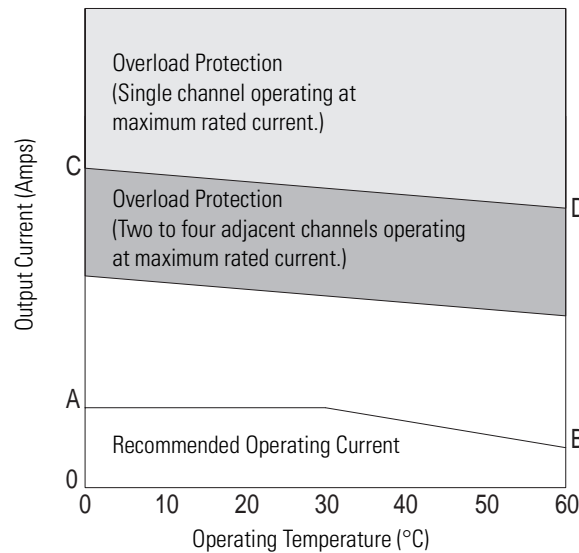
**Important:** The modules do not provide protection against reverse polarity wiring or wiring to AC power sources. Electronic protection is not intended to replace fuses, circuit breakers, or other code-required wiring protection devices.

---

### Overload Protection (1746-OB6EI, -OB16E, and -OB32E)

The chart and table below describe overload protection for the 1746-OB6EI, -OB16E, and -OB32E. The electronic protection is based on a thermal cut-out temperature, which is reached more quickly (at lower overload current) when two to four adjacent channels are operating. The adjacent channel groupings are:

- 1746-OB6EI: The channels on this modules are not grouped in sets. However, channels which are directly adjacent to one another will also allow the thermal cut-out temperature to be reached more quickly.
- 1746-OB16E: 0-3, 4-7, 8-11, and 12-15
- 1746-OB32E: 0-3, 4-7, 8-11, 12-15, 16-19, 20-23, 24-27, and 28-31



Catalog Number	Recommended Operating Current		Overload Protection	
	at 0°C (32°F)	at 60°C (140°F)	at 0°C (32°F)	at 60°C (140°F)
1746-OB6EI	A = 2A	B = 2A	C = 5.5A	D = 4.5A
1746-OB16E	A = 1A	B = 0.5A	C = 4A	D = 3.5A
1746-OB32E	A = 0.5A	B = 0.25A	C = 2A	D = 1A

**Important:** The 1746-OB6EI, -OB16E, and OB32E perform auto-reset under overload conditions. When an output channel overload occurs as described above, that channel limits current within milliseconds after its thermal cut-out temperature is reached. While in current limit, the output channel can cool below the thermal cut-out temperature, allowing the module to auto-reset and resume control of the output channel as directed by the processor, until the thermal cut-out temperature is again reached.

Removing power from an overloaded output channel also allows the output channel to cool below the thermal cut-out temperature, allowing auto-reset to occur when power is restored. The output channel operates as directed by the processor until the thermal cut-out temperature is again reached.

To avoid auto-reset of an output channel under overload conditions, use an external mechanical fuse to open the circuit when overloaded.

## Terms and Symbols Used in the Specification Tables and Wiring Diagrams

### Terms

**Backplane Current Draw** — the amount of current the module requires from the backplane. The sum of the backplane current draw for all modules in a chassis is used to select the appropriate chassis power supply.

**Continuous Current Per Module** — the maximum current for each module. The sum of the output current for each point should not exceed this value.

**Continuous Current Per Point** — the maximum current each output is designed to continuously supply to a load.

**Inrush Current** — the temporary surge current drawn when an input is initially energized.

**Minimum Load Current** — the lowest amount of current the output is designed to operate at. Operating at or below this value is not recommended.

**Nominal Input Current** — the current drawn at nominal input voltage.

**Off-State Current** — for input circuits, the maximum amount of leakage current allowed from an input device that will keep the SLCTM input circuits in their off state.

**Off-State Leakage** — for output circuits, the maximum amount of current present at the output terminal when the output circuit is in its off state.

**Off-State Voltage (max)** — the maximum input voltage level detected as an off condition by the input module.

**On-State Voltage Drop** — the voltage developed across the output driver circuit during the on state at maximum load current.

**Operating Voltage** — for inputs, the voltage range needed for the input to be in the on state. For outputs, the allowable range of user-supplied voltage.

**Points per Common** — the number of input or output points connected to a single return (common) or supply (Vcc).

**Signal Delay** — for inputs, the response time required to transmit the circuit status from the field logic to the digital logic. For outputs, the time required to transmit the circuit status from digital logic to the output driver.


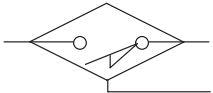



**Sinking/Sourcing** — describes a current signal flow relationship between field input and output devices in a control system and their power supply. Sourcing I/O modules supply (or source) current to sinking field devices. Sinking I/O modules receive (or sink) current from sourcing field devices.

**Surge Current** — the temporarily large current drawn by an inductive output device when it is initially energized.

**Surge Current Per Point** — the maximum amplitude and duration (pulse) of current an output can provide to an inductive output device.

**Voltage Category** — the nominal voltage used to describe the module.

## I/O Wiring Symbols

Symbol	Device Name
	2-wire Input Device
	3-wire Input Device
	Solenoid Output
	Contact Relay Output
	TTL Logic Output

**Related Publications:** Detailed wiring diagrams for 1746 input modules and Allen-Bradley Series 9000 Photoelectric Sensors are provided in publication 42GR-7.4.

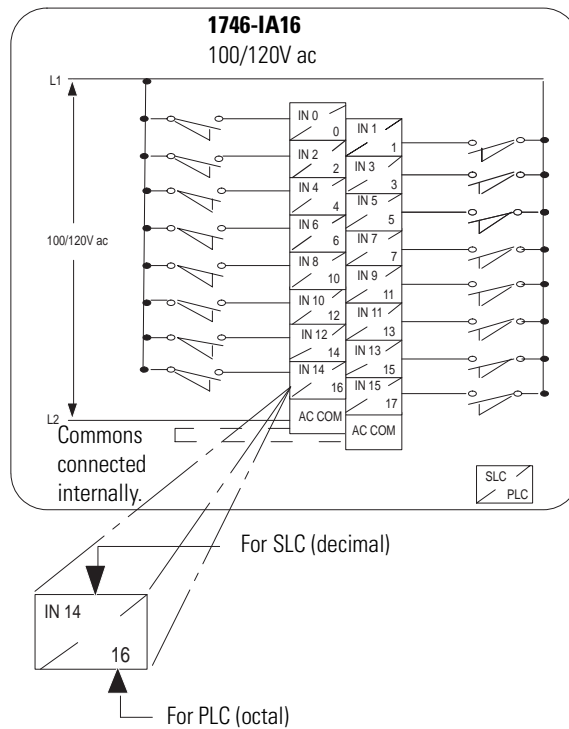
**Important:** The wiring diagrams in this document are examples only. It is not necessary to connect an I/O device to every terminal on an I/O module's terminal block.

### Wiring Diagrams

The 16-point I/O module wiring diagrams include both decimal and octal numbers for I/O addressing and wire identification. (See figure below.) Use the decimal numbers in the upper left portion of each box to wire your 16-point I/O module to an SLC system. Use the octal numbers in the lower right portion of the box for a PLC® system. (As shipped from the factory, the I/O module has a decimal address label on the inside of its door.) An octal label kit is included with your 16-point I/O modules or you can order a separate octal conversion kit to allow you to convert your module to the octal system.

**Important:** PLC systems use the octal labels. (See figure below.)

Directions on how to install the labels are included in publication number 1746-5.3, *Discrete I/O Modules Installation Instructions*. These instructions are provided in a kit that is shipped with each discrete I/O module.



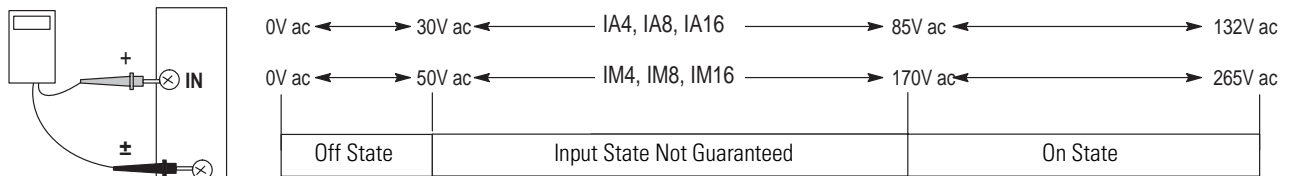
# Specifications, Wiring, and AC Input Modules (1746-IA4, -IA8, -IA16, -IM4, -IM8, -IM16) Circuit Diagrams

Specification		Catalog Number					
		1746-IA4	1746-IA8	1746-IA16 (RTB)	1746-IM4	1746-IM8	1746-IM16 (RTB)
<b>Voltage Category</b>		100/120V ac			200/240V ac		
<b>Operating Voltage</b>		85 to 132V ac at 47 to 63 Hz			170 to 265V ac at 47 to 63 Hz		
<b>Number of Inputs</b>		4	8	16	4	8	16
<b>Points per Common</b>		4	8	16	4	8	16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.035A	0.050A	0.085A	0.035A	0.050A	0.085A
	<b>24V dc</b>	0.0A	0.0A	0.0A	0.0A	0.0A	0.0A
<b>Signal Delay (max.)</b>		on = 35 ms off = 45 ms			on = 35 ms off = 45 ms		
<b>Off-State Voltage (max.)</b>		30V ac			50V ac		
<b>Off-State Current (max.)</b>		2 mA			2 mA		
<b>Nominal Input Current</b>		12 mA at 120V ac			12 mA at 240V ac		
<b>Inrush Current<sup>(1)</sup> (max.)</b>		0.8A			1.6A		
<b>Inrush Current Time Duration<sup>(1)</sup> (max.)</b>		500 μsec.			500 μsec.		

(1) An ac input device must be compatible with SLC 500 input circuit inrush current. A current limiting resistor can be used to limit inrush current; however, the operating characteristics of the ac input circuit are affected.

RTB = Removable Terminal Block.

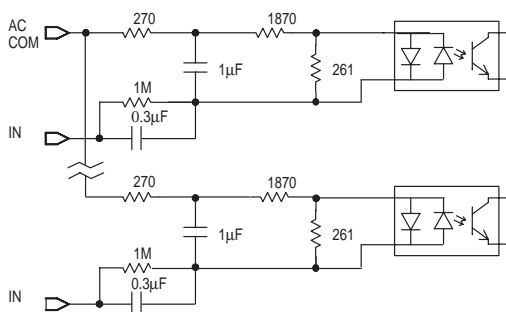
### On/Off-State Voltage Range



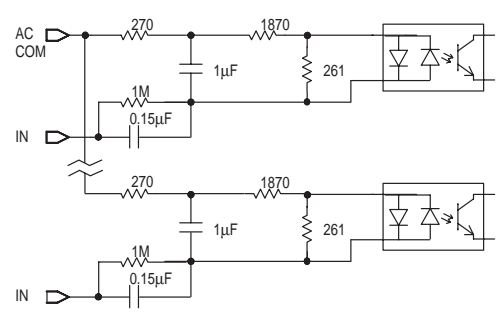
(Measure voltage from common terminal to input terminal.)

### Circuit Diagrams

**1746-IA4, IA8, IA16**

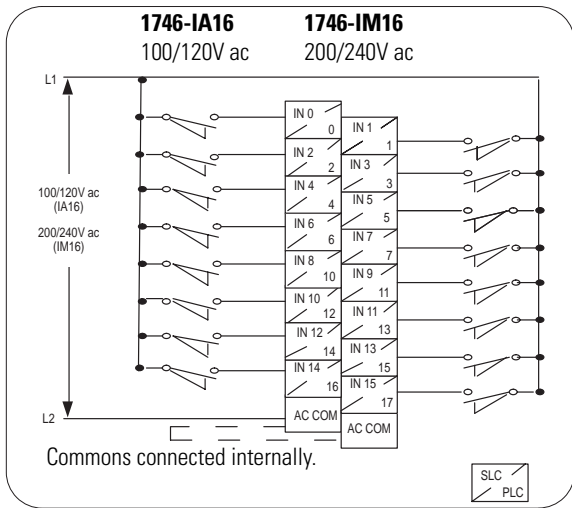
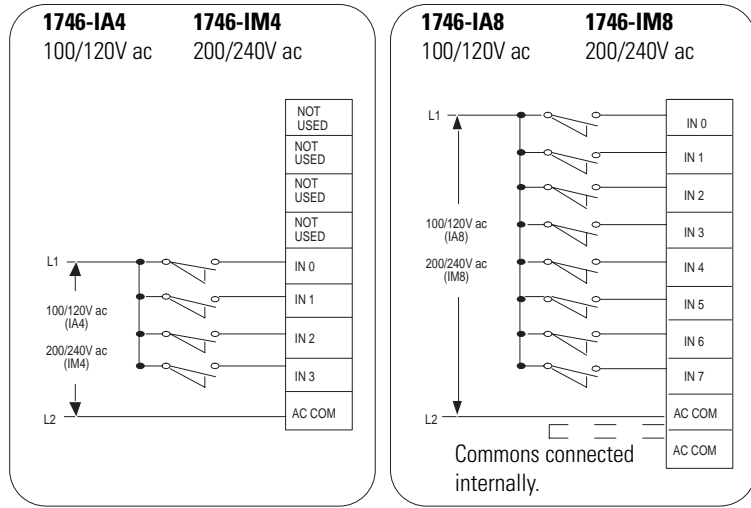


**1746-IM4, IM8, IM16**





Wiring Diagrams



## AC Output Modules (1746-0A8, -0A16, -0AP12)

Specification		Catalog Number		
		1746-0A8 <sup>(1)</sup>	1746-0A16 <sup>(1)</sup> (RTB)	1746-0AP12 <sup>(1)(2)</sup> (RTB)
<b>Voltage Category</b>		120/240V ac		
<b>Operating Voltage</b>		85 to 265V ac at 47 to 63 Hz		
<b>Number of Outputs</b>		8	16	12
<b>Points per Common</b>		4	8	6
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.185A	0.370A	0.370A
	<b>24V dc</b>	0.0A	0.0A	0.0A
<b>Signal Delay (max.)(Resistive Load)</b>		on = 1 ms off = 11 ms		
<b>Off-State Leakage<sup>(3)</sup> (max.)</b>		2 mA		
<b>Load Current (min.)</b>		10 mA		
<b>Continuous Current (max.)</b>	<b>Per Point<sup>(4)</sup></b>	1.0A at 30°C 0.50A at 60°C	0.50A at 30°C 0.25A at 60°C	2.0A at 30°C 1.25A at 55°C 1.0A at 60°C
	<b>Per Module</b>	8.0A at 30°C 4.0A at 60°C	8.0A at 30°C 4.0A at 60°C	9.0A at 30°C 6.0A at 60°C
<b>On-State Voltage Drop (max.)</b>		1.50V at 1A	1.50V at 0.50A	1.2V at 2.0A
<b>Surge Current per Point<sup>(5)</sup> (max.)</b>		10.0A for 25 ms	10.0A for 25 ms	per point - 17.0A for 25 ms per common - 35.0A for 10 ms

(1) Triac outputs turn on at any point in the ac line cycle and turn off at ac line zero cross.

(2) A fused common and blown fuse LED are provided on this module. (Fuses are designed to protect the module.) For replacement fuse, use catalog number 1746-F9 or SAN-0 HQ 6.3A.

(3) To limit the effects of leakage current through triac outputs, a loading resistor can be connected in parallel with your load. For typical 120V ac applications, use a 15k ohm, 2W resistor. For typical 240V ac applications, use a 15k ohm, 5W resistor.

(4) Recommended surge suppression for triac outputs when switching 120V ac inductive loads is Harris MOV part number V220MA2A. See page 6 for more information on surge suppression.

(5) Repeatability is once every 1 second at 30°C. repeatability is once every 2 seconds at 60°C.

RTB = Removable Terminal Block.

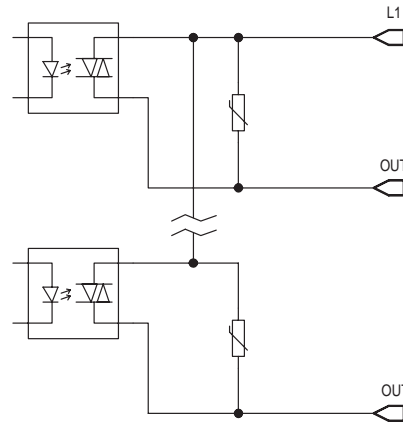
### Operating Voltage Range



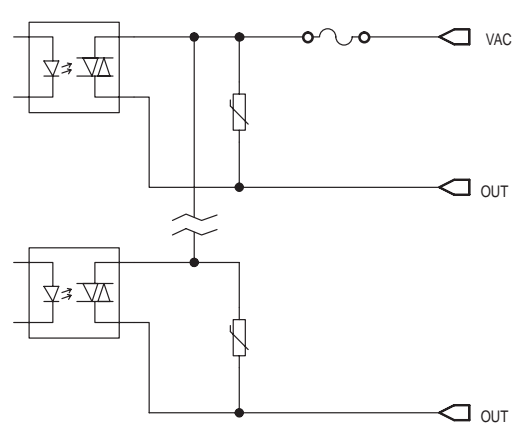
**Important:** If you measure the voltage at an output terminal that is not connected to a load or is connected to a high-impedance load, you may measure as much as 100V ac even though the output is off.

Circuit Diagrams

1746-OA8, OA16

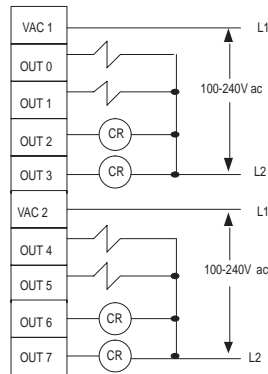


1746-OAP12

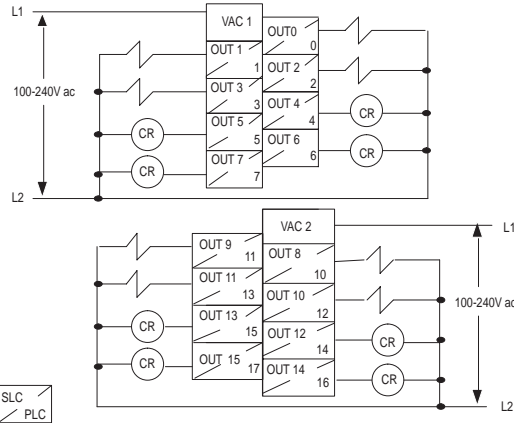


Wiring Diagrams

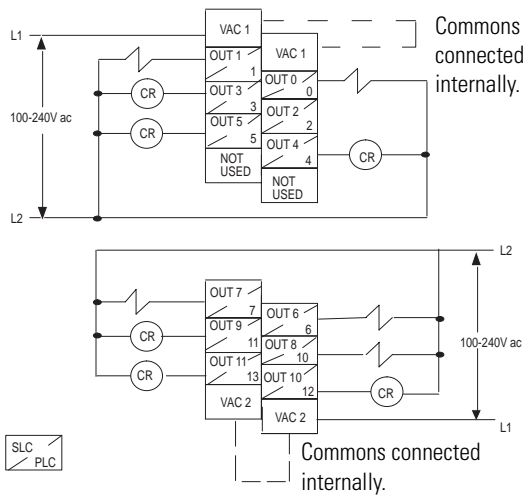
1746-OA8  
100-240V ac TRIAC OUTPUT



1746-OA16  
100-240V ac TRIAC OUTPUT



1746-OAP12  
100-240V ac HIGH CURRENT TRIAC OUTPUT



### Sinking DC Input Modules (1746-IB8, -IB16, -ITB16, -IB32)

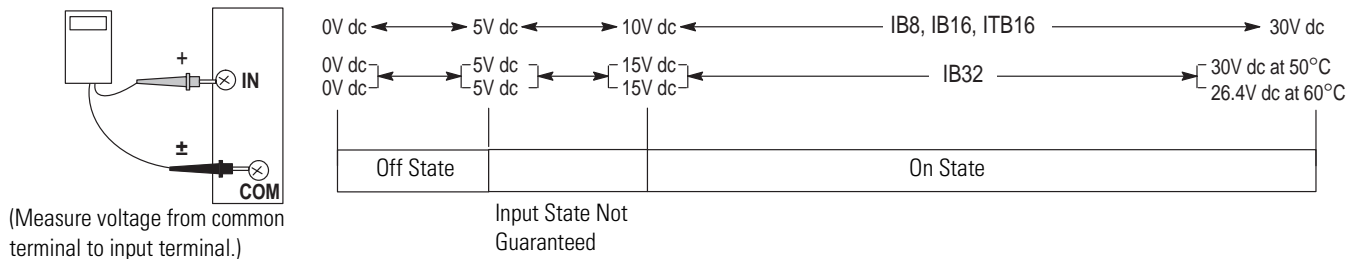
Specification	Catalog Number			
	1746-IB8	1746-IB16 (RTB)	1746-ITB16 (RTB) (Fast Response)	1746-IB32 <sup>(1)</sup>
<b>Voltage Category</b>	24V dc sink			
<b>Operating Voltage</b>	10 to 30V dc sink			15 to 30V dc at 50°C sink 15 to 26.4V dc at 60°C sink
<b>Number of Inputs</b>	8	16	16	32
<b>Points per Common</b>	8	16	16	8
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.050A	0.085A	0.050A
	<b>24V dc</b>	0.0A	0.0A	0.0A
<b>Signal Delay (max.)</b>	on = 8 ms off = 8 ms	on = 8 ms off = 8 ms	on = 0.3 ms <sup>(2)</sup> off = 0.5 ms	on = 3 ms off = 3 ms
<b>Off-State Voltage (max.)</b>	5V dc	5V dc	5V dc	5V dc
<b>Off-State Current (max.)</b>	1 mA	1 mA	1.5 mA	1.6 mA
<b>Nominal Input Current</b>	8 mA at 24V dc			

(1) Series A, B, and C 32-point input modules are fused to protect external wiring, one fuse per common. These fuses are non-replaceable and are rated at 2.5A. Series D 32-point input modules are not fused.

(2) Typical signal delay for these modules: on = 0.10 ms, off = 0.25 ms at 24V dc.

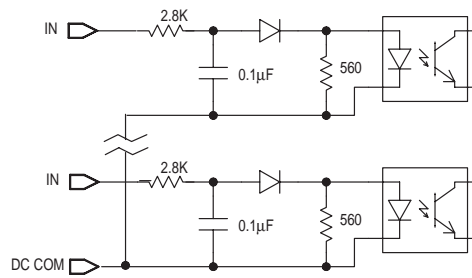
RTB = Removable Terminal Block.

#### On/Off-State Voltage Range

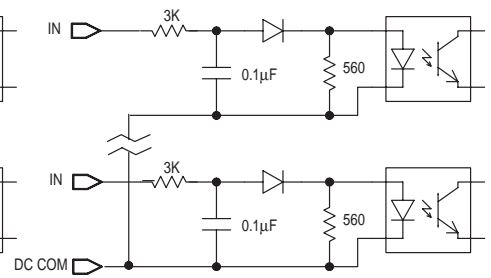


Circuit Diagrams

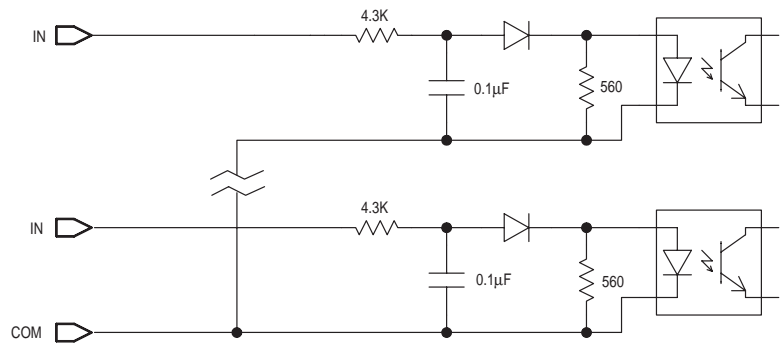
1746-ITB16



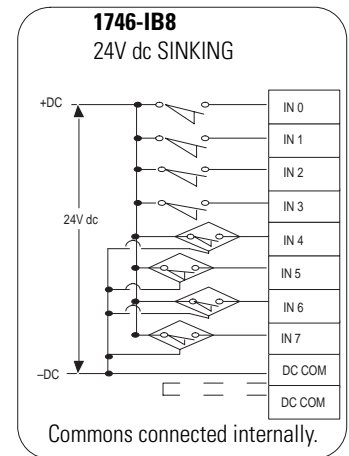
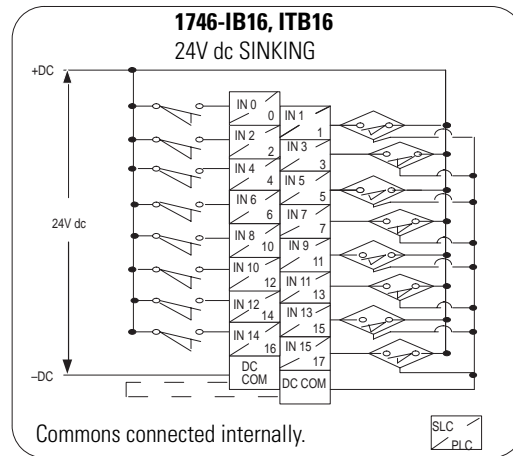
1746-IB8, IB16

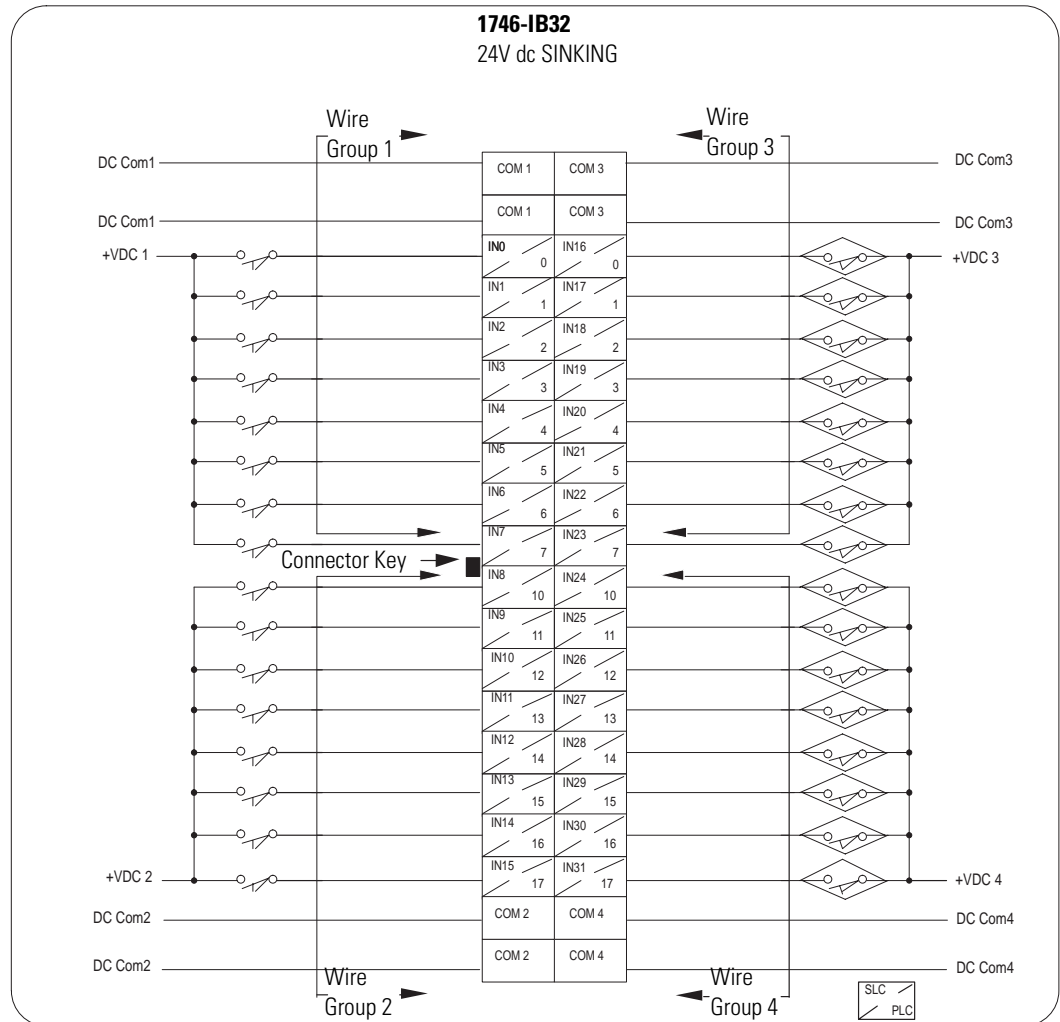


1746-IB32



Wiring Diagrams





**Important:** The dc com pins on the 1746-IB32 input module are isolated between the four groups and the two com pins in each group are connected internally. Use a 1492 terminal block to maintain group isolation provided by 32-point I/O modules. Consult 1492 documentation or your Allen-Bradley Sales Office for additional information.

The 1746 32-point modules include a keyed 40-pin female connector and crimp-type pins for connection to I/O wiring. In addition, 1492 prewired cables and interface modules can be used for connecting external I/O. (See pages 7 and 50.)

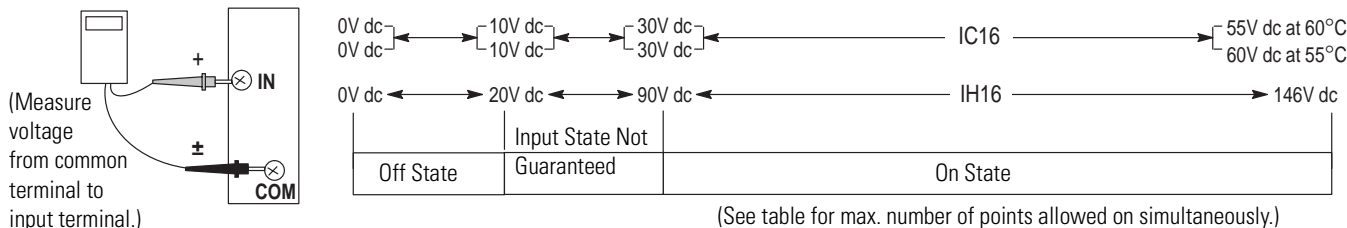
The maximum user cable length is dependent on how much voltage drop [current x (ohms/ft.) x (feet)] the user's system can tolerate. The user's system should take into account the minimum turn-on voltage required by external loads connected to the 32-point output modules and all of the voltage drops associated with wiring to and from the load, terminal blocks, power sources, and the module itself.

### Sinking DC Input Modules (1746-IC16, -IH16)

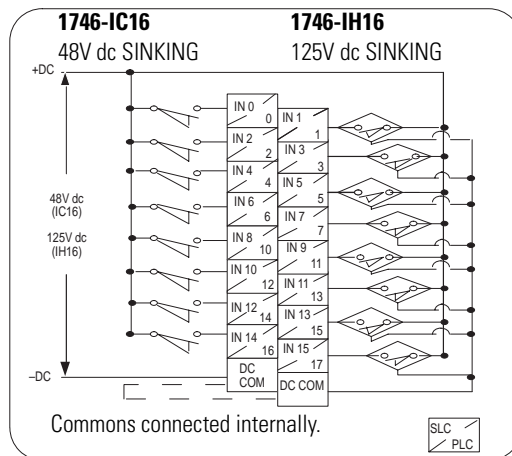
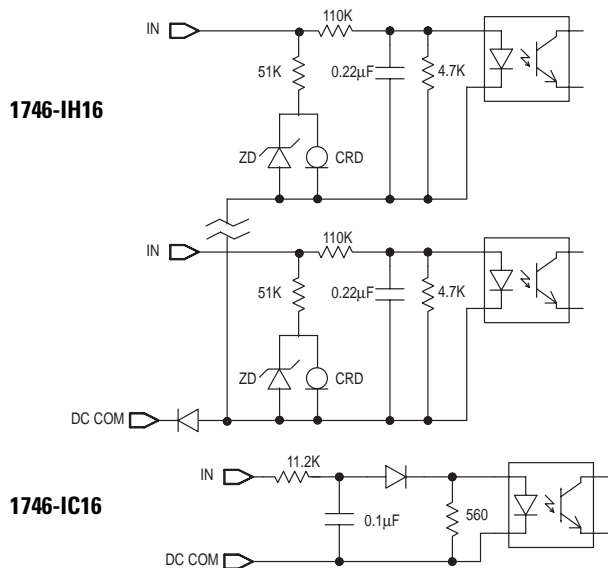
Specification	Catalog Number 1746-IC16 (RTB)	Catalog Number 1746-IH16 <sup>(1)</sup> (RTB)
<b>Voltage Category</b>	48V dc sink	125V dc sink
<b>Operating Voltage</b>	30 to 60V dc at 55°C sink 30 to 55V dc at 60°C sink	90 to 146V dc sink Max. Points on Simultaneously: 16 at 146V dc and 30°C 12 at 146V dc and 50°C 14 at 132V dc and 55°C 16 at 125V dc and 60°C
<b>Number of Inputs</b>	16	16
<b>Points per Common</b>	16	16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.085A
	<b>24V dc</b>	0.0A
<b>Signal Delay (max.)</b>	on = 4 ms / off = 4 ms	on = 9 ms / off = 9 ms
<b>Off-State Voltage (max.)</b>	10V dc	20V dc
<b>Off-State Current (max.)</b>	1.5 mA	0.8 mA
<b>Nominal Input Current</b>	4.1 mA at 48V dc	2.15 mA at 125V dc / 2.25 mA at 132V dc

(1) If the input module is connected in parallel with an inductive load, use surge suppression across the load to protect the input module from damage caused by reverse voltage.  
RTB = Removable Terminal Block.

#### On/Off-State Voltage Range



#### Circuit and Wiring Diagrams



### Sourcing DC Input Modules (1746-IV8, -IV16, -ITV16, -IV32)

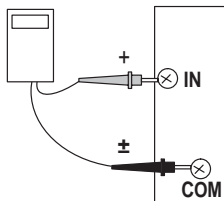
Specification	Catalog Number			
	1746-IV8	1746-IV16 (RTB)	1746-ITV16 (Fast Response) (RTB)	1746-IV32 <sup>(1)</sup>
<b>Voltage Category</b>	24V dc source			
<b>Operating Voltage</b>	10 to 30V dc source			15 to 30V dc at 50°C source 15 to 26.4V dc at 60°C source
<b>Number of Inputs</b>	8	16	16	32
<b>Points per Common</b>	8	16	16	8
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.050A	0.085A	0.085A
	<b>24V dc</b>	0.0A	0.0A	0.0A
<b>Signal Delay (max.)</b>	on = 8 ms / off = 8 ms		on = 0.3 ms / off = 0.5 ms <sup>(2)</sup>	on = 3 ms / off = 3 ms
<b>Off-State Voltage (max.)</b>	5.0V dc	5.0V dc	5.0V dc	5.0V dc
<b>Off-State Current (max.)</b>	1 mA	1 mA	1.5 mA	1.6 mA
<b>Nominal Input Current</b>	8 mA at 24V dc			

(1) Series A, B, and C 32-point input modules are fused to protect external wiring, one fuse per common. These fuses are non-replaceable and are rated at 2.5A. Series D 32-point input modules are not fused.

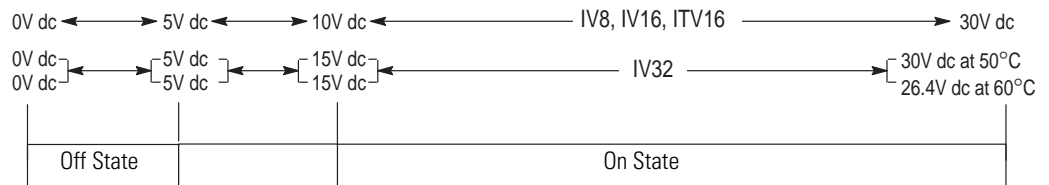
(2) Typical signal delay for these modules: on = 0.100 ms, off = 0.25 ms for 24V dc.

RTB = Removable Terminal Block.

#### On/Off-State Voltage Range



(Measure voltage from common terminal to input terminal.)

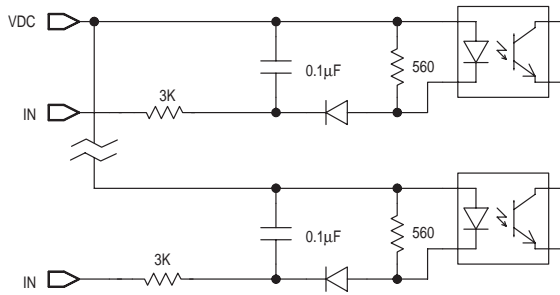


Input State Not Guaranteed

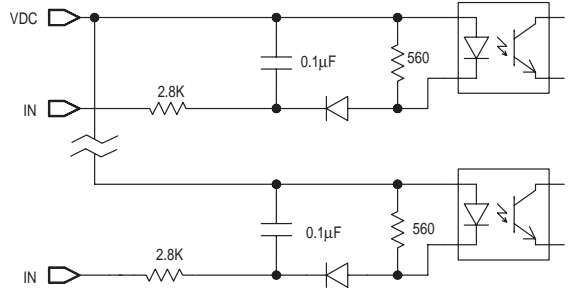


Circuit Diagrams

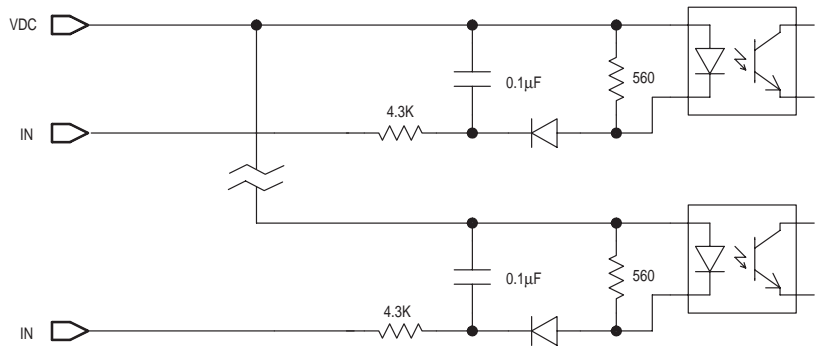
**1746-IV8, IV16**



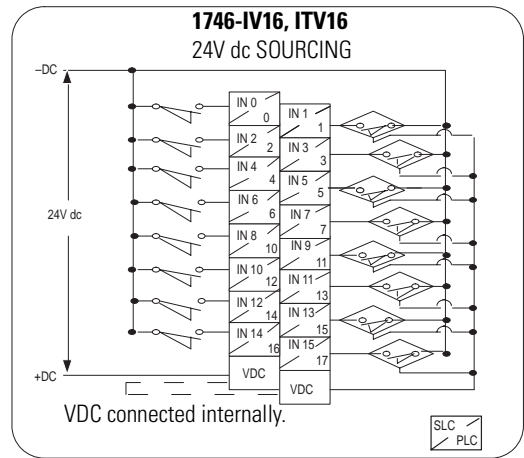
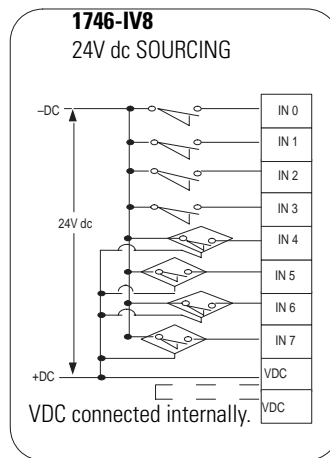
**1746-ITV16**

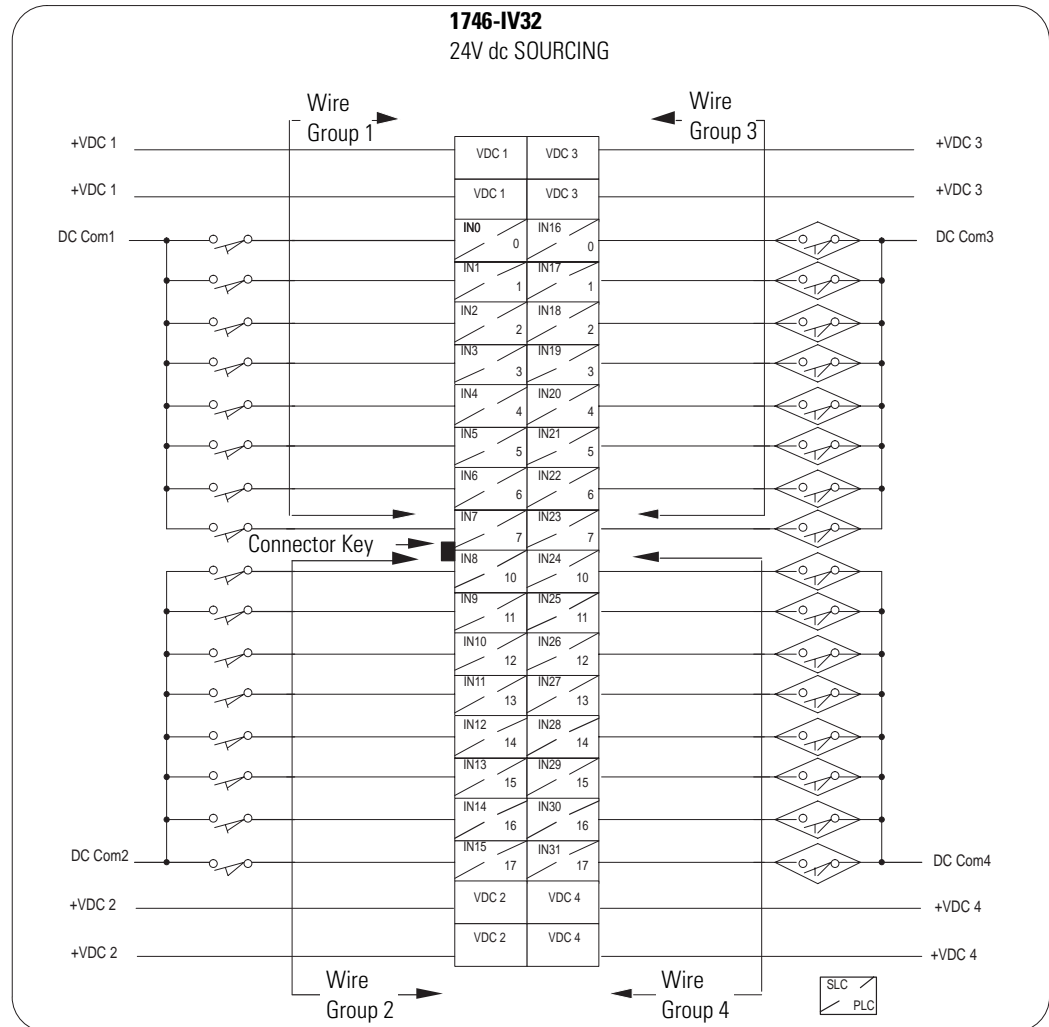


**1746-IV32**



Wiring Diagrams



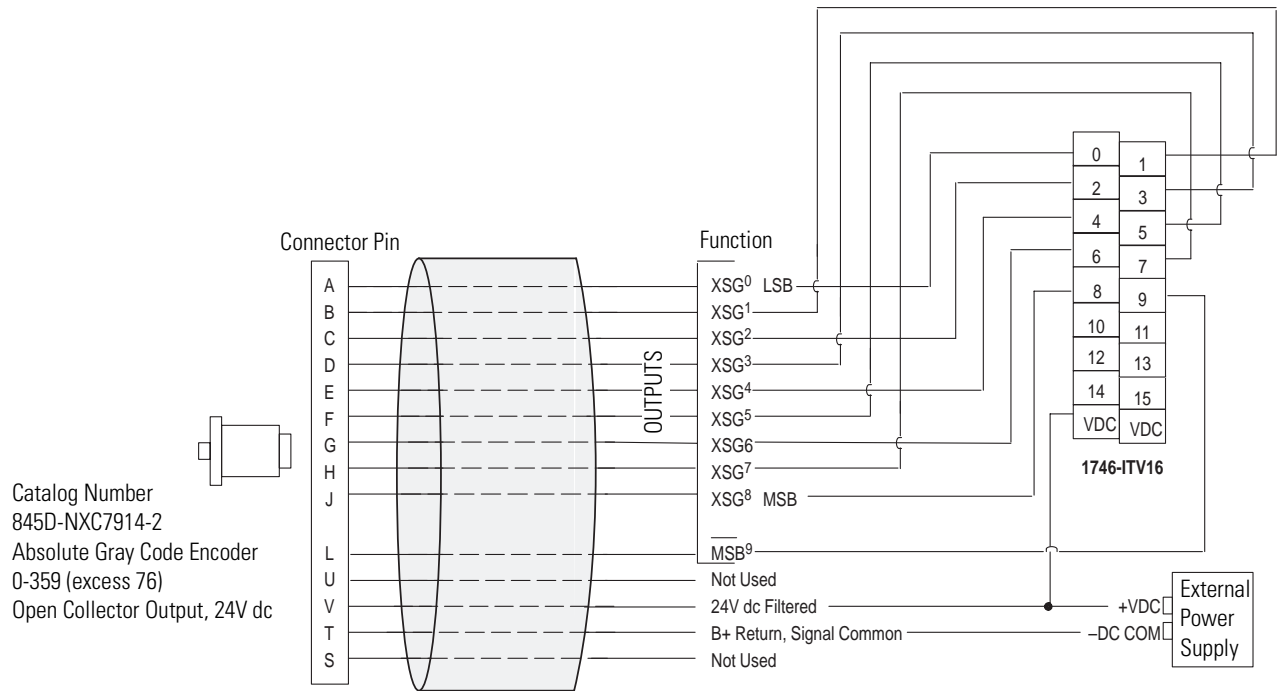


**Important:** The V dc pins on the 1746-IV32 input module are isolated between the four groups and the two V dc pins in each group are connected internally. Use a 1492 terminal block to maintain group isolation provided by 32-point I/O modules. Consult 1492 documentation or your Allen-Bradley Sales Office for additional information.

The 1746 32-point modules include a keyed 40-pin female connector and crimp-type pins for connection to I/O wiring. In addition, 1492 prewired cables and interface modules can be used for connecting external I/O. (See pages 7 and 50.)

The maximum user cable length is dependent on how much voltage drop [current x (ohms/ft.) x (feet)] the user's system can tolerate. The user's system should take into account the minimum turn-on voltage required by external loads connected to the 32-point output modules and all of the voltage drops associated with wiring to and from the load, terminal blocks, power sources, and the module itself.

845D Absolute Gray Code Encoder to 1746-ITV16



**Note:** Terminals 8 and 9 can be interchanged to select CW vs. CCW direction. Refer to your encoder installation manual for recommended cable type and length.

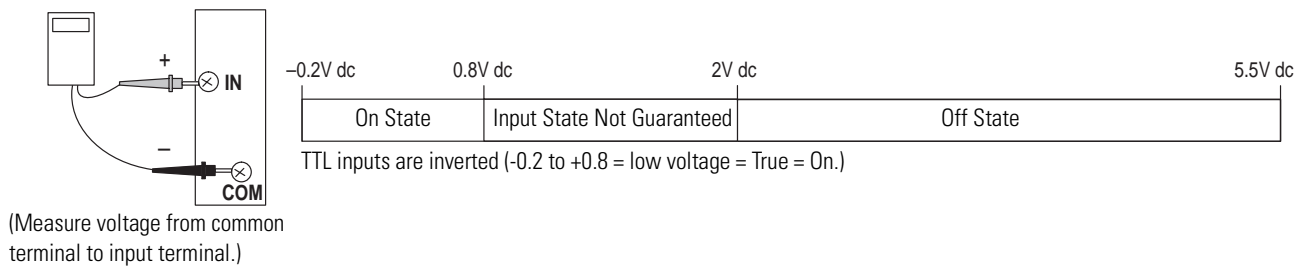
### Sourcing TTL Input Module (1746-IG16)

Specification		Catalog Number
		<b>1746-IG16 (RTB)</b>
<b>Voltage Category</b>		5V dc TTL source
<b>Operating Voltage</b>		4.5 to 5.5V dc source 50 mV peak-to-peak ripple max.
<b>Number of Inputs</b>		16
<b>Points per Common</b>		16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.140A
	<b>24V dc</b>	0.0A
<b>Signal Delay (max.)</b>		on = 0.25 ms off = 0.50 ms
<b>Off-State Voltage (max.)</b>		2.0V dc <sup>(1)</sup>
<b>Off-State Current (max.)</b>		4.1 mA
<b>Nominal Input Current</b>		3.7 mA at 5V dc

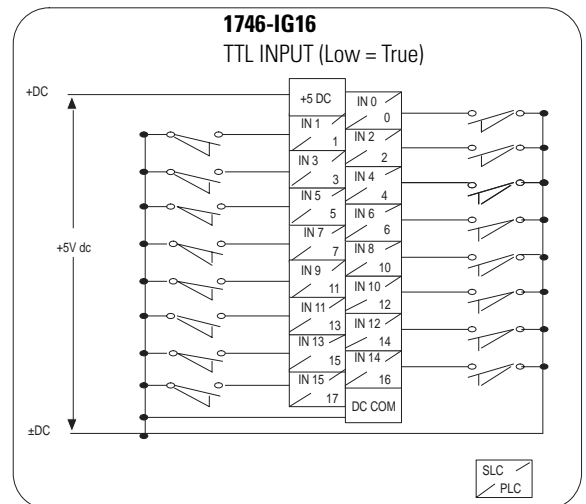
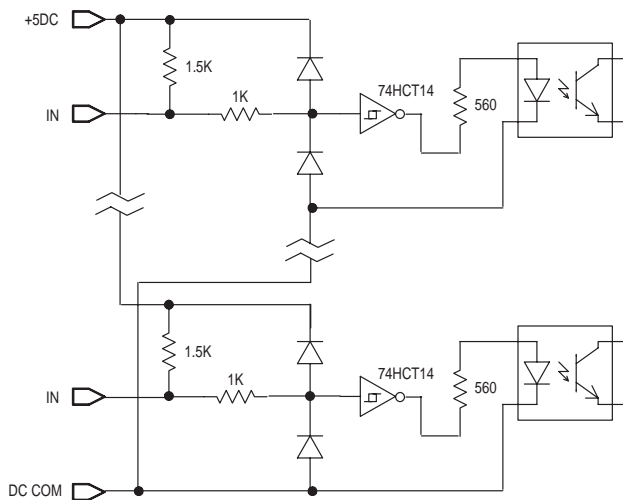
(1) TTL inputs are inverted (-0.2 to +0.8 = low voltage = True = on). Use a NOT instruction in your program to convert to traditional True = High logic.

RTB = Removable Terminal Block.

#### On/Off-State Voltage Range



#### Circuit and Wiring Diagrams



## Sourcing DC Output Modules (1746-OB8, -OB16, -OB32)

Specification	Catalog Number		
	1746-OB8	1746-OB16 (RTB)	1746-OB32 Series D <sup>(1)</sup>
<b>Voltage Category</b>	24V dc		
<b>Operating Voltage</b>	10 to 50V dc source		5 to 50V dc source
<b>Number of Outputs</b>	8	16	32
<b>Points per Common</b>	8	16	16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.135A	0.280A
	<b>24V dc</b>	0.0A	0.0A
<b>Signal Delay (max.) (Resistive Load)</b>	on = 0.1 ms off = 1.0 ms	on = 0.1 ms off = 1.0 ms	on = 0.1 ms off = 1.0 ms
<b>Off-State Leakage<sup>(2)</sup> (max.)</b>	1 mA		
<b>Load Current (min.)</b>	1 mA		
<b>Continuous Current (max.)</b>	<b>Per Point<sup>(3)</sup></b>	1A at 30°C 0.50A at 60°C	0.50A at 30°C 0.25A at 60°C
	<b>Per Module</b>	8A at 30°C 4A at 60°C	8A at 30°C 4A at 60°C
<b>On-State Voltage Drop (max.)</b>	1.2V at 1.0A	1.2V at 0.5A	1.2V at 0.5A
<b>Surge Current<sup>(5)</sup> (max.)</b>	3A for 10 ms	3A for 10 ms	1A for 10 ms

(1) Series A, B, and C 32-point output modules are fused to protect external wiring, one fuse per common. These fuses are non-replaceable and are rated at 2.5A. Series D modules are not fused and have a higher current rating than Series A, B, and C.

(2) To limit the effects of leakage current, a loading resistor can be connected in parallel with your load. For 24V dc operation use a 5.6k ohm, ½W resistor.

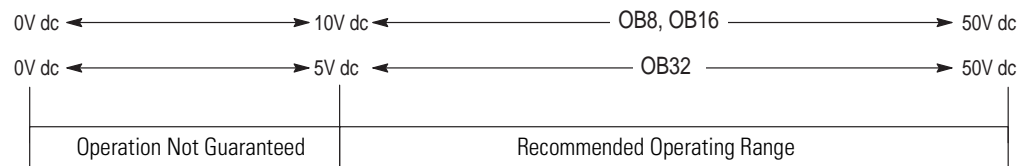
(3) Recommended surge suppression for switching 24V dc inductive loads is a 1N4004 diode that is reverse wired across the load. See page 6 for more information on surge suppression.

(4) To attain the maximum Continuous Current per common rating of 4A for an OB32 Series D module, both V dc connections in a wire group must be connected to your DC source.

(5) Repeatability is once every second at 30°C. Repeatability is once every 2 seconds at 60°C.

RTB = Removable Terminal Block.

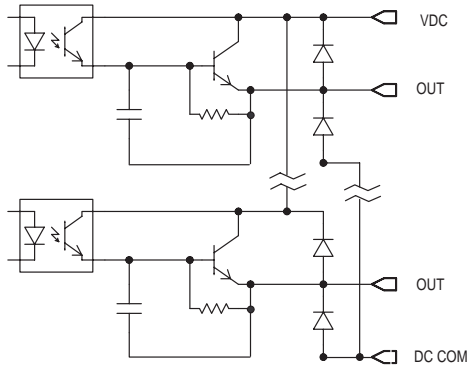
### Operating Voltage Range



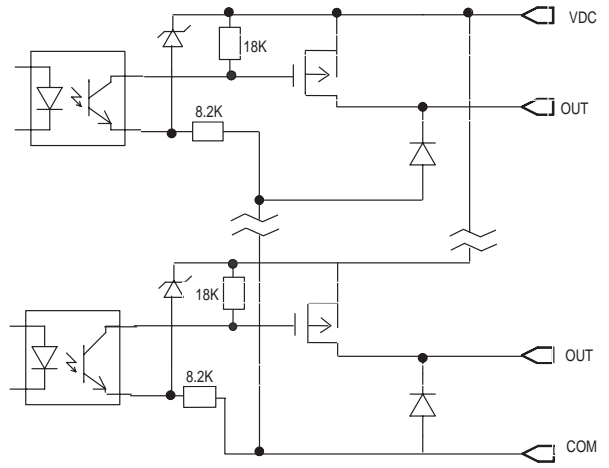
(Voltage is applied between +VDC and DC common.)

*Circuit Diagrams*

**1746-OB8, OB16**

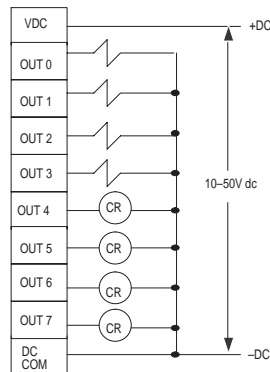


**1746-OB32**

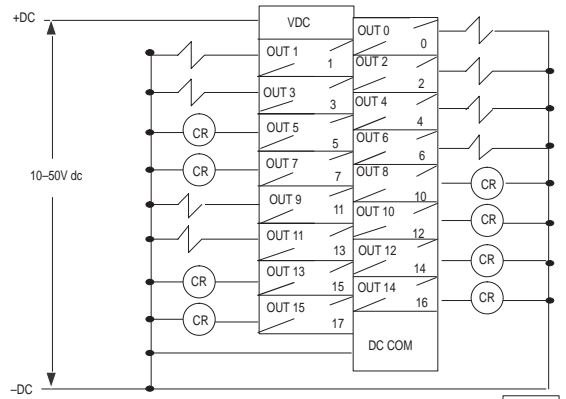


*Wiring Diagrams*

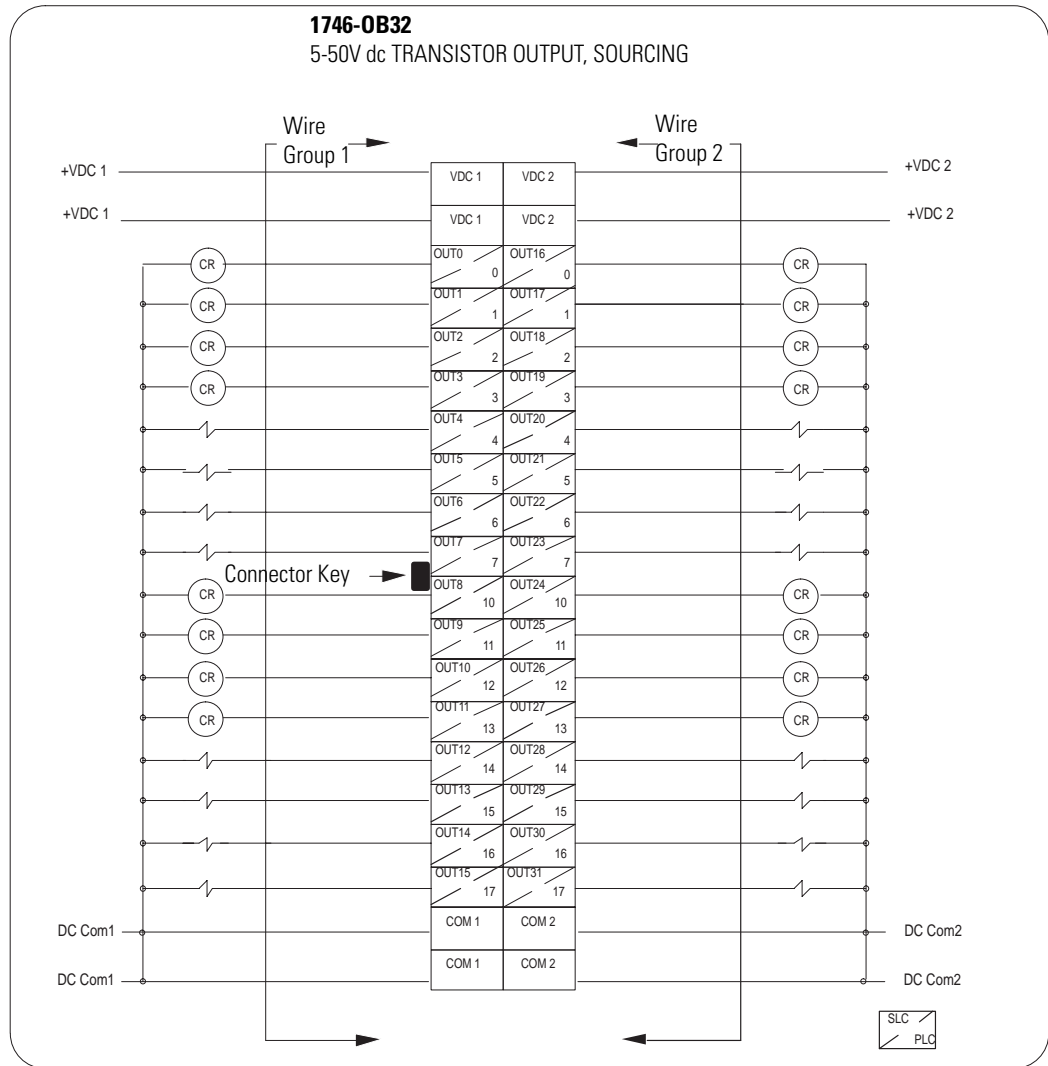
**1746-OB8**  
10-50V dc TRANSISTOR OUTPUT  
SOURCING



**1746-OB16**  
10-50V dc TRANSISTOR OUTPUT, SOURCING



SLC / PLC



**Important:** The V dc and dc Com pins on the 1746-OB32 output module are isolated between the two groups and the two dc Com pins in each group are connected internally. Both V dc pins on the 1746-OB32 must be connected to the dc power source if current for a common group is expected to exceed 2 Amps. Use a 1492 terminal block to maintain group isolation provided by 32-point I/O modules. Consult 1492 documentation or your Allen-Bradley Sales Office for additional information.

The 1746 32-point modules include a keyed 40-pin female connector and crimp-type pins for connection to I/O wiring. In addition, 1492 prewired cables and interface modules can be used for connecting external I/O. (See pages 7 and 50.)

The maximum user cable length is dependent on how much voltage drop [current x (ohms/ft.) x (feet)] the user's system can tolerate. The user's system should take into account the minimum turn-on voltage required by external loads connected to the 32-point output modules and all of the voltage drops associated with wiring to and from the load, terminal blocks, power sources, and the module itself.

## Electronically Protected Sourcing DC Output Modules (1746-OB6EI, -OB16E, -OB32E)

Specification		Catalog Number		
		1746-OB6EI (RTB)	1746-OB16E (RTB)	1746-OB32E
<b>Voltage Category</b>		24V dc		
<b>Operating Voltage</b>		10 to 30V dc source		
<b>Number of Outputs</b>		6	16	32
<b>Points per Common</b>		Individually Isolated	16	16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.046A	0.135A	0.190A
	<b>24V dc</b>	0.0A	0.0A	0.0A
<b>Signal Delay (max.) (Resistive Load)<sup>(1)</sup></b>		on = 1.0 ms off = 2.0 ms	on = 1.0 ms off = 1.0 ms	on = 1.0 ms off = 2.0 ms
<b>Off-State Leakage<sup>(2)</sup> (max.)</b>		1 mA		
<b>Load Current (min.)</b>		1 mA		
<b>Continuous Current (max.)</b>	<b>Per Point</b>	2.0A at 0 to 60°C	1.00A at 30°C 0.50A at 60°C	0.50A at 30°C 0.25A at 60°C
	<b>Per Module</b>	12.0A at 0 to 60°C	8A at 0 to 60°C	8A at 0 to 60°C 4A at 0 to 60°C per common <sup>(3)</sup> 2A at 0 to 60°C per common pin
<b>On-State Voltage Drop (max.)</b>		1.0V at 2A	1.0V at 0.5A	1.2V at 0.5A
<b>Surge Current<sup>(4)</sup> (max.)</b>	<b>Per Point</b>	4.0A for 10 ms	2A for 10 ms	1.0A for 10 ms
	<b>Per Module</b>	24.0A for 10 ms	32A for 10 ms	32A for 10 ms
<b>Electronic Protection</b>		yes - See page 10 for more information on the electronically protected modules.		

(1) Fast turn-off modules (1746-OB6EI, -OBP8 Series B and later, -OB16E Series B and later, -OBP16, and -OVP16) provide fast OFF delay for inductive loads. Fast turn-off delay for inductive loads is accomplished with surge suppressors on this module. A suppressor at the load is not needed unless another contact is connected in series. If this is the case, a 1N4004 diode should be reverse wired across the load. This defeats the fast turn-off feature. Comparative OFF delay times for 1746-OB8/-OV8 and fast turn-off modules, when switching Bulletin 100-B110 (24W sealed) contactor, are: 1746-OB8/-OV8 OFF delay = 152 ms; fast turn-off modules OFF delay = 47 ms.

(2) To limit the effects of leakage current, a loading resistor can be connected in parallel with your load. For 24V dc operation use a 5.6k ohm, ½W resistor.

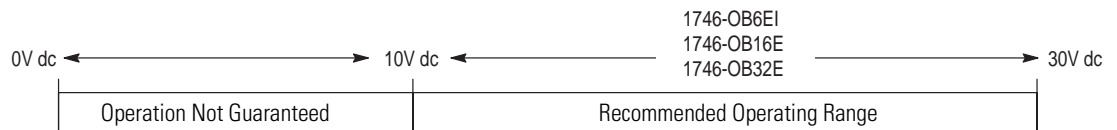
(3) To attain the maximum Continuous Current per common rating of 4A for an OB32 Series D module, both V dc connections in a wire group must be connected to your DC source.

(4) Repeatability is once every second at 30°C. Repeatability in once every 2 seconds at 60°C.

RTB = Removable Terminal Block.

### Operating Voltage Range

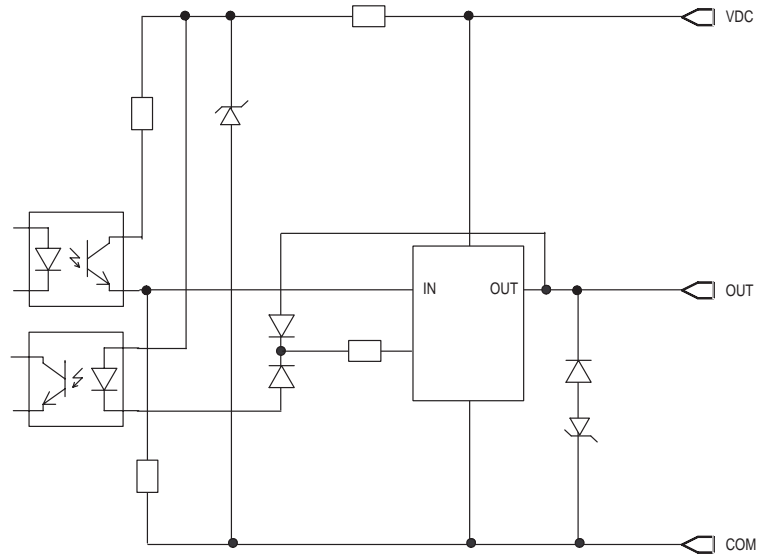
(Voltage is applied between +VDC and DC common.)



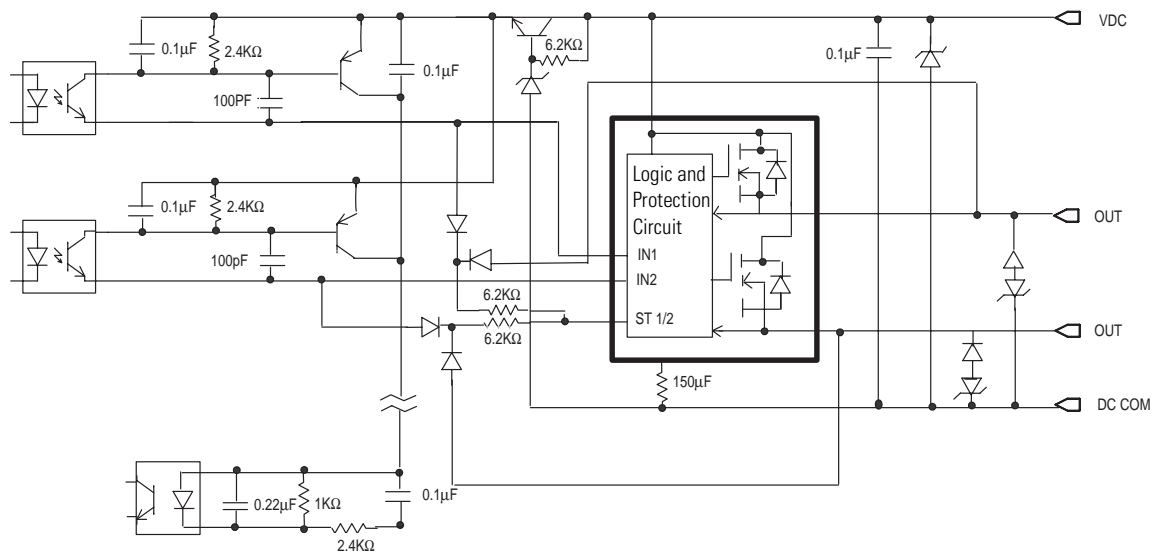


Circuit Diagrams

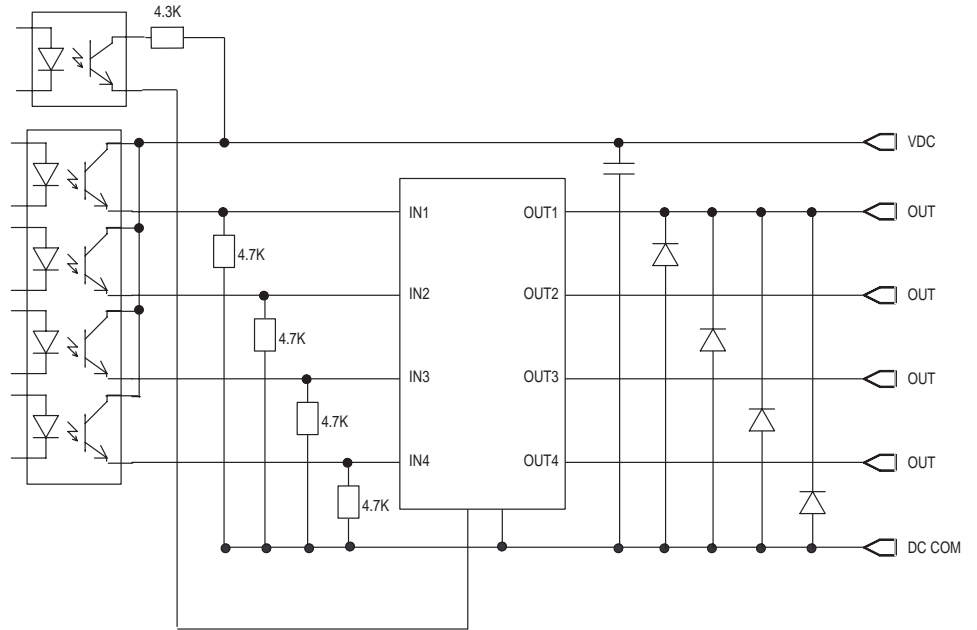
1746-OB6EI



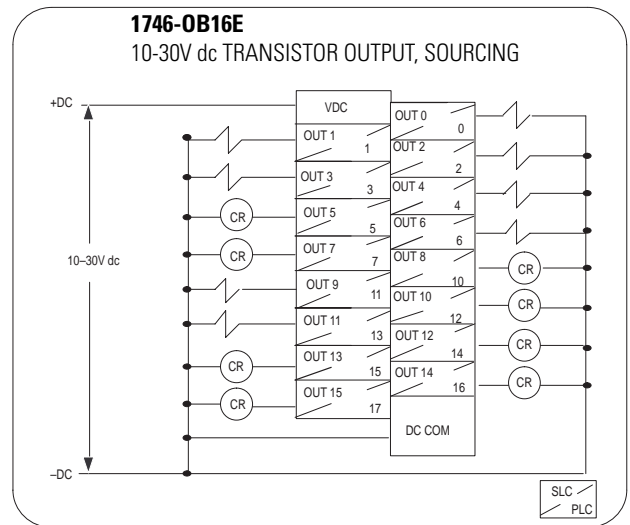
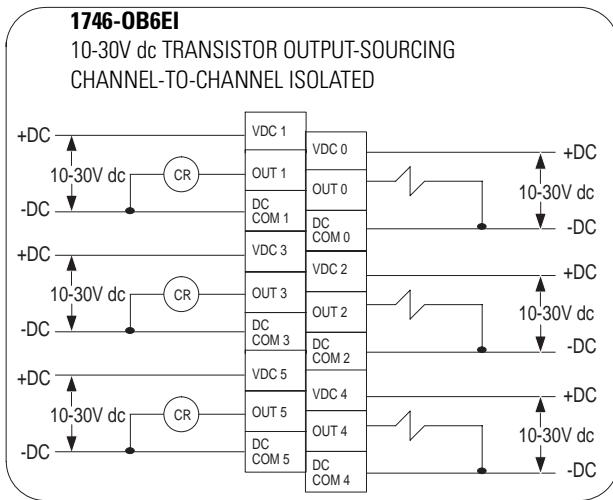
1746-OB16E

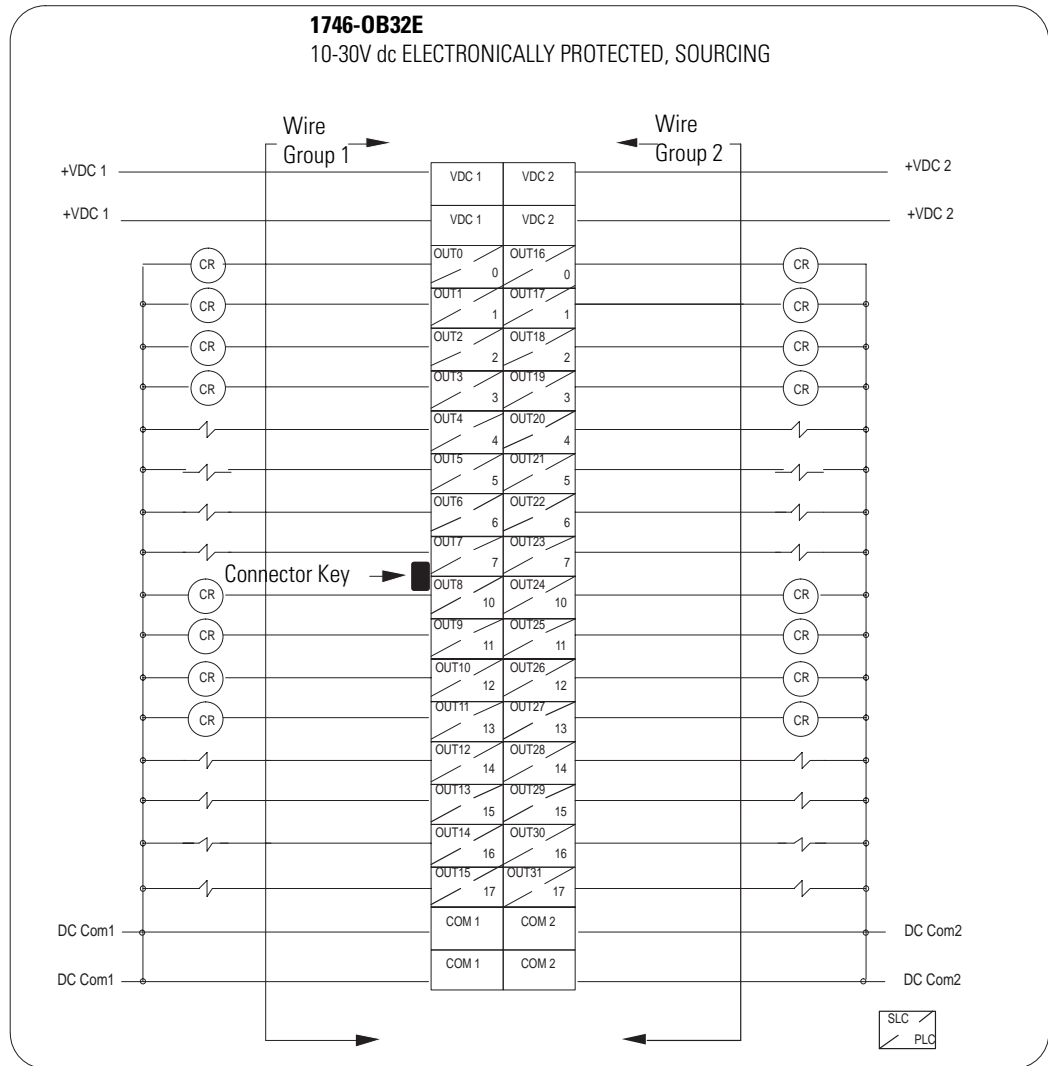


**1746-OB32E**



*Wiring Diagrams*





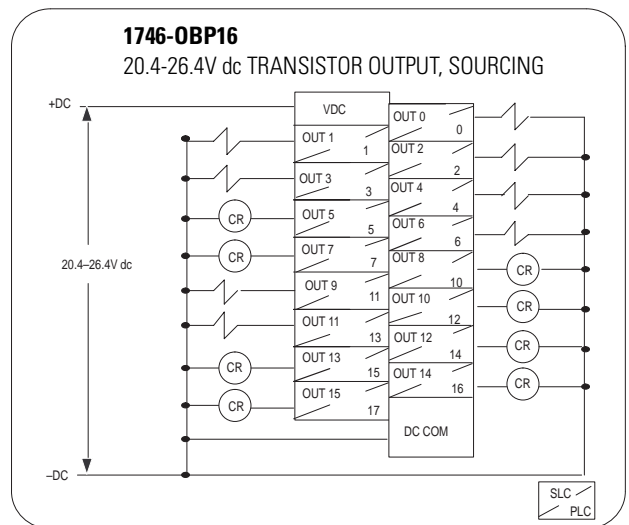
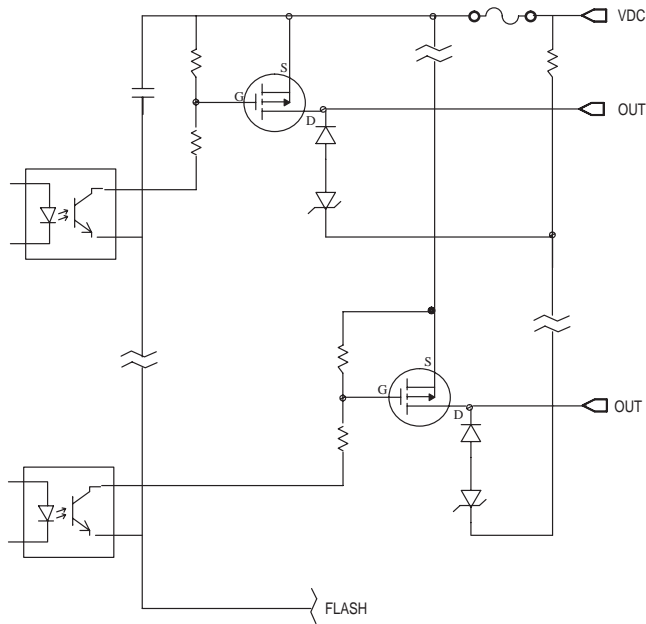
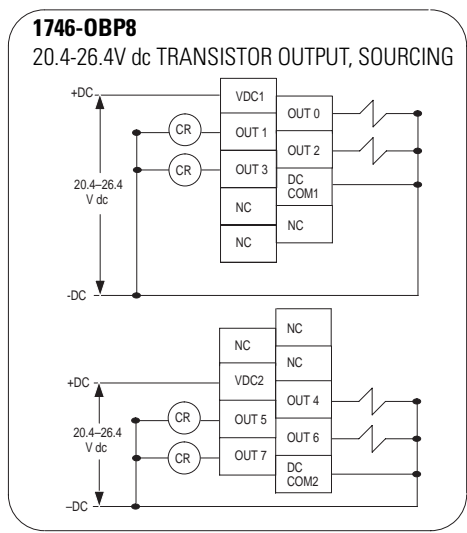
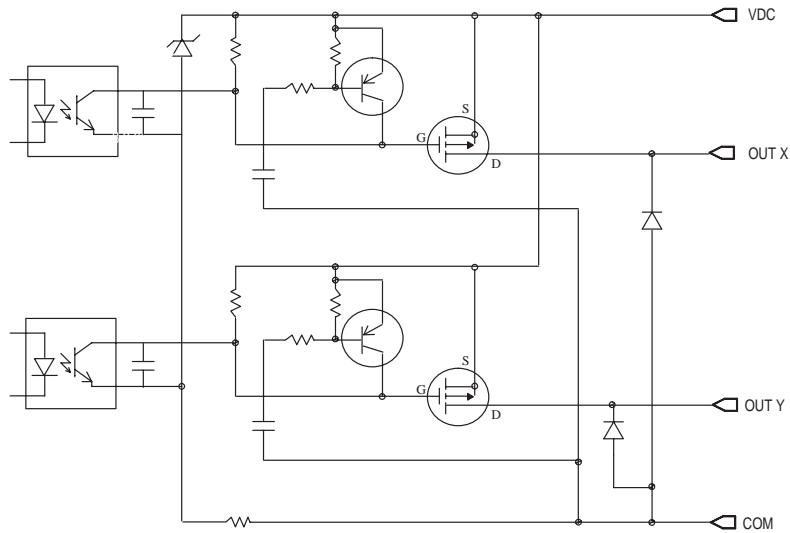
**Important:** The V dc and dc Com pins on the 1746-OB32E output module are isolated between the two groups and the two dc Com pins in each group are connected internally. Both V dc pins on the 1746-OB32E must be connected to the dc power source if current for a common group is expected to exceed 2 Amps. Use a 1492 terminal block to maintain group isolation provided by 32-point I/O modules. Consult 1492 documentation or your Allen-Bradley Sales Office for additional information.

The 1746 32-point modules include a keyed 40-pin female connector and crimp-type pins for connection to I/O wiring. In addition, 1492 prewired cables and interface modules can be used for connecting external I/O. (See pages 7 and 50.)

The maximum user cable length is dependent on how much voltage drop [current x (ohms/ft.) x (feet)] the user's system can tolerate. The user's system should take into account the minimum turn-on voltage required by external loads connected to the 32-point output modules and all of the voltage drops associated with wiring to and from the load, terminal blocks, power sources, and the module itself.



*Circuit and Wiring Diagrams*



## Sinking DC Output Modules (1746-OV8, -OV16, -OV32)

Specification		Catalog Number		
		1746-OV8	1746-OV16 (RTB)	1746-OV32 Series D <sup>(1)</sup>
Voltage Category		24V dc		
Operating Voltage		10 to 50V dc sink		5 to 50V dc sink
Number of Outputs		8	16	32
Points per Common		8	16	16
Backplane Current Draw	5V dc	0.135A	0.270A	0.190A
	24V dc	0.0A	0.0A	0.0A
Signal Delay (max.) (Resistive Load)		on = 0.1 ms / off = 1.0 ms		
Off-State Leakage <sup>(2)</sup> (max.)		1 mA		
Load Current (min.)		1 mA		
Continuous Current <sup>(3)</sup> (max.)	Per Point <sup>(4)</sup>	1A at 30°C 0.5A at 60°C	0.5A at 30°C 0.25A at 60°C	0.5A at 30°C 0.25A at 60°C
	Per Module	8A at 30°C 4A at 60°C	8A at 30°C 4A at 60°C	8.0A at 0°C to 60°C 4A at 0 to 60°C per common <sup>(5)</sup> 2A at 0 to 60°C per common pin
On-State Voltage Drop (max.)		1.2V at 1A	1.2V at 0.5A	1.2V at 0.5A
Surge Current Per Point <sup>(6)</sup> (max.)		3A for 10 ms	3A for 10 ms	1A for 10 ms

(1) Series A, B, and C 32-point output modules are fused to protect external wiring, one fuse per common. These fuses are non-replaceable and are rated at 2.5A. Series D modules are not fused and have a higher current rating than Series A, B, and C.

(2) To limit the effects of leakage current, a loading resistor can be connected in parallel with your load. For 24V dc operation use a 5.6k ohm, ½W resistor.

(3) To attain the maximum Continuous Current per common of 4A for an OV32 Series D module, both dc com connections in a wire group must be connected to your DC source.

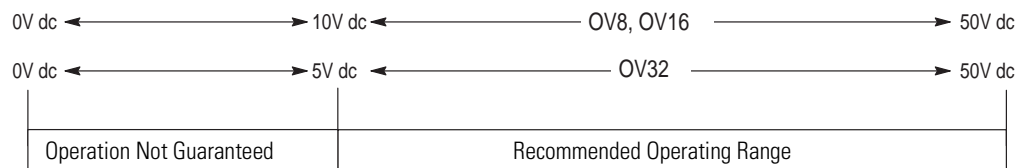
(4) Recommended surge suppression for switching 24V dc inductive loads is a 1N4004 diode that is reverse wired across the load. See page 6 for more information on surge suppression.

(5) To attain the maximum Continuous Current per common rating of 4A for an OV32 Series D module, both V dc connections in a wire group must be connected to your DC source.

(6) Repeatability is once every 1 second at 30°C. Repeatability is once every 2 seconds at 60°C.

RTB = Removable Terminal Block.

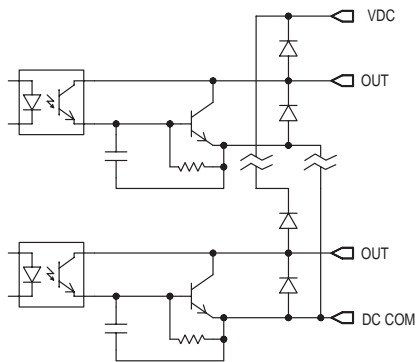
### Operating Voltage Range



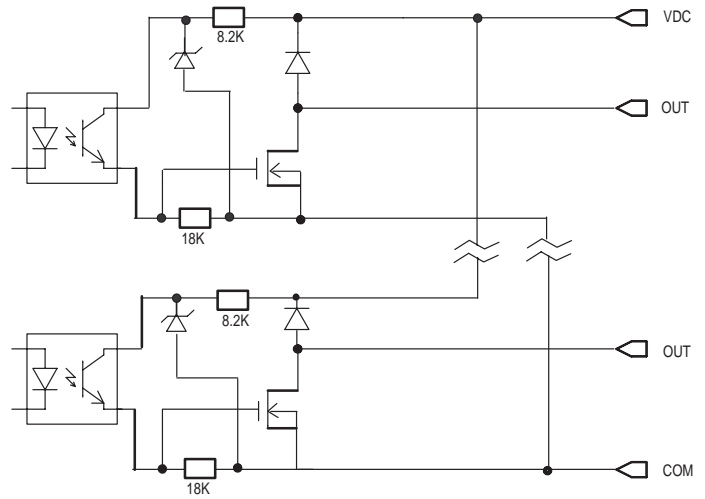
(Voltage is applied between +VDC and DC common.)

*Circuit Diagrams*

**1746-0V8, 0V16**

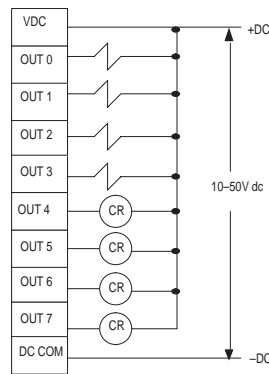


**1746-0V32**

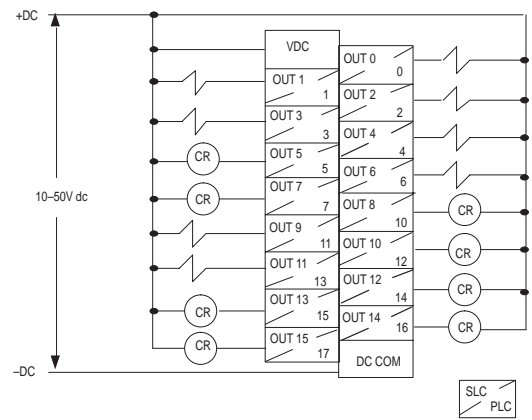


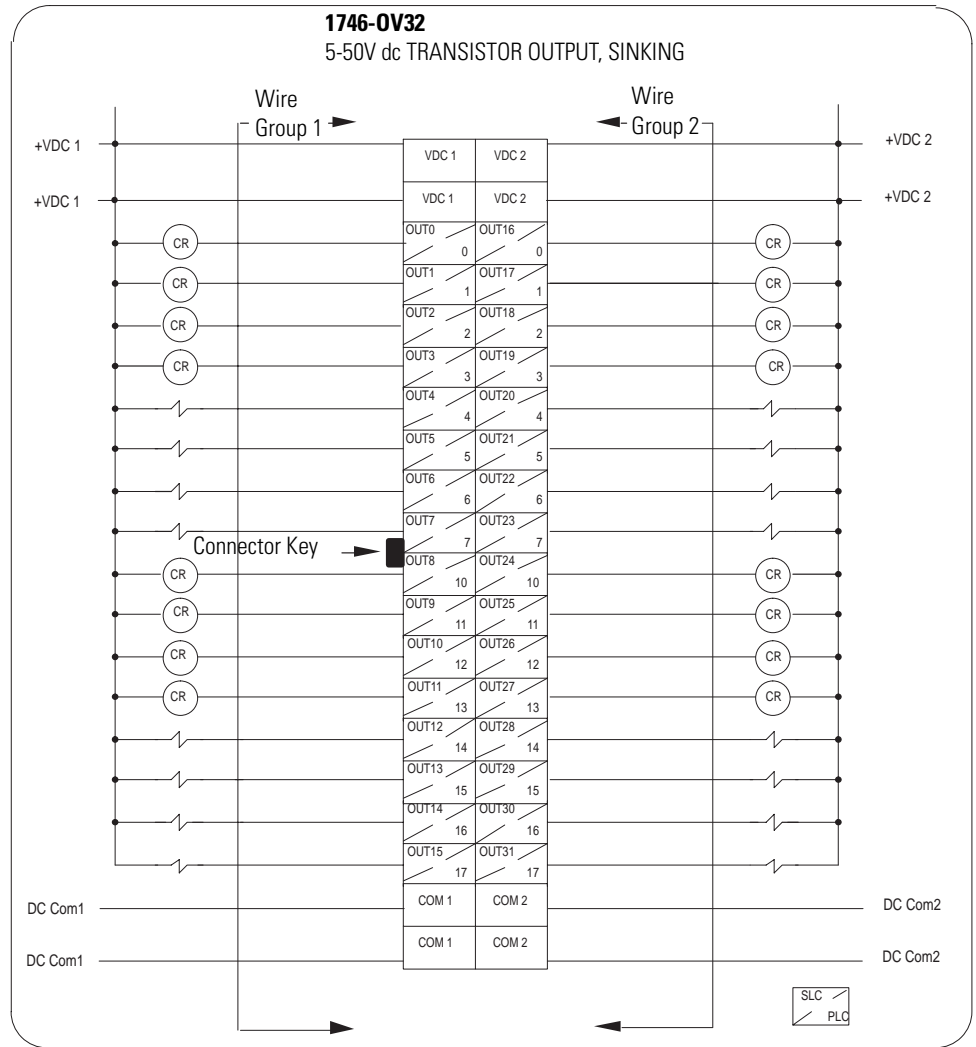
*Wiring Diagrams*

**1746-0V8**  
10-50V dc TRANSISTOR OUTPUT  
SINKING



**1746-0V16**  
10-50V dc TRANSISTOR OUTPUT, SINKING





**Important:** The V dc and dc Com pins on the 1746-OV32 output module are isolated between the two groups and the two V dc and two dc Com pins in each group are connected internally. Both dc com pins on the 1746-OV32 must be connected to the dc power source if current for a common group is expected to exceed 2 Amps. Use a 1492 terminal block to maintain group isolation provided by 32-point I/O modules. Consult 1492 documentation or your Allen-Bradley Sales Office for additional information.

The 1746 32-point modules include a keyed 40-pin female connector and crimp-type pins for connection to I/O wiring. In addition, 1492 prewired cables and interface modules can be used for connecting external I/O. (See pages 7 and 50.)

The maximum user cable length is dependent on how much voltage drop [current x (ohms/ft.) x (feet)] the user's system can tolerate. The user's system should take into account the minimum turn-on voltage required by external loads connected to the 32-point output modules and all of the voltage drops associated with wiring to and from the load, terminal blocks, power sources, and the module itself.



### High Current Sinking DC Output Module (1746-OVP16)

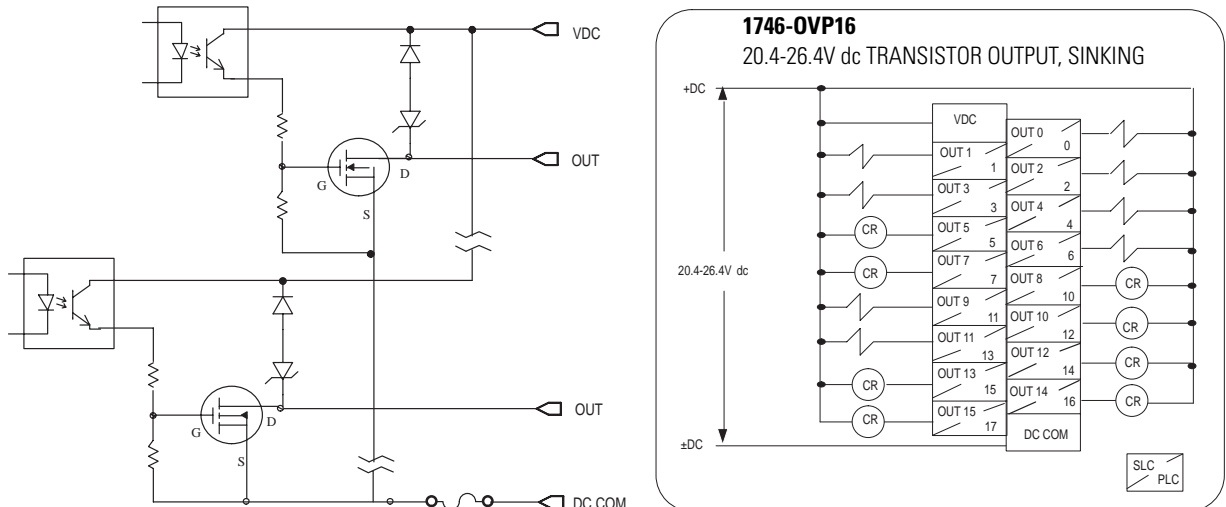
Specification		Catalog Number
		<b>1746-OVP16</b> <sup>(1)</sup> <sup>(2)</sup> (RTB)
<b>Voltage Category</b>		24V dc
<b>Operating Voltage</b>		20.4 to 26.4V dc sink
<b>Number of Outputs</b>		16
<b>Points per Common</b>		16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.25A
	<b>24V dc</b>	0.0A
<b>Signal Delay (max.) (Resistive Load)</b>		on = 0.1 ms / off = 1 ms
<b>Off-State Leakage<sup>(3)</sup> (max.)</b>		1 mA
<b>Load Current (min.)</b>		1 mA
<b>Continuous Current (max.)</b>	<b>Per Point</b>	1.5A at 30°C / 1A at 60°C
	<b>Per Module</b>	6.4A at 0°C to 60°C
<b>On-State Voltage Drop (max.)</b>		1V at 1A
<b>Surge Current<sup>(4)</sup> (max.)</b>	<b>Per Point</b>	4A for 10 ms
	<b>Per Module</b>	32A for 10 ms

- (1) A fused common and blown fuse LED are provided on this module.
  - (2) Fast turn-off modules (1746-OB6EI, -OBP8 Series B and later, -OB16E Series B and later, -OBP16, and -OVP16) provide fast OFF delay for inductive loads. Fast turn-off delay for inductive loads is accomplished with surge suppressors on this module. A suppressor at the load is not needed unless another contact is connected in series. If this is the case, a 1N4004 diode should be reverse wired across the load. This defeats the fast turn-off feature. Comparative OFF delay times for 1746-OB8/-OV8 and fast turn-off modules, when switching Bulletin 100-B110 (24W sealed) contactor, are: 1746-OB8/-OV8 OFF delay = 152 ms; fast turn-off modules OFF delay = 47 ms.
  - (3) To limit the effects of leakage current, a loading resistor can be connected in parallel with your load. For 24V dc operation use a 5.6k ohm, ½W resistor.
  - (4) Repeatability is once every 1 second at 30°C. Repeatability is once every 2 seconds at 60°C.
- RTB = Removable Terminal Block.

#### Operating Voltage Range



#### Circuit and Wiring Diagrams



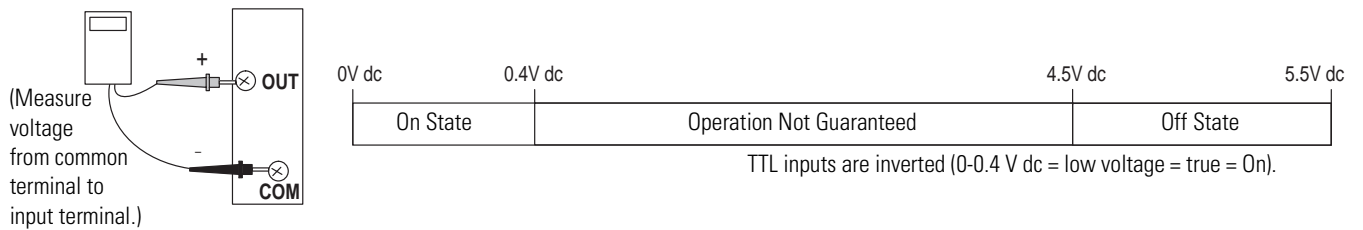
### Sinking TTL Output Module (1746-OG16)

Specification		Catalog Number
		<b>1746-OG16 (RTB)</b>
<b>Voltage Category</b>		5V dc TTL <sup>(1)</sup>
<b>Operating Voltage Range</b>		4.5 to 5.5V dc 50 mV peak-to-peak ripple maximum 495 mA maximum at 5V dc
<b>Number of Outputs</b>		16
<b>Points per Common</b>		16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.180A
	<b>24V dc</b>	0.0A
<b>Signal Delay (max.) (Resistive Load)</b>		on = 0.25 ms / off = 0.5 ms
<b>Off-State Leakage (max.)</b>		0.1 mA
<b>Load Current (min.)</b>		0.15 mA
<b>Continuous Current (max.)</b>		24 mA

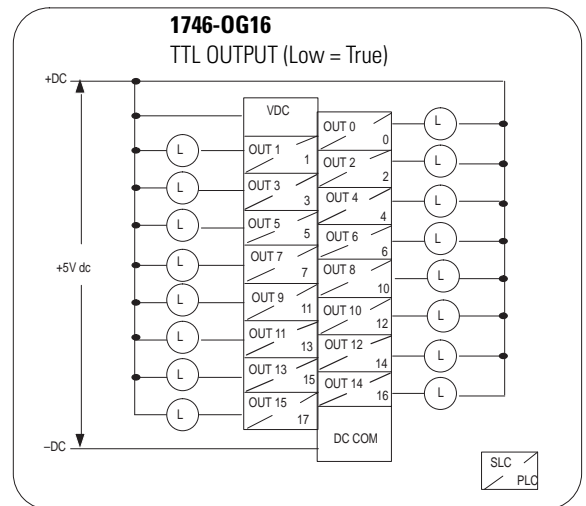
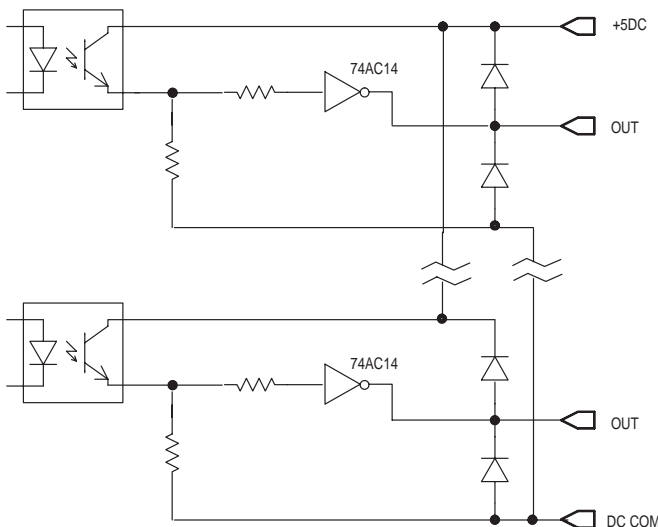
(1) TTL outputs are inverted (0-0.4V dc = low voltage = True = On). Use a NOT instruction in your ladder program to convert to traditional True = High logic.

RTB = Removable Terminal Block.

#### On/Off-State Voltage Range



#### Circuit and Wiring Diagrams



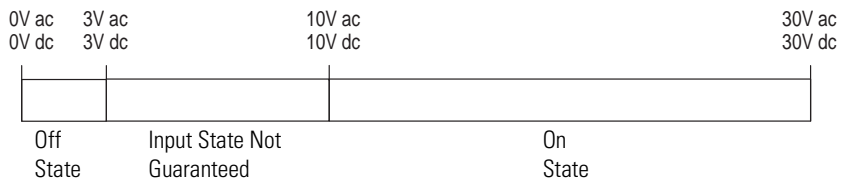
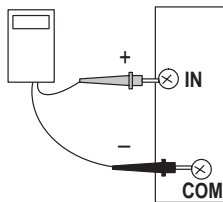
### AC/DC Input Module (1746-IN16)

Specification		Catalog Number
		<b>1746-IN16 (RTB)</b>
<b>Voltage Category</b>		24V ac/dc
<b>Operating Voltage</b>		10 to 30V dc sink 10 to 30V ac at 47 to 63 Hz
<b>Number of Inputs</b>		16
<b>Points per Common</b>		16
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.085A
	<b>24V dc</b>	0.0A
<b>Signal Delay (max.)</b>		dc: on = 15 ms / off = 15 ms ac: on = 25 ms / off = 25 ms
<b>Off-State Voltage (max.)</b>		3V dc 3V ac
<b>Off-State Current (max.)</b>		1 mA dc 1 mA ac
<b>Nominal Input Current</b>		8 mA at 24V dc 8 mA at 24V ac
<b>Inrush Current (max.)</b>		0.02A (ac only)

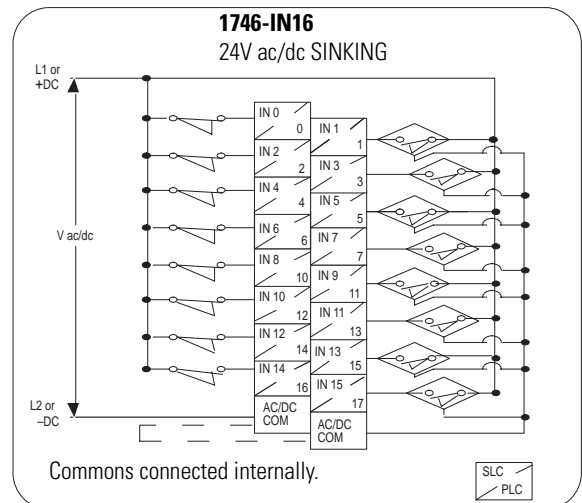
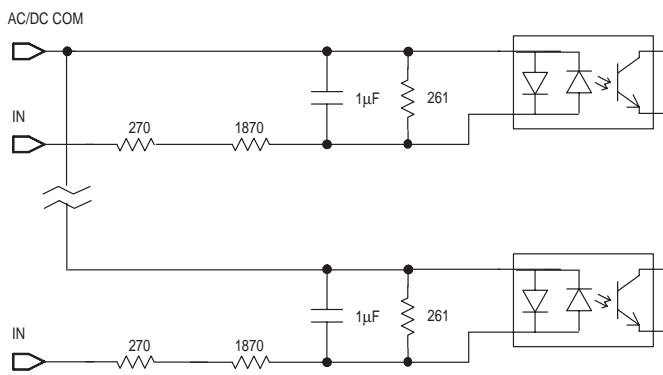
RTB = Removable Terminal Block.

#### On/Off-State Voltage Range

(Measure voltage from common terminal to input terminal.)



#### Circuit and Wiring Diagrams



### AC/DC Relay Output Modules (1746-OW4, -OW8, -OW16, -OX8)

Specification		Catalog Number			
		1746-OW4	1746-OW8	1746-OW16 (RTB)	1746-OX8 (RTB)
Voltage Category		ac/dc Relay			
Operating Voltage		5 to 265V ac at 47 to 63 Hz / 5 to 125V dc			
Number of Outputs		4	8	16	8
Points per Common		4	4	8	Individually Isolated
Backplane Current Draw	5V dc	0.045A	0.085A	0.170A	0.085A
	24V dc	0.045A	0.090A	0.180A	0.090A
Signal Delay (max.) (Resistive Load)		on = 10 ms / off = 10 ms			
Off-State Leakage (max.)		0 mA			
Load Current (min.)		10 mA at 5V dc			
Continuous Current per Point <sup>(1)</sup> (max.)		See the <i>Relay Contact Ratings</i> tables shown below.			
Continuous Current per Module (max.)		8.0A ac	16.0A ac	16.0A ac	(2)
Current per Common (max.)		8.0A	8.0A	8.0A	

#### Relay Contact Ratings for 1746-OW4, OW8, and OW16

Maximum Volts		Amperes <sup>(1)</sup>		Amperes Continuous <sup>(2)</sup>	Volt-Amperes	
		Make	Break		Make	Break
ac	240V ac	7.5A	0.75A	2.5A	1800 VA	180 VA
	120V ac	15A	1.5A			
dc	125V dc	0.22A <sup>(3)</sup>		1.0A	28 VA	
	24V dc	1.2A <sup>(3)</sup>		2.0A		

#### Relay Contact Ratings for 1746-OX8

Maximum Volts		Amperes <sup>(1)</sup>		Amperes Continuous <sup>(2)</sup>	Volt-Amperes	
		Make	Break		Make	Break
ac	240V ac	15A	1.5A	5.0A	3600 VA	360 VA
	120V ac	30A	3.0A			
dc	125V dc	0.22A <sup>(3)</sup>		1.0A	28 VA	
	24V dc	1.2A <sup>(3)</sup>		2.0A		

(1) Connecting surge suppressors across your external load extends the life of SLC 500 relay contacts. For recommended surge suppressors when switching ac inductive loads, consult the *SLC 500 Modular Hardware Style Installation and Operation User Manual* (Publication 1746-6.2) or the *SLC 500 Fixed Hardware Style Installation and Operation User Manual* (Publication 1747-6.21). Recommended surge suppression for switching 24V dc inductive loads is 1N4004 diode reverse wired across the load.

(2) The continuous current per module must be limited so the module power does not exceed 1440 VA.

(3) For dc voltage applications, the make/break ampere rating for relay contacts can be determined by dividing the 28 VA by the applied dc voltage. For example, 28 VA/48V dc = 0.58A. For dc voltage applications less than 14V, the make/break ratings for relay contacts cannot exceed 2A.

RTB = Removable Terminal Block.

### Operating Voltage Range

(For ac operation: voltage is applied between L1 and L2.)

(For dc operation: voltage applied is between +VDC and DC common.)

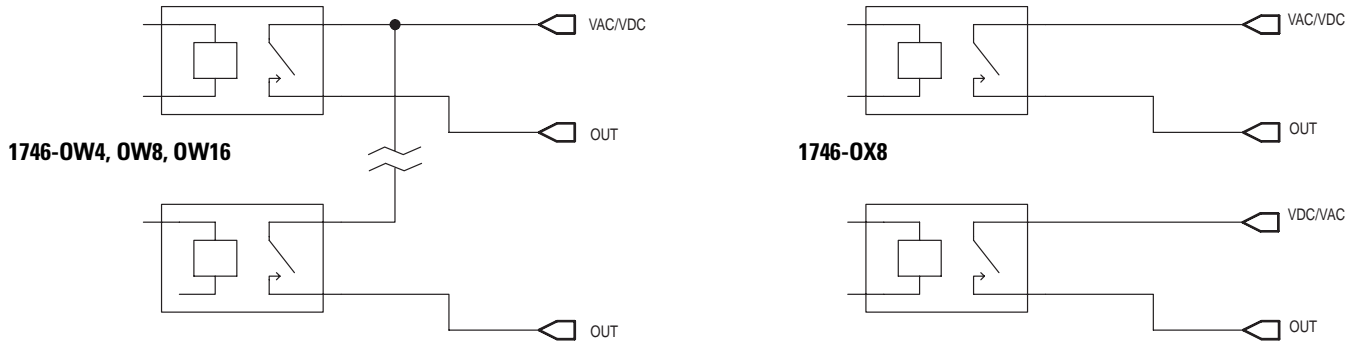
0 V 5V ac  
0 V 5V dc

265V ac  
125V dc

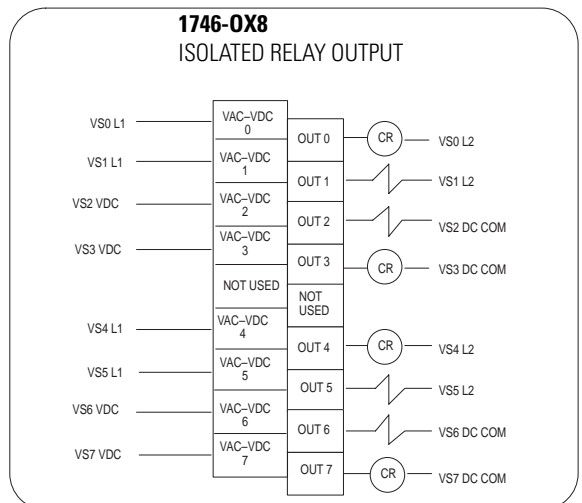
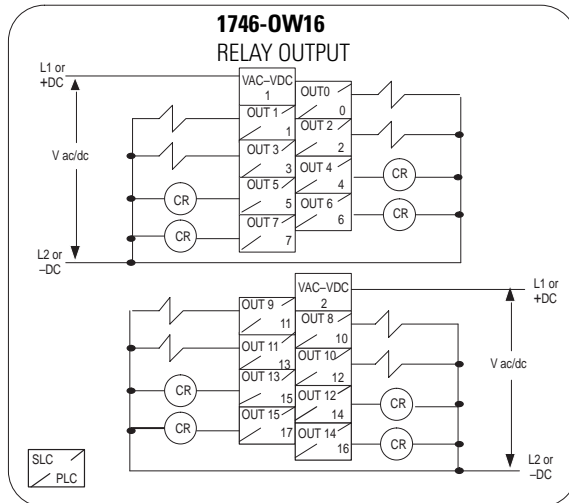
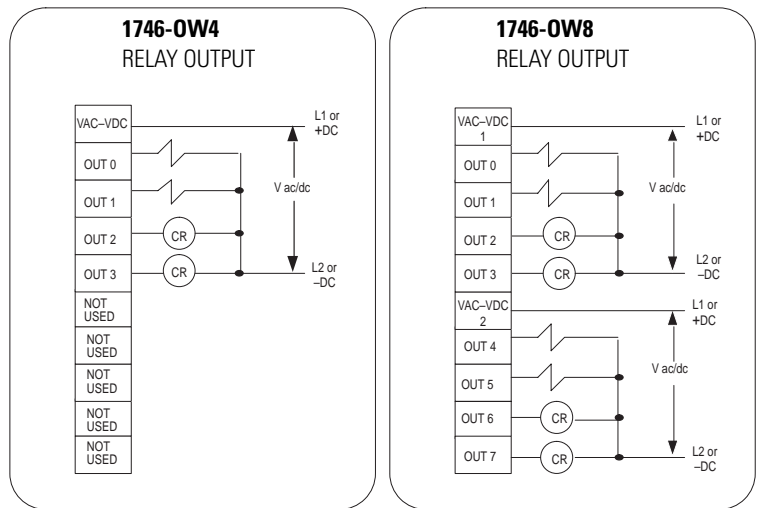


Operation Not Guaranteed

### Circuit Diagram



### Wiring Diagrams

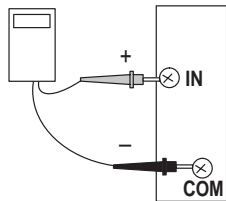


### Combination Modules (1746-IO4, -IO8, -IO12, -IO12DC)

Specification	Catalog Number			
	1746-IO4	1746-IO8	1746-IO12 (RTB)	1746-IO12DC (RTB)
<b>Voltage Category</b>	inputs: 120V ac outputs: ac/dc Relay			inputs: 24V dc outputs: ac/dc Relay
<b>Operating Voltage</b>	inputs: 85 to 132V ac at 47 to 63 Hz outputs: 5 to 265V ac at 47 to 63 Hz / 5 to 125V dc			inputs: 10 to 30V dc sinking
<b>Points per Common</b>	2	4	6	6
<b>Points per Module</b>	2 inputs / 2 outputs	4 inputs / 4 outputs	6 inputs / 6 outputs	6 inputs / 6 outputs
<b>Backplane Current Draw</b>	<b>5V dc</b>	0.030A	0.060A	0.090A
	<b>24V dc</b>	0.025A	0.045A	0.070A
<b>Continuous Current per Module</b>	4.0A	8.0A	8.0A	8.0A
<b>Specification Reference</b>	input same as 1746-IA4 output same as 1746-OW4		input same as 1746-IA16 output same as 1746-OW16	

RTB = Removable Terminal Block.

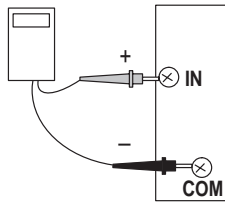
#### On/Off-State Voltage Range (AC Inputs)



(Measure voltage from common terminal to input terminal.)



#### On/Off-State Voltage Range (DC Inputs)

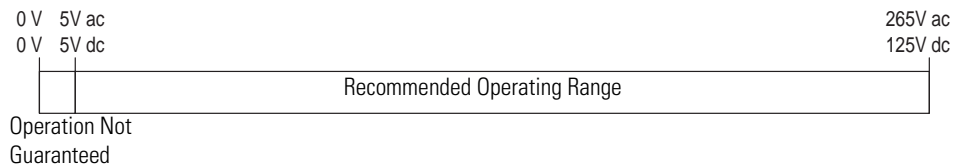


(Measure voltage from common terminal to input terminal.)

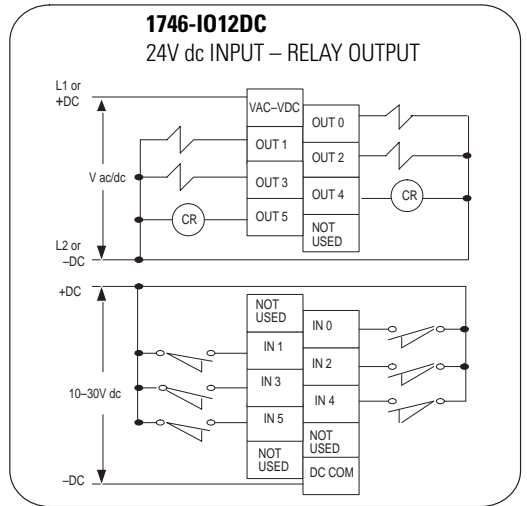
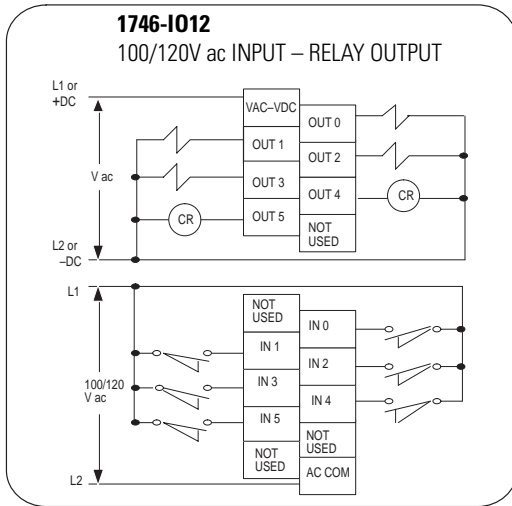
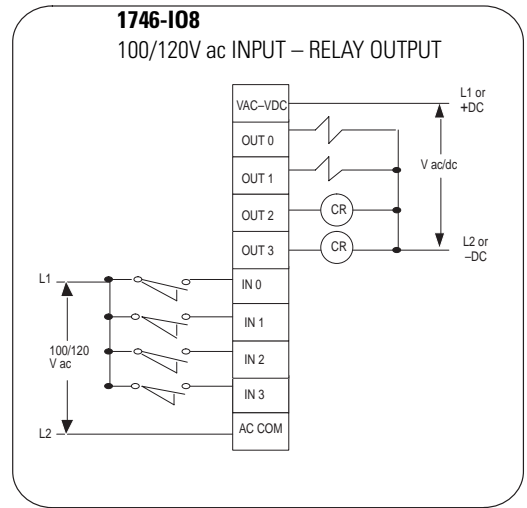
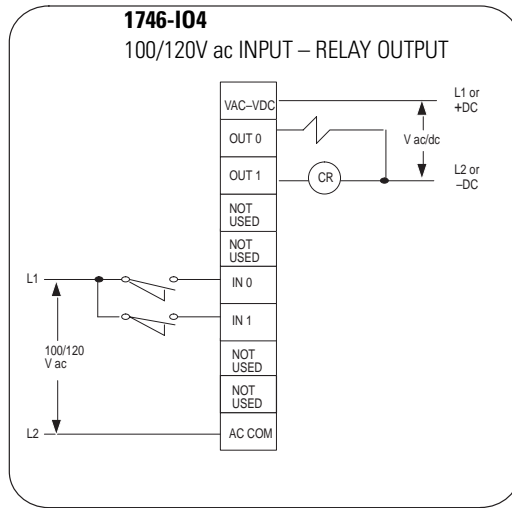
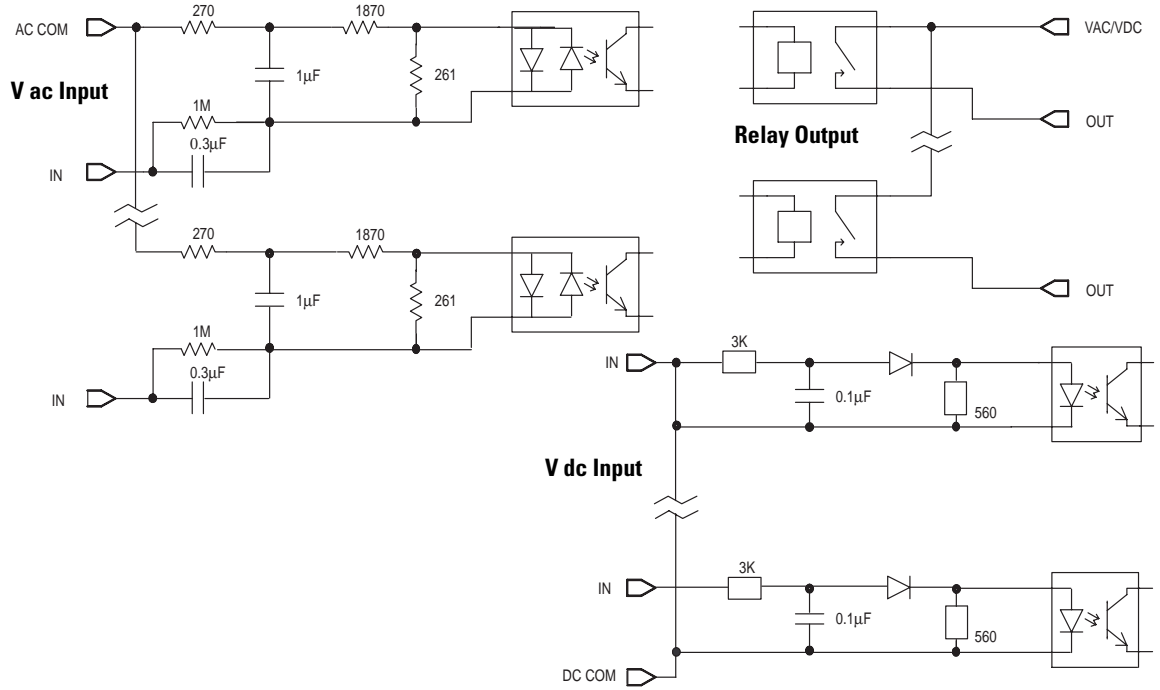


#### Operating Voltage Range (AC/DC Relay Outputs)

(For ac operation: voltage is applied between L1 and L2.)  
(For dc operation: voltage is applied between +VDC and DC common.)



*Circuit and Wiring Diagrams*



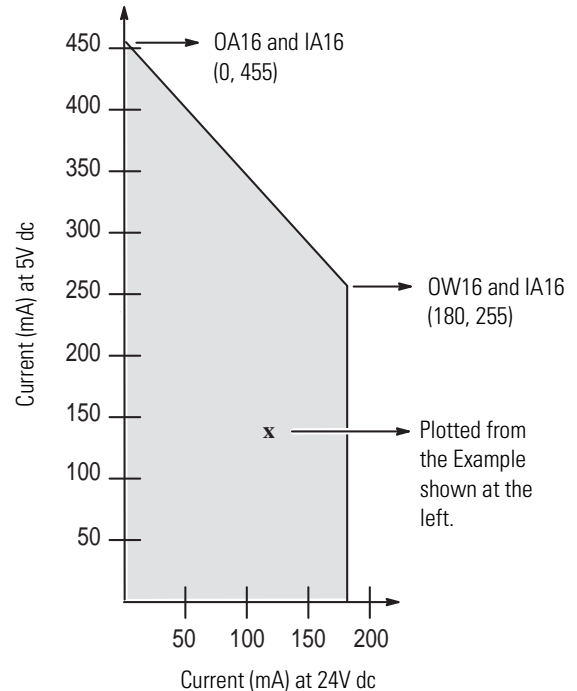
## Fixed I/O Chassis and Module Compatibility

The following chart depicts the range of current combinations supported by the fixed I/O expansion chassis. To use it, you must first determine the backplane current draw and operating voltage for both of the modules you plan to use in the chassis. You can get these specifications from the *Power Supply Loading* table on page 48.

Next, plot each of the currents on the chart below. If the point of intersection falls within the operating region, your combination is valid. If not, your combination cannot be used in a 2-slot, fixed I/O chassis.

**Example:** Plot IN16 and NIO4V  
 IN16 = 0.085A at 5V dc and 0A at 24V dc.  
 NIO4V = 0.055A at 5V dc and 0.115A at 24V dc

1. Add current draws of both modules at 5V dc to get 0.14A (140 mA).
2. Plot this point on the chart at the right. (140 mA at 5V dc).
3. Add current draws of both modules at 24V dc to get 0.115A (115 mA).
4. Plot current draw at 24V dc (115 mA at 24V dc).
5. Note the point of intersection on the chart (marked x). This combination falls within the valid operating region for your fixed I/O chassis.




---

**Important:** The 1746-NO4I and 1746-NO4V analog output modules may require an external power supply. Refer to your analog module user's manual.

---



---

**Important:** There are certain conditions that affect the compatibility characteristics of the BASIC module (1746-BAS) and the DH-485/RS-232C module (1746-KE).

---

When you use the BAS module or the KE module to supply power to a 1747-AIC Link Coupler, the Link Coupler draws its power through the module. The higher current drawn by the AIC at 24V dc is calculated and recorded in the tables for the modules identified as BASn (BAS networked) or KEn (KE networked). Make sure to check the current draw values for these modules if your application uses the BAS or KE module in this way.

---



## Power Supply Loading

Hardware Components	Catalog Number	Maximum Current at 5V dc (Amps)	Maximum Current at 24V dc (Amps)	Hardware Component	Catalog Number	Maximum Current at 5V dc (Amps)	Maximum Current at 24V dc (Amps)
Discrete Input Modules	1746-IA4	0.035	0	Discrete Output Modules	1746-OA8	0.185	0
	1746-IA8	0.050	0		1746-OA16	0.370	0
	1746-IA16	0.085	0		1746-OAP12	0.370	0
	1746-IB8	0.050	0		1746-OB6EI	0.046	0
	1746-IB16	0.085	0		1746-OB8	0.135	0
	1746-IB32	0.050	0		1746-OB16	0.280	0
	1746-IC16	0.085	0		1746-OB16E	0.135	0
	1746-IG16	0.140	0		1746-OB32	0.190	0
	1746-IH16	0.085	0		1746-OB32E	0.190	0
	1746-IM4	0.035	0		1746-OBP8	0.135	0
	1746-IM8	0.050	0		1746-OBP16	0.250	0
	1746-IM16	0.085	0		1746-OG16	0.180	0
	1746-IN16	0.085	0		1746-OV8	0.135	0
	1746-ITB16	0.085	0		1746-OV16	0.270	0
	1746-ITV16	0.085	0		1746-OV32	0.190	0
	1746-IV8	0.050	0		1746-OVP16	0.250	0
	1746-IV16	0.085	0		1746-OW4	0.045	0.045
1746-IV32	0.050	0	1746-OW8	0.085	0.090		
Discrete Input and Output Modules	1746-IO4	0.030	0.025	1746-OW16	0.170	0.180	
	1746-IO8	0.060	0.045	1746-OX8	0.085	0.090	
	1746-IO12	0.090	0.070				
	1746-IO12DC	0.080	0.060				

## Discrete I/O Power Dissipation

The table below lists the power dissipation for the discrete I/O modules operating at nominal voltage. The following terms are used in the Power Dissipation table:

Watts per Point	Minimum Watts	Total Watts
The heat dissipation that can occur in each field wiring point when energized at nominal voltage.	The amount of heat dissipation that can occur when there is no field power present.	The watts per point plus the minimum watts (with all points energized).

For examples on calculating system heat dissipation, refer to the *SLC 500 Modular Hardware Style Installation and Operation User Manual* (Publication 1747-6.2) or the *SLC 500 Fixed Hardware Style Installation and Operation User Manual* (Publication 1747-6.21).

### Power Dissipation

Catalog Number	Watts per Point	Minimum Watts	Total Watts	Catalog Numbers	Watts per Point	Minimum Watts	Total Watts
<b>1746-IA4</b>	0.27	0.175	1.30	<b>1746-OB6EI</b>	0.440	0.230	2.90
<b>1746-IA8</b>	0.27	0.250	2.40	<b>1746-OB8</b>	0.775	0.675	6.90
<b>1746-IA16</b>	0.27	0.425	4.80	<b>1746-OB16</b>	0.338	1.40	7.60
<b>1746-IB8</b>	0.20	0.250	1.90	<b>1746-OB16E</b>	0.150	0.675	3.07
<b>1746-IB16</b>	0.20	0.425	3.60	<b>1746-OB32</b>	0.172	0.950	6.45
<b>1746-IB32</b>	0.20	0.250	6.65	<b>1746-OB32E</b>	0.250	0.95	8.95
<b>1746-IC16</b>	0.22	0.425	3.95	<b>1746-OBP8</b>	0.300	0.675	3.08
<b>1746-IG16</b>	0.02	0.700	1.00	<b>1746-OBP16</b>	0.310	1.250	6.26
<b>1746-IH16</b>	0.32	0.217	5.17	<b>1746-OG16</b>	0.033	0.900	1.50
<b>1746-IM4</b>	0.35	0.175	1.60	<b>1746-OV8</b>	0.775	0.675	6.90
<b>1746-IM8</b>	0.35	0.250	3.10	<b>1746-OV16</b>	0.388	1.400	7.60
<b>1746-IM16</b>	0.35	0.425	6.00	<b>1746-OV32</b>	0.172	0.950	6.45
<b>1746-IN16</b>	0.35	0.425	6.00	<b>1746-OVP16</b>	0.310	1.250	6.26
<b>1746-ITB16</b>	0.20	0.425	3.60	<b>1746-OW4</b>	0.133	1.310	1.90
<b>1746-ITV16</b>	0.20	0.425	3.60	<b>1746-OW8</b>	0.138	2.590	3.70
<b>1746-IV8</b>	0.20	0.250	1.90	<b>1746-OW16</b>	0.033	5.170	5.70
<b>1746-IV16</b>	0.20	0.425	3.60	<b>1746-OX8</b>	0.825	2.590	8.60
<b>1746-IV32</b>	0.20	0.250	6.65	<b>1746-IO4</b>	0.27 per input point 0.133 per output point	0.75	1.60
<b>1746-OA8</b>	1.000	0.925	9.00	<b>1746-IO8</b>	0.27 per input point 0.133 per output point	1.38	3.00
<b>1746-OA16</b>	0.462	1.850	9.30	<b>1746-IO12</b>	0.27 per input point 0.133 per output point	2.13	4.60
<b>1746-OAP12</b>	1.000	1.850	10.85	<b>1746-IO12DC</b>	0.20 per input point 0.133 per output point	1.84	3.90

## Environmental Specifications

Operating Temperature	0°C to 60°C (32°F to 140°F) <sup>(1)</sup>
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Operating Humidity	5% to 95% (non-condensing)
Noise Immunity	NEMA standard ICS 2-230
Vibration (Operating)	Displacement 0.015 inch peak at 5 to 57 Hz. Acceleration 2.5Gs at 57 to 2000 Hz
Shock (Operating)	30Gs (all modules except relay contact) 10Gs (relay contact modules, 1746-OW, -OX, I/O Combo)
Isolation <sup>(2)</sup>	1500 Volts
Certification <sup>(3)(4)</sup>	UL listed. CSA or C-UL approved as indicated by product markings. CE compliant for all applicable directives when product or packaging is marked.
Hazardous Environment Class <sup>(4)</sup>	Class I, Division 2, Groups A, B, C, D Hazardous Environment

(1) Exceptions are indicated with certain modules.

(2) Electro-optical isolation between I/O terminals and control logic.

(3) Some modules are not CE marked. See page 2.

(4) All modules meet Class 1, Division 2 requirements for hazardous location. Some modules are rated Class 1, Division 2 by CSA only. See page 2.

## Accessories

The following accessories are available for use with discrete I/O modules:

Catalog Number	Item	Description
1746-N2	Modular chassis slot filler	Helps prevent debris from entering the SLC enclosure that can cause shorts or improper operation.
1492-IFMxx	Feed-through interface modules	Connects electronic wiring (discrete I/O modules, particularly 16- and 32-point) to electric wiring (factory devices). Available with either 20 or 40 terminals.
1492-CABLExxxx • xxxx = 010H • xxxx = 025H • xxxx = 050H	Cables: • 1 m (3.3 ft.) • 2.5 m (8.2 ft.) • 5 m (16.4 ft.)	Connects directly to the 1492-IFMxx interface module and is available with a removable terminal block or a ready-to-wire free end.
1746-N3	Connector kit	This kit allows you to create your own cable. It contains one female connector and 45 crimp contacts. <b>Note:</b> 32-point modules are shipped with one connector kit.

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**Rockwell  
Automation**



***Allen-Bradley***

***SLC 500™ Analog  
I/O Modules***

***(Cat. Nos. 1746-NI4, -NIO4I,  
-NIO4V, -NO4I, and -NO4V)***

# User Manual

## Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

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Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

**Important:** Identifies information that is critical for successful application and understanding of the product.

## Summary of Changes

The information below summarizes the changes to this manual since the last printing as 1746-NM003, Series B in February 1994. This manual incorporates the Document Update from October 1995.

To help you find new information and updated information in this release of the manual, we have included change bars as shown to the right of this paragraph.

### New Information

The table below lists sections that document new features and additional information about existing features, and shows where to find this new information.

For This New Information	See
Quick Start for Experienced Users	Chapter 2
Wiring Schematic for Single-ended Analog Input Connections	Chapter 3
CE Certification	Chapter 3, Appendix A
Module Input and Output Circuits	Appendix D

### Updated Information

Changes from the previous release that require you to perform a procedure differently or that require different equipment are listed below:

- Determining Your Power Requirements table – added specialty and discrete I/O modules (see chapter 3, Installing Your Analog Module).
- Additional information added to Grounding Your Cable section (see chapter 3, Installing Your Analog Module).
- Foil Shield and Drain Wire diagram, Figure 3.11, has been modified (see chapter 3, Installing Your Analog Module).



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## Overview

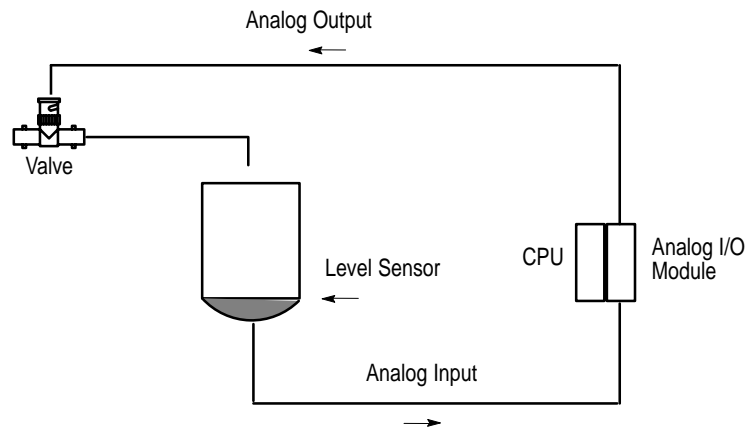
This chapter describes how analog is used and provides two application examples of analog. The types of available analog modules and their related specifications are also described.

### How to Use Analog

Analog refers to the representation of numerical quantities by the measurement of continuous physical variables. Analog applications are present in many forms. The following application shows a typical use of analog.

In this application the processor controls the amount of fluid placed in a holding tank by adjusting the percentage of the valve opening. The valve is initially open 100%. As the fluid level in the tank approaches the preset point, the processor modifies the output to degrade closing the valve 90%, 80%, adjusting the valve to maintain a set point.

Figure 1.1



## Types of Analog Modules

### 1746-NI4 Analog Input Module

The 1746-NI4 Analog Input module contains 4 analog input channels that are user selectable per channel for voltage or current to support a variety of monitoring and controlling applications

### 1746-NIO4I and NIO4V Analog Combination Modules

The NIO4I and NIO4V Analog Combination I/O modules provide two input and two output channels in a single slot module. The 1746-NIO4I module contains two current or voltage inputs (user selectable per channel), and two current outputs. The 176-NIO4V module contains two current or voltage inputs (user selectable per channel) and two voltage outputs.

### 1746-NO4I and NO4V Analog Output Modules

The NO4I and NO4V Analog Output Modules provide 4 analog output channels. The NO4I module contains four current outputs. The NO4V module contains four voltage outputs. Both of these modules support a variety of monitoring and controlling applications.

Table 1.A

Catalog 1746-	Input Channels per Module	Output Channels per Module	Backplane Current Draw		External 24V dc Power Supply Tolerance
			5V (max.)	24V (max.)	
NI4	4 differential, voltage or current selectable per channel, not individually isolated	NA	35 mA	85 mA	NA
NIO4I	2 differential, voltage or current selectable per channel, not individually isolated	2 current outputs, not individually isolated	55 mA	145 mA	NA
NIO4V	2 differential, voltage or current selectable per channel, not individually isolated	2 voltage outputs, not individually isolated	55 mA	115 mA	NA
NO4I	NA	4 current outputs, not individually isolated	55 mA	195 mA	24 $\pm$ 10% at 195 mA max. (21.6 to 26.4V dc) <sup>①</sup>
NO4V	NA	4 voltage outputs, not individually isolated	55 mA	145 mA	24 $\pm$ 10% at 145 mA max. (21.6 to 26.4V dc) <sup>①</sup>

<sup>①</sup> Required for some applications if SLC 24V power is at a premium.

For more specification information, refer to Appendix A.

## Quick Start for Experienced Users

This chapter can help you to get started using analog. We base the procedures here on the assumption that you have an understanding of SLC 500 products. You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application.

Because it is a start-up guide for experienced users, this chapter *does not* contain detailed explanations about the procedures listed. It does, however, reference other chapters in this book where you can get more information.

If you have any questions or are unfamiliar with the terms used or concepts presented in the procedural steps, *always read the referenced chapters* and other recommended documentation before trying to apply the information.

This chapter:

- tells you what tools and equipment you need
- lists preliminary considerations
- describes when to configure the module
- explains how to install and wire the module
- discusses system power-up procedures

### Required Tools and Equipment

Have the following tools and equipment ready:

- small blade screwdriver
- an adequate length of communication cable (Belden 8761) for your specific application. (See chapter 3, Installing and Wiring Your Analog Module for maximum cable distances.)
- programming equipment

## Procedures

<b>1.</b>	<b>Check the contents of shipping box.</b>	<b>Reference</b>
-----------	--	------------------

Unpack the shipping box making sure that the contents include:

- Analog I/O module (Catalog Number 1746- Series)
- user manual (Publication 1746-6.4)

If the contents are incomplete, call your local Allen-Bradley representative for assistance.

<b>2.</b>	<b>Determine your power requirements for the modular controller.</b>	<b>Reference</b>
-----------	--	------------------

Review the power requirements of your system to see that your chassis supports placement of the analog module.

- For modular style systems, calculate the total load on the system power supply using the procedure described in the SLC Installation & Operation Manual for modular style controllers (Publication Number 1747-6.2) or the SLC 500 Family System Overview (Publication Number 1747-2.30).
- For fixed SLC 500 controllers, refer to table 3.B on page 3-3.

**Chapter 3**  
*(Installing and  
Wiring Your  
Analog Module)*

**Appendix A**  
*(Specifications)*

Catalog Number	Backplane Current Draw		External 24V dc Power Supply Tolerance
	5V (max.)	24V (max.)	
1746-NI4	35 mA	85 mA	NA
1746-NIO4I	55 mA	145 mA	NA
1746-NIO4V	55 mA	115 mA	NA
1746-NO4I	55 mA	195 mA	24 ±10% at 195 mA max. (21.6 to 26.4V dc) <sup>①</sup>
1746-NO4V	55 mA	145 mA	24 ±10% at 145 mA max. (21.6 to 26.4V dc) <sup>①</sup>

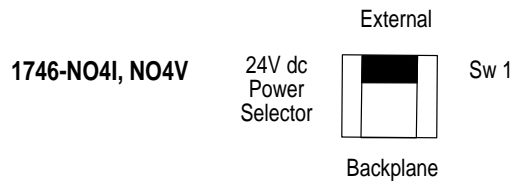
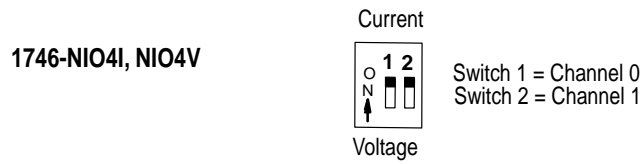
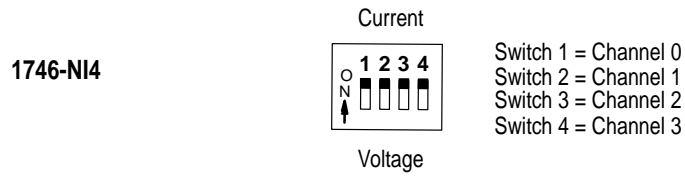
<sup>①</sup> Required for some applications.

<b>3.</b>	<b>Configure the module using the DIP switches (analog inputs only).</b>	<b>Reference</b>
-----------	--	------------------

Each analog input channel can be configured for either voltage or current. Locate the DIP switches on your module and set them for your application.

**Chapter 3**  
*(Installing and Wiring Your Analog Module)*

- ON – Configures channel for current input
- Off – Configures channel for voltage input





**4. Install your module.****Reference**

When selecting a slot for an analog module, position the module:

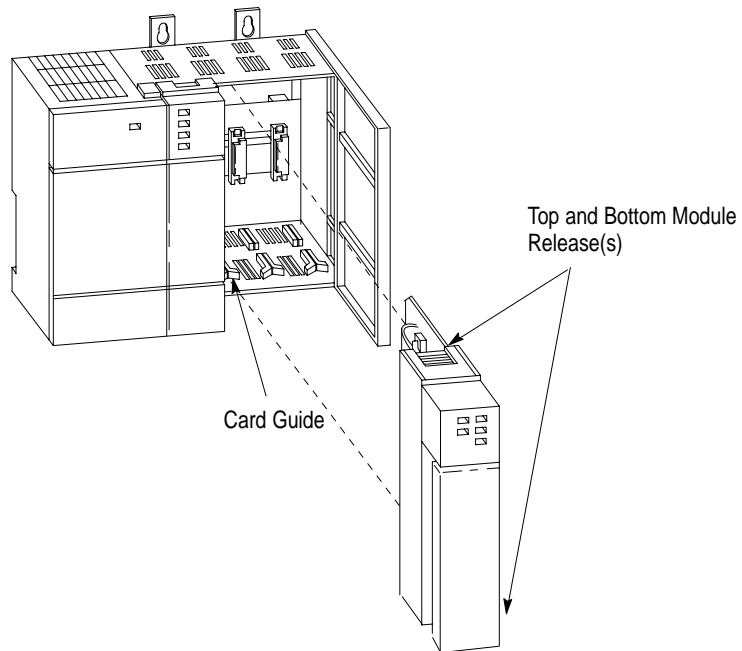
- in a slot away from ac or high voltage dc modules
- in the chassis closest to the bottom of the enclosure where the SLC 500 system is installed
- away from the chassis power supply if installed in a modular system

**Chapter 3**  
*(Installing and  
Wiring Your  
Analog Module)*



**ATTENTION:** Never install, remove, or wire modules with power applied to the chassis or devices wired to the module.

Make sure system power is off; then insert the analog module into your 1746 chassis. In this example procedure, local slot 1 is selected.

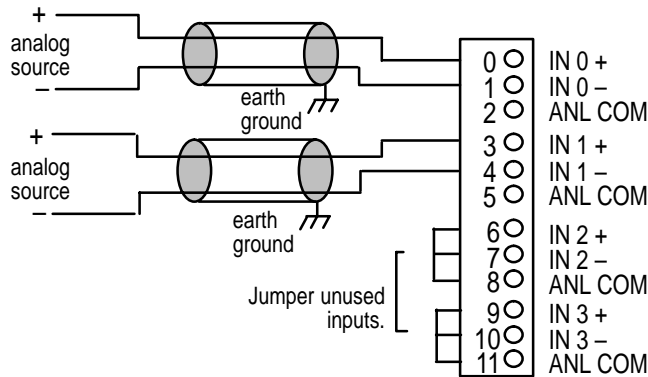


<b>5.</b>	<b>Wire the module.</b>	<b>Reference</b>
-----------	-------------------------	------------------

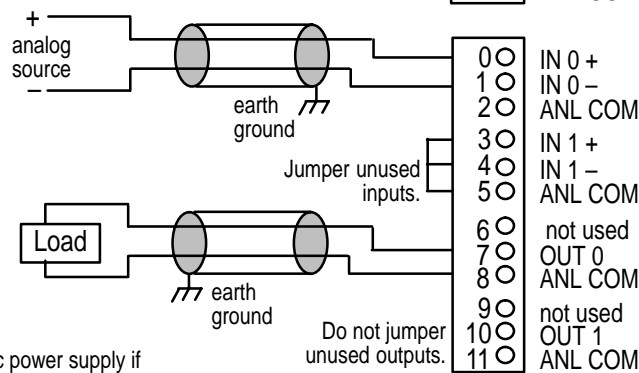
**Chapter 3**  
(Installing and  
Wiring Your  
Analog Module)

- Important:** Follow these guidelines when wiring the module.
- Use shielded communication cable (Belden 8761) and keep length as short as possible.
  - Connect only one end of the cable shield to earth ground.
  - Channels are not isolated from each other. All analog commons are connected together internally.
  - The module does not provide power for analog inputs.
  - Use a power supply that matches the transmitter (sensor) specifications.

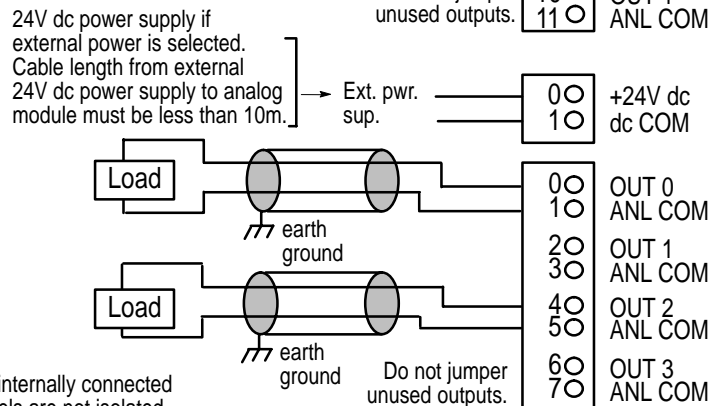
**NI4**



**NIO4I & NIO4V**



**NO4I & NO4V**



Analog commons are internally connected in the module. Channels are not isolated from each other.

**6. Configure system I/O configuration.****Reference**

Configure your system I/O configuration for the particular slot the analog module is in. When assigning an I/O module to a slot location, select the module from the displayed list. If not listed, select *OTHER* at the bottom of the list and enter the module's ID code at the prompt.

**Chapter 4**  
*(Module Operation  
and System  
Considerations)*

Catalog No.	Module ID Code
1746-NI4	4401
1746-NIO4I	3201
1746-NIO4V	3202
1746-NO4I	5401
1746-NO4V	5402

**7. Check that the module is operating correctly.****Reference**

**ATTENTION:** Machine motion during system checkout can be hazardous to personnel. During all checkout procedures, you must disconnect all devices which, when energized, might cause machine motion.

**Chapter 5**  
*(Testing Your  
Module)*

Apply power to the fixed or modular system. The analog module LED (red) should be illuminated, indicating that the module is receiving 24V dc power.

**8. Understanding analog inputs.****Reference**

Analog inputs convert current and voltage signals into 16-bit (max.) integer values and place them in the input image for the slot that the analog module resides in.

**Chapter 4**  
(Module Operation  
and System  
Considerations)

Address	NI4
I:e.0	Input Channel 0
I:e.1	Input Channel 1
I:e.2	Input Channel 2
I:e.3	Input Channel 3

e=slot number

Address	NIO4I, NIO4V
I:e.0	Input Channel 0
I:e.1	Input Channel 1

Voltage/Current Range	Integer Representation
-10V dc to +10V dc	-32,768 to +32,767
0 to 10V dc	0 to 32,767±10V dc
0 to 5V dc	0 to 16,384
1 to 5V dc	3,277 to 16,384
-20 mA to +20 mA	-16,384 to +16,384
0 to 20 mA	0 to 16,384±20 mA
4 to 20 mA	3,277 to 16,384

**9. Understanding analog outputs.****Reference**

Analog outputs convert 16-bit integer values placed in the output image to voltage or current signals for the slot that the analog card is in.

**Chapter 4**  
(Module Operation  
and System  
Considerations)

Address	NO4
O:e.0	Output Channel 0
O:e.1	Output Channel 1
O:e.2	Output Channel 2
O:e.3	Output Channel 3

Address	NIO4I, NIO4V
O:e.0	Output Channel 0
O:e.1	Output Channel 1

NO4I, NIO4I	
Current Range	Decimal Representation for Output Word
0 to 21 mA	0 to 32,764
0 to 20 mA	0 to 31,208
4 to 20 mA	6,242 to 31,208

NO4V, NIO4V	
Voltage Range	Decimal Representation for Output Word
-10 to +10V dc	-32,768 to +32,764
0 to 10V dc	0 to 32,764
0 to 5V dc	0 to 16,384
1 to 5V dc	3,277 to 16,384

**10.****Write ladder logic to process the module's analog data.****Reference**

Several programming examples are provided in chapter 6 that demonstrate how to scale the raw data from the analog card into engineering units such as psi, percent, etc. Study these examples and apply them to your application as appropriate.

**Chapter 5**  
*(Testing Your  
Module)*

**Chapter 6**  
*(Programming  
Examples)*

## Installing and Wiring Your Analog Module

To obtain the maximum performance from an analog module, proper module installation is imperative. This chapter describes the procedures that you must follow to install the analog module in an SLC 500 system. The following items are described:

- European Union Directive Compliance
- determining your power requirements
- configuring your module
- selecting a slot in the chassis
- installing your module
- wiring considerations
  - system wiring guidelines
  - grounding your cable
  - determining the cable length
- wiring the analog module
- minimizing electrical noise on the analog module

### European Union Directive Compliance

If this product is installed within the European Union or EEA regions and has the CE mark, the following regulations apply.

#### EMC Directives

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2  
EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2  
EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

## Determining Your Power Requirements for a Modular Controller

Analog modules require both 5V dc and 24V dc power from the backplane of the SLC 500 system. However, the NO4I and NO4V analog modules can use an external 24V dc power supply. This eliminates the 24V dc backplane power requirement, providing configuration flexibility if SLC power supply loading is critical. These two modules provide user-supplied external 24V dc power supply connections.<sup>①</sup>

The following table shows the power requirements for each analog module using backplane power. Use this table to calculate the total load on the modular system power supply. For more information refer to the Installation & Operation Manual for modular controllers.

**Important:** The analog modules do not supply loop power for the input device. You must supply the appropriate loop power for loop-powered input devices.

**Table 3.A**

Catalog Number	5 Volt Current	24 Volt Current
1746-NI4	35 mA	85 mA
1746-NIO4I	55 mA	145 mA
1746-NIO4V	55 mA	115 mA
1746-NO4I	55 mA	195 mA <sup>②</sup>
1746-NO4V	55 mA	145 mA <sup>②</sup>

<sup>①</sup> The 24V dc user power connection on a fixed SLC 500 can power an NO4I or NO4V analog module. However, the regulation of the 24V dc user connection on a modular SLC 500 power supply, Catalog Number 1746-P1, -P2, -P4 is outside of the requirements of the NO4I and NO4V analog modules and cannot be used.

<sup>②</sup> Omit these values from your SLC power supply loading calculations if you decide to use an external power supply.

## Determining Your Power Requirements for a Fixed Controller

The following chart provides available analog module combinations in the expansion chassis of a fixed controller.

Table 3.B

NI4	NIO4I	NIO4V	NO4I	NO4V	
•	•	•	–	•	IA4
•	•	•	∇	•	IA8
•	•	•	∇	•	IA16
•	•	•	∇	•	IM4
•	•	•	∇	•	IM8
•	•	•	∇	•	IM16
•	•	•	∇	•	OA8
			∇	∇	OA16
			∇	∇	OAP12
•	•	•	∇	•	IB8
•	•	•	∇	•	IB16
•	•	•	∇	•	IV8
•	•	•	∇	•	IV16
•	•	•	∇	•	IG16
•	•	•	∇	•	OV8
•		•	∇	∇	OV16
•	•	•	∇	•	OB8
•	•	•	∇	•	OG16
•		•	∇	∇	OW4
•			∇	∇	OW8
			∇	∇	OW16
•	•	•	∇	•	IO4
•		•	∇	∇	IO8
•			∇	∇	IO12
•			∇	∇	NI4
			∇	∇	NIO4I
			∇	∇	NIO4V
			∇	∇	DCM
•			∇	∇	HS
•			∇	∇	OB16
•	•	•	∇	•	IN16
			∇	∇	BASIC net
•		•	∇	∇	BASIC
					OB32
					OV32
•	•	•	∇	•	IV32
•	•	•	∇	•	IB32
•			∇	∇	OX8
∇	∇	∇	∇	∇	NO4I
∇	∇	∇	∇	∇	NO4V
•	•	•	∇	•	ITB16
•	•	•	∇	•	ITV16
•	•	•	∇	•	IC16
•		•	∇	∇	OBP16
•		•	∇	∇	OVP16
•	•	•	∇	•	NT4
•	•	•	∇	•	NR4

• valid combination

∇ invalid combination

∇ valid combination when used with external power supply

BASIC net = Basic Module is supplying power to an AIC. No other device requiring power is connected to the AIC.



**Important:** The NO4I and NO4V modules provide user supplied external 24V dc power supply connections. When the NO4I module is used in a fixed controller, you must provide an external power supply.



When the NO4I or NO4V is used with an external 24V dc power supply and is placed in a fixed controller expansion chassis, it is compatible with those modules noted in the compatibility chart on the previous page.<sup>①</sup> When set for external power, the module will only draw the 5V current off the backplane. Refer to the next section for details on how to configure your module for external power.

<sup>①</sup> The 24V dc user power connection on a fixed SLC 500 can power an NO4I or NO4V analog module. However, the regulation of the 24V dc user connection on a modular SLC 500 power supply, Catalog Number 1746-P1, -P2, and -P4 is outside of the requirements of the NO4I and NO4V analog modules and cannot be used.

## Configuring Your Module

The NI4, NIO4I and NIO4V analog modules have user selectable DIP switch settings which allow you to configure the input channels as either current or voltage inputs. The switches are located on the analog module board. The following illustration shows the ON and OFF switch settings. Switch orientation is also provided on the nameplate of the module.

Figure 3.1

-  ON – Configures channel for current input
-  OFF – Configures channel for voltage input

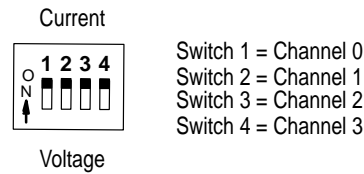


**ATTENTION:** Care should be taken to avoid connecting a voltage source to a channel configured for current input. Improper module operation or damage to the module can occur.

### Switch Settings for the 1746-NI4

The NI4 has 4 individual DIP switches that control the input mode of input channels 0 through 3. A switch in the ON position configures the channel for current input. A switch in the OFF position configures the channel for voltage input.

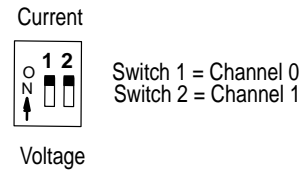
Figure 3.2



### Switch Settings for the 1746-NIO4I and -NIO4V

The NIO4I and NIO4V have 2 individual switches labeled 1 and 2. These switches control the input mode of input channel 0 and 1. A switch in the ON position configures the channel for current input. A switch in the OFF position configures the channel for voltage input.

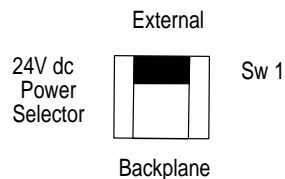
Figure 3.3



### External Power Switch for the 1746-NO4I and -NO4V

The NO4I and NO4V analog output modules have an external 24V dc power switch, SW1, which gives you the option of using an external power supply.<sup>①</sup> In the UP position, power is drawn from an external power source. In the DOWN position, power is drawn from the backplane of the module. The switch is located on the analog module board. Switch orientation is also provided on the nameplate of the module.

Figure 3.4



<sup>①</sup> The 24V dc user power connection on a fixed SLC 500 can power an NO4I or NO4V analog module. However, the regulation of the 24V dc user connection on a modular SLC 500 power supply, Catalog Number 1746-P1, -P2, is outside of the requirements of the NO4I and NO4V analog modules and cannot be used.

## Choosing a Slot in the Chassis

Two factors determine where the analog module should be located in the chassis: ambient temperature and electrical noise. Consider the following conditions when selecting a slot for an analog module.

Position the module:

- in a slot away from ac or high voltage dc module
- in the chassis closest to the bottom of the enclosure where the SLC 500 system is installed
- away from the chassis power supply if installed in a modular system

## Installing Your Module

All modules are mounted in a single slot. Remember that in a modular system the processor always occupies the first slot of the first chassis.

When installing the analog module in a chassis, it is not necessary to remove the terminal block from the module. However, if the terminal block is removed, use the write-on label located on the side of the terminal block to identify the module location and type.

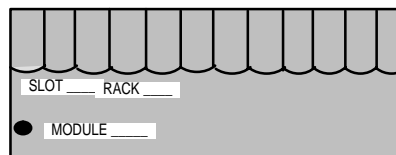


**ATTENTION:** Never install, remove, or wire modules with power applied to the chassis. Also, do not expose analog modules to surfaces or other areas that may typically hold an electrostatic charge. Electrostatic charges can destroy the analog circuitry.

---

**Figure 3.5**

### Terminal Block



### Removing the Analog Module Terminal Block

To remove the terminal block, grasp it on the top and bottom and pull outward and down.

**Important:** The potentiometer sets the voltage during factory calibration to 2.5 volts. It is set and sealed at the factory and does not require any adjustments.

1. Verify that all switches are set correctly for the application.

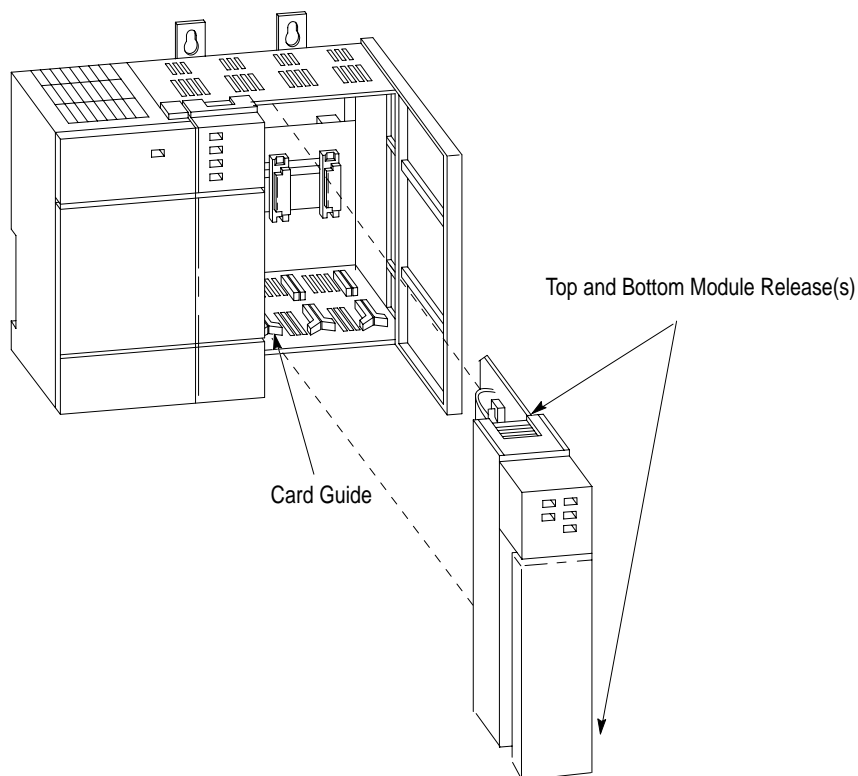


**ATTENTION:** Care should be taken to avoid connecting a voltage source to a channel configured for a current input.

---

2. Align the circuit board of the analog module with the card guide of the chassis (Figure 3.6).
3. Slide the module in until both top and bottom retaining clips are secured.
4. To remove the module, depress the retaining clips at the top and bottom of the module and slide the module out.

Figure 3.6



## Wiring Considerations

The following section provides system wiring guidelines, how to ground your Belden cable, and how to determine the cable length.



**ATTENTION:** Before wiring any analog module, disconnect power from the SLC 500 system and from any other source to the analog module.

---

### System Wiring Guidelines

Use the following guidelines in planning the system wiring for the analog modules:

- all analog common terminals (ANL COM) are electrically connected inside the module. ANL COM is *not* connected to earth ground inside the module.
- voltages on IN+ and IN- terminals must remain within  $\pm 20$  Volts with respect to ANL COM to ensure proper input channel operation. This is true for current and voltage input channel operation.
- voltage outputs (OUT 0 and OUT 1) of the NIO4V and NO4V are referenced to ANL COM. Load resistance (R1) for a voltage output channel must be equal to or greater than 1K ohms.
- current output channels (OUT 0 and OUT 1) of the NIO4I and NO4I source current that returns to ANL COM. Load resistance (R1) for a current output channel must remain between 0 and 500 ohms.

### Grounding Your Cable

Belden cable #8761 has two signal wires (black and clear), one drain wire and a foil shield. Refer to Figure 3.7. The drain wire and foil shield must be grounded at one end of the cable. *Do not* earth ground the drain wire and foil shield at *both* ends of the cable.

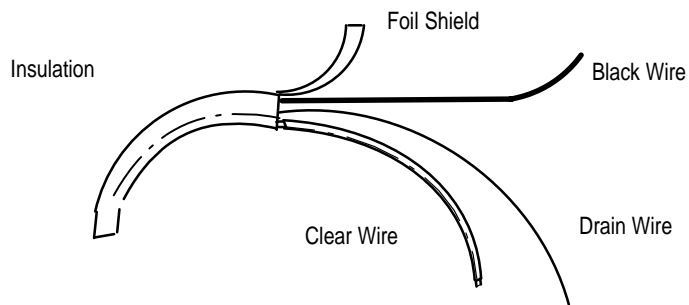
**Input Channel** – Use a chassis mounting tab as a ground for the drain wire and foil shield.

**Output Channel** – Ground the drain wire and foil shield at the analog load.

**Important:** If you cannot ground the output channel at the load, ground the drain wire and foil shield at the chassis mounting tab. *Do not* connect the foil shield or drain wire to the analog terminal block. They *must be* connected to an earth ground, which is not provided at the analog module.

Figure 3.7

Belden Cable #8761



### Determining the Cable Length

Determine the length of cable you will need to connect a channel to its input or output device. Remember to leave additional length to route the drain wire and foil shield for earth grounding.

## Wiring the Analog Module

After the analog module is properly installed in the chassis, use the following wiring procedure. Belden cable #8761 is recommended when wiring analog modules. This section assumes that you have properly installed the analog module.



**ATTENTION:** Before wiring any analog module, disconnect power from the SLC 500 system and from any other source to the analog module.

To wire your analog module follow these steps and refer to Figures 3.8 and 3.9.

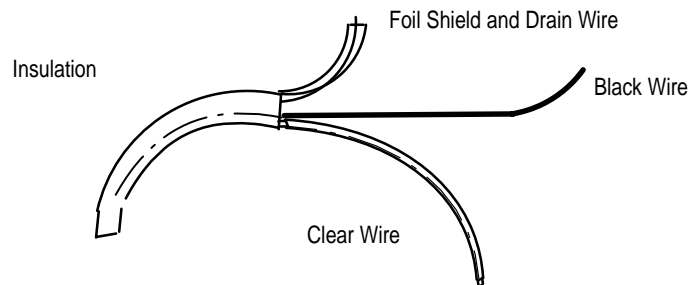
1. Designate the end of the cable where the drain wire and foil shield is earth grounded as END 1. Designate the other end as END 2.
2. At each end of the cable strip some casing to expose the individual wires.
3. Trim the signal wires to 2 inch lengths. Strip about 3/16 inch (4.76mm) of insulation away to expose the end of the wire.
4. At End 1, twist the drain wire and foil shield together, bend them away from the cable, and apply shrink wrap.
5. At End 2, cut the drain wire and foil shield back to the cable and apply shrink wrap.
6. Connect the signal wires (black and clear) to the terminal block and the input and output devices. The recommended maximum torque is 5 lb.-in (0.565 NM) for all terminals.
  - If the foil shield and drain wire of the channel are grounded at the sourcing device, make sure End 2 of the cable is connected to the terminal block.
  - If the foil shield and drain wire are grounded at the chassis mounting tab, make sure End 1 is connected to the terminal block.
7. Repeat steps 1 through 6 for each channel on the analog module. Jumper the unused plus (+), minus (-) and common terminals of each input channel individually. Unused output and common terminals should be left unconnected.

Figures 3.8 and 3.9 depict the proper cable preparation for END 1 and END 2. Shrink wrap is applied to each cable end. Make sure the foil shield and drain wires on END 1 are long enough to reach their designated earth ground points.

**Figure 3.8**

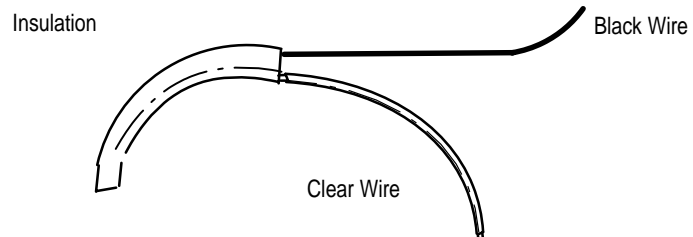
**Cable Preparation**

**END 1**



**Figure 3.9**

**END 2**



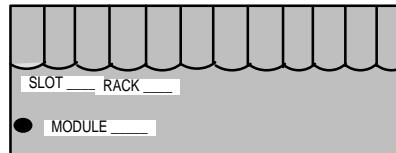


## Labeling and Installing the Terminal Block

The terminal block has a write-on label. Labeling the terminal block will help ensure that it is installed on the correct module.

**Figure 3.10**

### Terminal Block



Note: The black dot on the terminal block label indicates the position of terminal 0.

Once you have wired your analog module and properly labeled the terminal block, install the terminal block on the analog module. To install the terminal block:

1. Align the terminal block with the receptacle.
2. Insert the terminal block and press firmly at the top and bottom until it is properly secured.

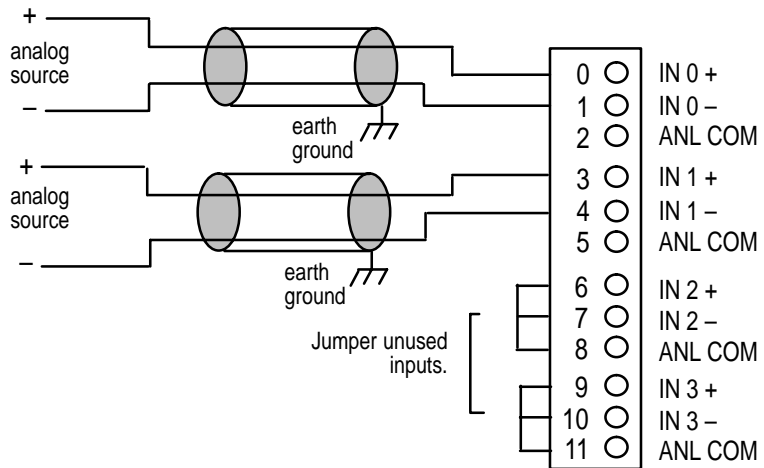
## Grounding the Foil Shields and Drain Wires

You are now ready to earth ground your foil shield and drain wire from each cable. Do not connect the foil shield or drain wire to the analog module terminal block. The foil shield and drain wire *must be* connected to earth ground, which is not available on the terminal block. Refer to Figure 3.11 for wiring diagrams of the analog modules.

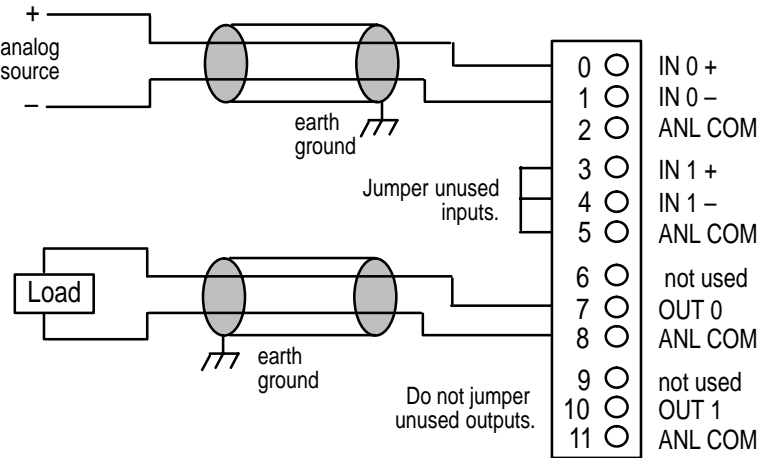
Figure 3.11

**Wiring Diagram  
(showing differential inputs)**

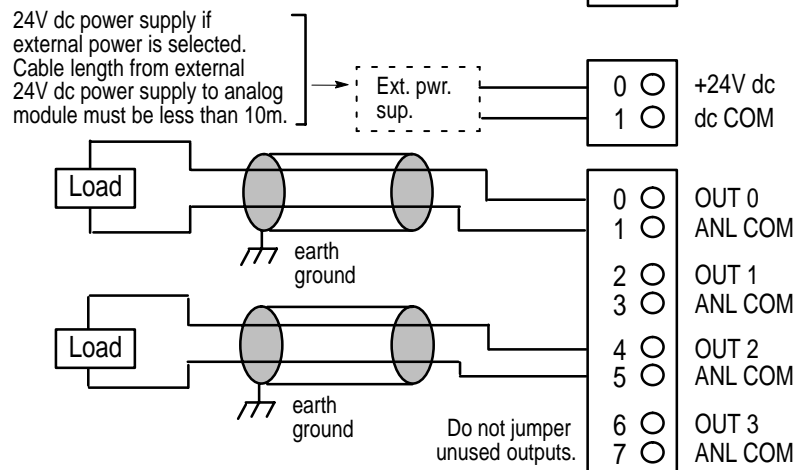
**NI4**



**NIO4I & NIO4V**



**NO4I & NO4V**



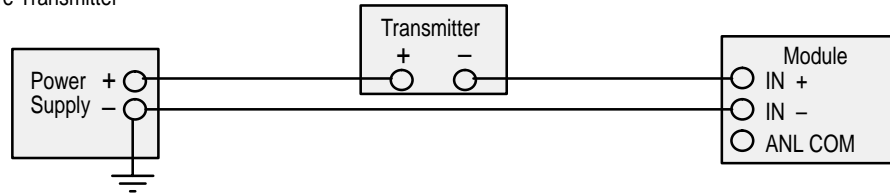
Analog commons are internally connected in the module. Channels are not isolated from each other.

Figure 3.12

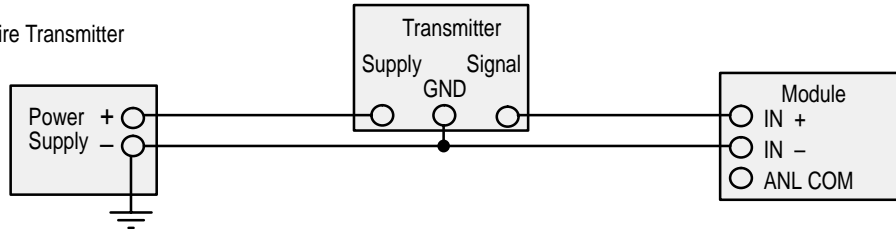
Wiring Schematics for 2, 3, and 4-Wire Analog Input Devices

**Important:** The module does *not* provide loop power for analog inputs.  
Use a power supply that matches the transmitter specifications.

2-Wire Transmitter



3-Wire Transmitter



4-Wire Transmitter

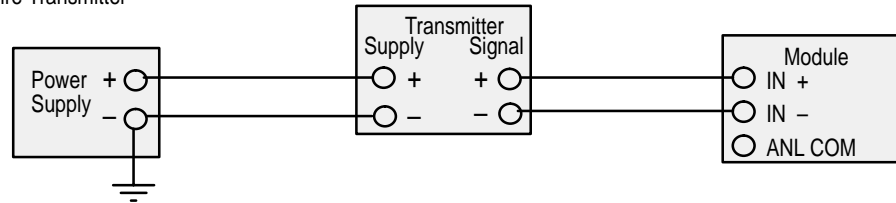
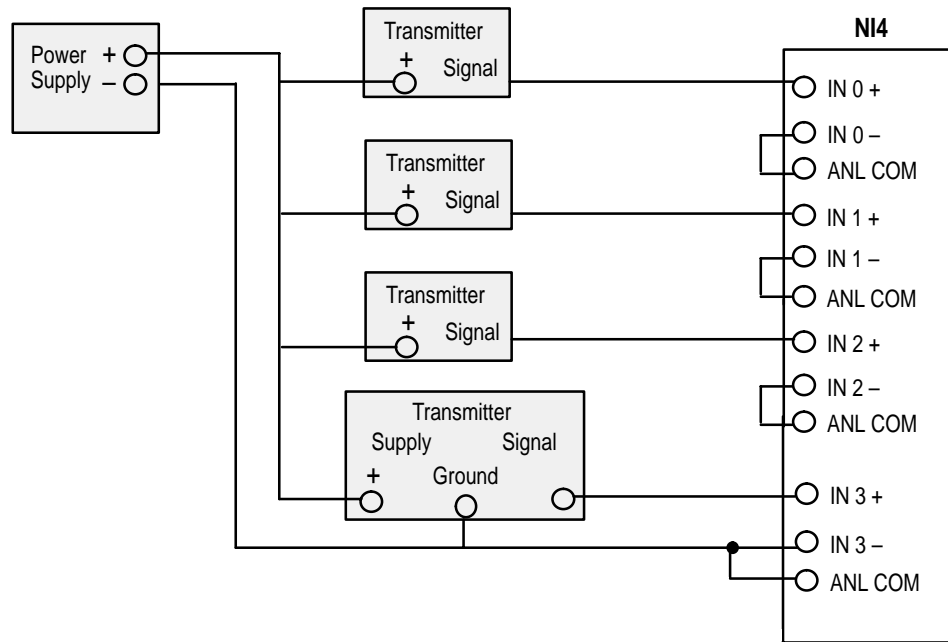


Figure 3.13

Wiring Schematic for Single-ended Analog Input Connections

When wiring single-ended analog input devices to the analog input card, the number of total wires necessary can be limited by using the ANALOG COMMON terminal. Note that differential inputs are more immune to noise than single-ended inputs.



## Minimizing Electrical Noise on Analog Modules

Inputs on analog modules employ digital high frequency filters that significantly reduce the effects of electrical noise on input signals. However, because of the variety of applications and environments where analog modules are installed and operating, it is impossible to ensure that all environmental noise will be removed by the input filters.

Although it is not the purpose of this manual to address SLC 500 system procedures, several specific steps can be taken to help reduce the effects of environmental noise on analog signals:

- install the SLC 500 system in a properly rated (i.e., NEMA) enclosure. Make sure that the SLC 500 system is properly grounded.
- use Belden cable #8761 for wiring the analog modules making sure that the drain wire and foil shield are properly earth grounded.
- route the Belden cable separate from any other wiring. Additional noise immunity can be obtained by routing the cables in grounded conduit.
- group analog and low voltage dc modules away from ac I/O or high voltage dc modules.

A system may malfunction due to a change in the operating environment after a period of time. We recommend periodically checking system operation, particularly when new machinery or other noise sources are installed near the SLC 500 system. For further details on system installation and startup refer to:

- Modular Hardware Style Installation & Operation Manual
- Fixed Hardware Style Installation & Operation Manual
- Safety Guidelines for the Application, Installation Maintenance of Solid State Control – A-B Publication SGI-1.1.

## Module Operation and System Considerations

After successfully installing your analog module, consider its operation within the SLC 500 system and in a specific application. This chapter describes:

### Interface between the Module and Processor

- entering module ID codes
- addressing analog modules
- processor update of analog data
- monitoring the input and output data
- converting analog inputs
- converting analog outputs

### System Considerations

- safe state for outputs
- retentive programming
- input out-of-range detection
- response to slot disable
- input channel filtering

## Interface between the Module and the Processor

This section describes how to set up an analog module in a SLC 500 system.

### Entering Module ID Codes

When configuring an analog module for an SLC 500 system using your programming software, a list of the different I/O modules, including the analog modules, is most likely provided for you. If a list is not provided, you need to enter the module identification code when configuring the slot. Refer to the table below for the appropriate analog module ID code.

Using the Hand-Held Terminal (HHT) firmware v1.1, enter the proper MODULE ID CODE under the “other” selection. Version 2.0 or later of the HHT firmware provides a list of I/O modules. Refer to the following publications for complete information:

- your programming software’s user manual
- the Hand-Held Terminal User Manual

Table 4.A

Catalog No.	Module ID Code
1746-NI4	4401
1746-NIO4I	3201
1746-NIO4V	3202
1746-NO4I	5401
1746-NO4V	5402

### Addressing Analog Modules

**NI4** – Each input channel of the NI4 is addressed as a single word in the input image table. The NI4 uses a total of 4 words in the input image table. The converted values from channels 0 through 3 are addressed as input words 0 through 3 respectively for the slot where the module resides.

**Example** – If you want to address input channel 2 of the NI4 in slot 4, you would address it as input word 2 in slot 4 (I:4.2).

**NIO4I and NIO4V** – Each input channel of the NIO4I and NIO4V is addressed as a single word in the input image table and each output channel of the module is addressed as a single word in the output image table. Both the NIO4I and NIO4V use a total of 2 input words and 2 output words.

The converted input values from input channels 0 and 1 are addressed as words 0 and 1 of the slot where the module resides. The output values for the output channels 0 and 1 are addressed as output words 0 and 1 of the slot where the module resides.

**Example** – If you want to address output channel 0 of the NIO4I in slot 3, you would address it as output word 0 in slot 3 (O:3.0).

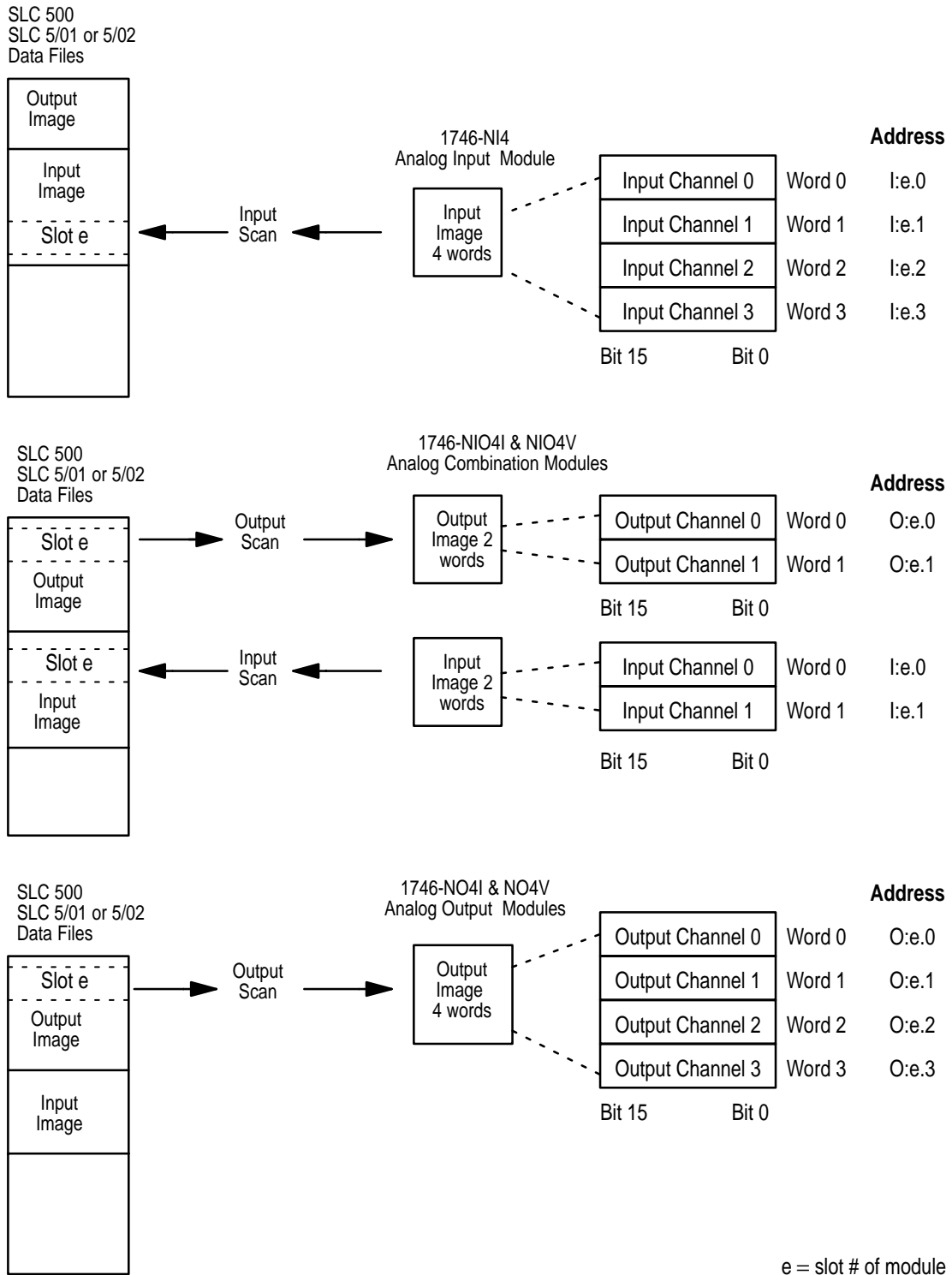
**NO4I and NO4V** – Each output channel of the NO4I and NO4V is addressed as a single word in the output image table. Both modules use a total of 4 output words. The converted output values from output channels 0 through 3 are addressed as words 0 through 3 respectively for the slot where the module resides.

**Example** – If you want to address output channel 3 of the NO4I in slot 3, you would address it as output word 3 in slot 3 (O:3.3).



Figure 4.1 shows I/O addressing for the analog modules.

**Figure 4.1**  
**Addressing your Module**



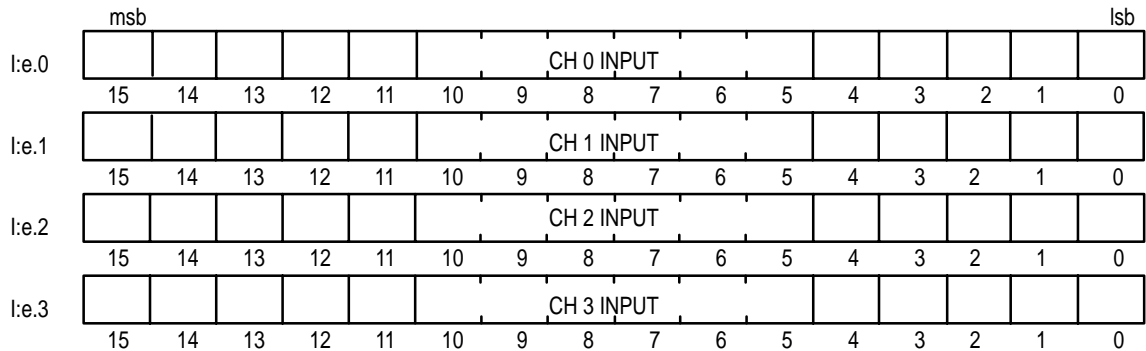
### Bit Level Addressing

The following bit maps show bit level addressing for the analog inputs and outputs. The input channel converter resolution is 16 bits, or 1 word. The output channel converter resolution is 14 bits and is loaded from the most significant 14 bits of the associated output word.

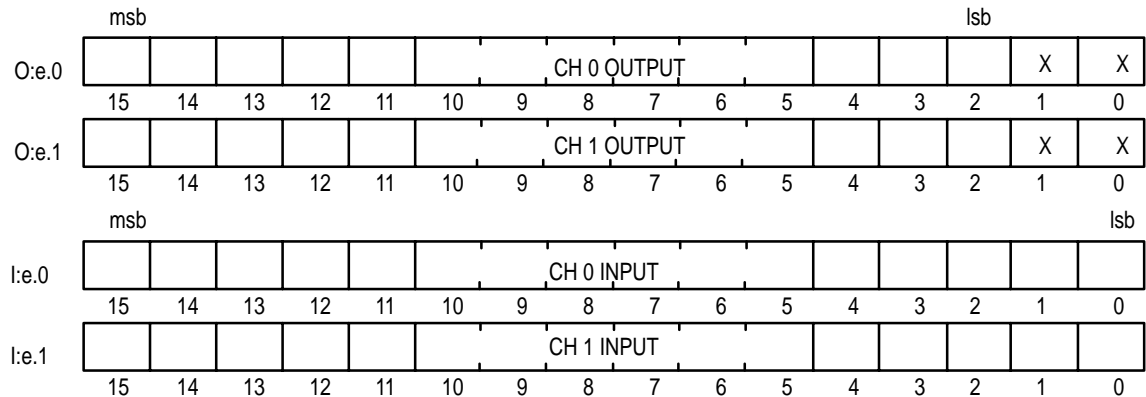
The two least significant bits (O:e.0/0 and O:e.0/1) of the output word have no effect on the actual output value.

Figure 4.2

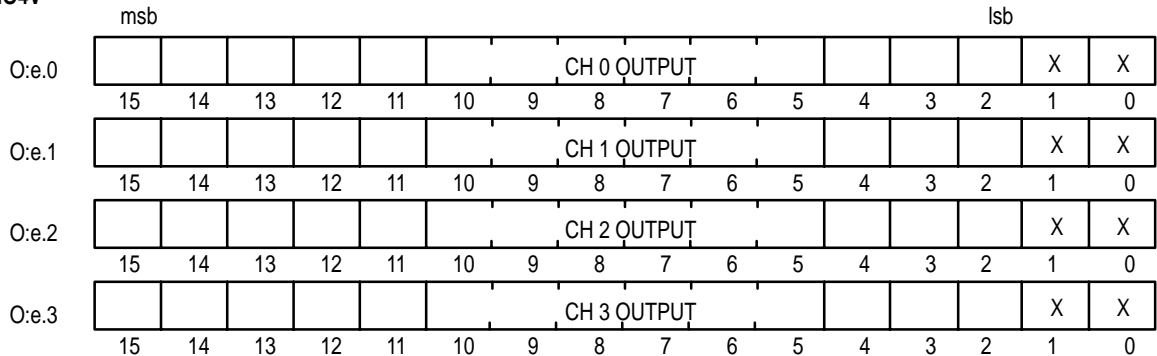
1746-NI4



1746-NIO4I & NIO4V



1746-NO4I & NO4V



e = slot # of module  
 x = bit not used

### Processor Update of Analog Data

The analog input and output data is updated by the processor once during each scan of the user program. The table below shows typical analog update scan times and the number of input and output bits for the specified modules.

If an application requires processor updates of the analog data more frequently than once per scan, use an Immediate Input or an Immediate Output instruction. An Immediate Input or Output instruction typically updates 16 bits (or 1 analog channel) in 1 millisecond.

Refer to your programming software's user manual or Hand-Held Terminal User Manual for more information.

**Table 4.B**

Typical Time for Analog Data Updates to the Processor's Input and Output Image	
Once per processor scan (Automatic)	10 milliseconds for typical 1K program
Using immediate Input or Output Instruction	1 millisecond per analog channel

**Table 4.C**

Number of Input and Output Bits Representing Analog Data		
Description	Input Bits	Output Bits
NI4	64	–
NI4OI and NIO4V (2 input and 2 Output channels)	32	32
NO4I and NO4V	–	64

### Monitoring the Input and Output Data

The analog input and output data can be monitored in several different radices using your programming software. Viewing the radix as decimal allows the analog input and output data to be viewed as decimal representations of integer words.

When monitoring in binary radix, data is viewed in two's complement representation for negative values. A description of two's complement data is available in Appendix B.

If you are using the Hand-Held Terminal (HHT) or the Data Table Access Module (DTAM) to monitor input and output data, the binary radix is the only available option. To view the analog input and output data in decimal radix, the data must be moved to an integer data file.

## Converting Analog Input Data

Analog inputs convert current and voltage signals into 16 bit two's complement binary values.

The table below identifies the current and voltage input ranges for the input channels, the number of significant bits for the applications using input ranges less than full scale, and their resolution

Table 4.D

Voltage/Current Range	Decimal Representation	Number of Significant Bits	Resolution per LSB
-10V dc to +10V dc - 1LSB	-32,768 to +32,767	16 bits	305.176 $\mu$ V
0 to 10V dc - 1LSB	0 to 32,767	15 bits	
0 to 5V dc	0 to 16,384	14 bits	
1 to 5V dc	3,277 to 16,384	13.67 bits	
-20 mA to +20 mA	-16,384 to +16,384	15 bits	1.22070 $\mu$ A
0 to +20 mA	0 to 16,384	14 bits	
4 to +20 mA	3,277 to 16,384	13.67 bits	

To determine an approximate voltage that an input value represents, use one of the following equations:

$$\frac{10V}{32,768} \times \text{input value}^{\textcircled{1}} = \text{input voltage(V)}$$

<sup>①</sup>The Input Value is the decimal value of the word in the input image for the corresponding analog input.

For example, if an input value of -16,021 is in the input image, the calculated input voltage is:

$$\frac{10V}{32,768} \times -16,201 = -4.889221(V)$$

It should be noted that this is the calculated value. The actual value may vary within the accuracy limitations of the module.

To determine an approximate current that an input value represents, you can use the following equation:

$$\frac{20 \text{ mA}}{16,384} \times \text{input value}^{\textcircled{2}} = \text{input current (mA)}$$

<sup>②</sup>The Input Value is the decimal value of the word in the input image for the corresponding analog input.

For example, if an input value of 4096 is in the input image, the calculated input current is:

$$\frac{20 \text{ mA}}{16,384} \times 4096 = 5(\text{mA})$$

It should be noted that this is the calculated value. The actual value may vary within the accuracy limitations of the module.

### Converting Analog Output Data

Analog outputs convert a 16 bit two's complement binary value into an analog output signal. Because the analog output channels have a 14 bit converter, the 14 most significant bits of this 16 bit number are the bits that the output channel converts.

The NIO4I and NO4I support two and four current outputs respectively, ranging from 0 mA to a maximum of 21 mA. The NIO4V and NO4V support two and four voltage outputs respectively, ranging from -10 to +10 Volts dc.

The following tables identify the current and voltage output ranges for the output channels, the number of significant bits for the applications using output ranges less than full scale, and their resolution.

**Table 4.E Analog Output Conversion NIO4I and NO4I**

Current Range	Decimal Representation for Output Word	Number of Significant Bits	Resolution per LSB
0 to 21 mA - 1LSB	0 to +32,764	13 bits	2.56348 $\mu$ A
0 to +20 mA	0 to +31,208	12.92 bits	
4 to +20 mA	6,242 to +31,208	12.6 bits	

**Table 4.F Analog Output Conversion NIO4V and NO4V**

Voltage Range	Decimal Representation for Output Word	Number of Significant Bits	Resolution per LSB
-10 to +10V dc - 1LSB	-32,768 to +32,764	14 bits	1.22070 mV
0 to +10V dc - 1LSB	0 to +32,764	13 bits	
0 to 5V dc	0 to +16,384	12 bits	
1 to 5V dc	+3,277 to +16,384	11.67 bits	

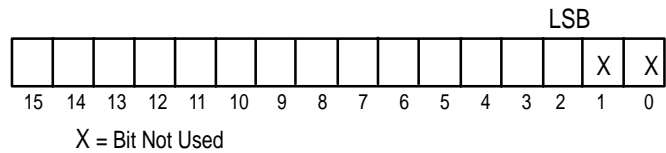
Use the following equation to determine the decimal value for the current output:

$$\frac{32,768}{21 \text{ mA}} \times \text{Desired Current Output (mA)} = \text{Output Decimal Value}$$

For example, if an output value of 4 mA is desired, the value to be put in the corresponding word in the output image can be calculated as follows:

$$\frac{32,768}{21 \text{ mA}} \times 4 \text{ mA} = 6242$$

Note: The actual resolution for analog current outputs is 2.56348  $\mu\text{A}$  per LSB, where the LSB position in the output word is indicated as:



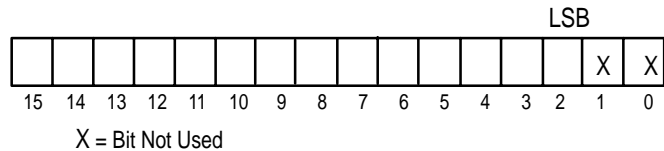
Use the following equation to determine the decimal value for the voltage output:

$$\frac{32,768}{10\text{V dc}} \times \text{Desired Voltage Output (V dc)} = \text{Output Decimal Value}$$

For example, if an output value of 1V dc is desired, the value to be put in the corresponding word in the output image can be calculated as follows:

$$\frac{32,768}{10\text{V dc}} \times 1\text{V dc} = 3277$$

Note: The actual resolution for analog voltage outputs is 1.22070 mV per LSB, where the LSB position in the output word is indicated as:



## System Considerations

This section describes the system considerations for an analog module. These include:

- safe state for outputs
- retentive programming
- input out-of-range detection
- response to slot disable
- input channel filtering

### Safe State for Outputs

Whenever an SLC 500 system is NOT in the RUN mode, the outputs on the analog module are automatically forced to 0 Volts or 0 milliamps by the SLC 500 system. This occurs when the processor is in the:

- FAULT mode
- PROGRAM mode
- TEST mode



**ATTENTION:** When designing and installing the SLC 500 system, devices connected to the analog module output channels must be placed into a safe state whenever the analog output is 0 volts or 0 milliamps ( $\pm$  the offset error).

---

### Retentive Programming Option

This section describes the affects of a processor mode change on analog outputs. The following information applies to the 1746-NIO4I, NIO4V, NO4I and NO4V analog modules.

This programming option allows you to retain analog data in the Input and Output Image tables when the SLC 500 processor:

- transitions from RUN-PROGRAM-RUN mode OR
- when power is turned OFF and reapplied

In both cases, when power is reapplied, the data is transferred to the module whether the programming rung is true or false.

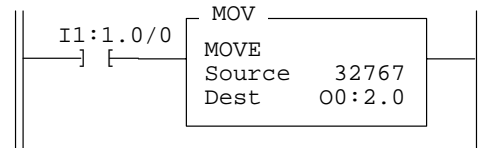
If an SLC 500 system detects a fault condition, the analog outputs reset to zero. The data in the Output Image table is retained during the fault. Once the fault condition is corrected and the major fault bit in the processor is cleared, the retained data is sent to the analog output channels.

If you choose not to use the retentive programming option, retained data is not sent to the output channels.

The following section provides example program options for retentive data and non-retentive data.

### Retentive Analog Output Example

If a modular system is configured with the CPU in slot 0, a discrete I/O module in slot 1, and an analog output module in slot 2 the following ladder logic rung can be programmed.

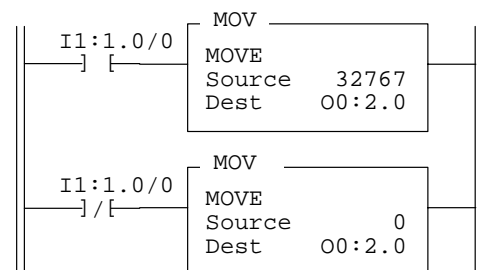


When bit 0 of the discrete I/O module turns ON, the rung is true and the value 32767 is moved into the Output Image table location that corresponds with analog output channel 0 in slot 2. At the end of the scan, this value is transferred to the module where it is converted to the appropriate voltage or current (depending on the type of module used).

If on the next program scan the rung becomes false, the MOVE of the value of 32767 to the Output Image table does not occur. Unless another rung is added to transfer data to the Output Image based on this rung being false, the previous data is retained. That is, the value 32767 remains in the Output Image table and is transferred to the analog module at the end of subsequent program scans until changed by the user program.

### Non-Retentive Analog Output Example

The following example shows a non-retentive program during a program execution and for a mode change or power cycle.

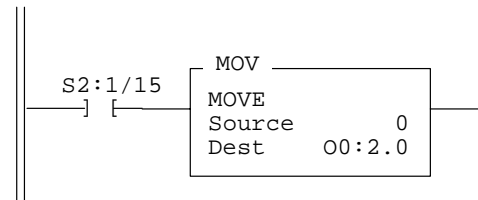




In the above example, as long as discrete input 0 is ON, the value 32767 is transferred to analog output channel 0. If discrete input 0 turns OFF, the value 0 is transferred to analog output channel 0.

### During a Mode Change or Power Cycle

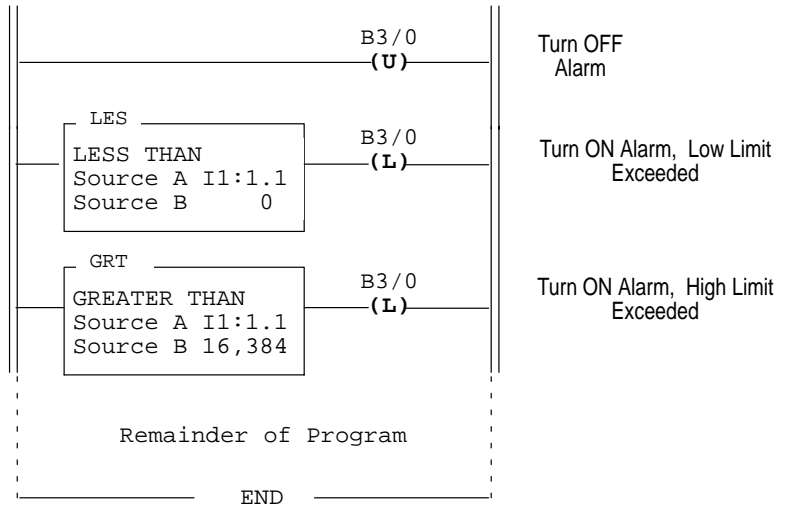
The first pass bit in the Status File is used to initialize the analog output following a power up in the RUN mode or entry into the RUN or TEST mode. The address of the First Pass bit is S2:1/15. When this bit is ON, the first pass of the program scan is taking place. Therefore, the following ladder rung can be programmed to always clear the analog output channel during the first program scan.



### Input Out-of-Range Detection

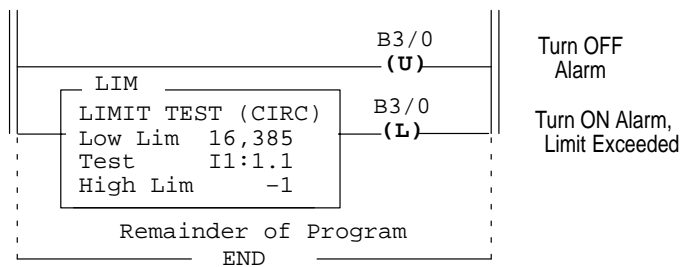
Analog modules do not provide an input out-of-range signal to the processor. However, if this feature is critical to a specific application, you can program the processor to provide this function.

The following program applies to all SLC 500 processors. The program shows two compare instructions that check for analog input values which exceed low and high limits respectively. For this example, the analog input value is in word 1 of slot 1 (I1:1.1). Whenever the input value exceeds a limit, this program latches a binary variable in memory that could serve as an alarm indication at some other point in the program.



The second program is for SLC 5/02 processors. This program uses the Limit Test instruction that checks both low and high limits in a single instruction. This instruction assumes that the analog input value is in word 1 of slot 1 (I1:1.1).

As in the above program, whenever the input value exceeds a limit, this program latches a binary variable in memory which could serve as an alarm indication at some other point in the program.



### Response to Slot Disable

You have the ability to disable any slot in the chassis using the processor. Before disabling any slot containing an analog module, it is important to consider how the analog module will respond when the slot is disabled.



**ATTENTION:** Make sure that the implications of disabling an analog module slot are clearly understood before utilizing this feature.

---

The response to slot disable for inputs and outputs is the same for all the analog modules.

### Input Response to Slot Disable

The module continues to update the input values to the processor. However, the processor does not read inputs from a module that is disabled. Therefore, when the processor disables the analog module slot, the module inputs appearing in the processor image table remain in their last state. When the processor re-enables the analog module slot, the current state of the module inputs are received by the processor during the subsequent scan.

### Output Response to Slot Disable

The processor may change the analog module output data as it appears in the processor image table. However, this data is not transferred to the analog module.

Instead, the analog module holds its outputs in their last state. When the slot is re-enabled, the data that appears in the processor image table is transferred to the analog module on the subsequent scan.

### Input Channel Filtering

The input channels for all of the analog modules incorporate extensive on board signal conditioning. The purpose of this conditioning is to reject the high frequency noise that can couple into an analog input signal while passing the normal variations of the input signal. The conditioning is performed by passing the input signal through a 6 pole Gaussian digital filter.

The sharp cut-off of this filter is demonstrated in the frequency response plot, Figure 4.3. Frequency components of the input signal at or below the filter corner frequency of 10 Hz are passed with under 3 dB of attenuation. This pass band allows the normal variation of sensor inputs such as temperature, pressure and flow transducers to be input data to the processor.

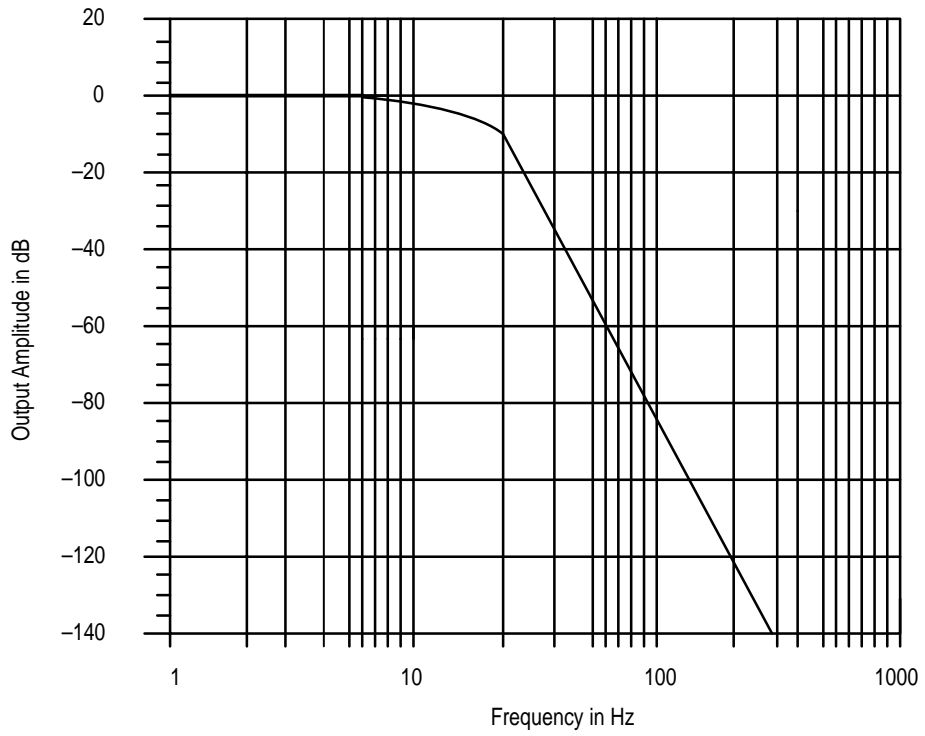
Noise signals coupled in at frequencies above the 10 Hz pass band is sharply rejected. An area of particular concern is the 50/60 Hz region, where pick up from power lines can occur. From the frequency response diagram, you see that a 60 Hz signal on the plus (+) input with respect to the minus (-) input is attenuated by over 55 dB (60 Hz normal mode rejection).

If power line noise is coupling into the input signal through the input cable, the proper use of differential inputs reduces the effect of noise. With differential inputs, noise couples into both the plus (+) and minus (-) inputs where it is attenuated by over 105 dB (60 Hz common mode rejection).

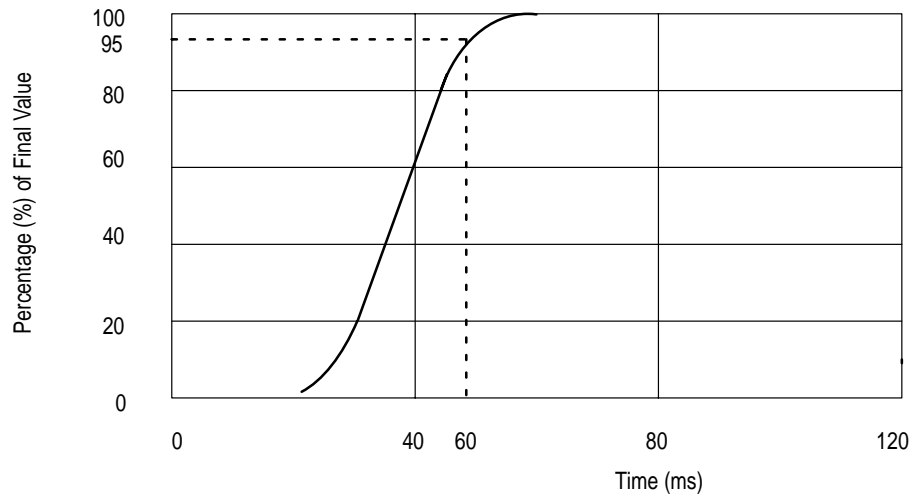
The affect of the filter with respect to time can be seen by examining the step response of the input channel. Figure 4.4 shows the response of the input value versus time when a step change is made in the voltage or current at the input terminal. The response of the filter demonstrates no overshoot and rapid settling time. The input value settles to within 95% of the final value in 60 milliseconds, independent of the input magnitude.

**Example** – If the input instantaneously changes from 0 to 10 volts, the value converted by the analog module after 60 milliseconds is 9.5 volts. Within this time the analog module updates the input data value in memory with an intermediate response every 512 microseconds.

**Figure 4.3**  
**Input Channel Frequency Response**



**Figure 4.4**  
**Input Channel Step Response**



## Testing Your Module

The purpose of this chapter is to help you isolate problems in a systematic and controlled manner before beginning normal system operation.

### Testing the SLC 500 System

If your analog module is installed in the expansion chassis of a fixed system, test your system using the procedures described in the Fixed Hardware Style Installation & Operation Manual before executing the analog module start up procedures.

If your analog module is installed in a modular system, test the modular system using the procedures described in the Modular Hardware Style Installation & Operation Manual before executing the analog module start up procedures.

#### Start-up Procedures

Once you have tested your SLC 500 system, follow the steps below in sequence to test your analog module:

1. Inspect the analog module.
2. Disconnect prime movers.
3. Power up the SLC 500 system.
4. Test the analog inputs.
5. Test the analog outputs.
6. Start up the system.

### Inspect the Analog Module

Problems can be prevented by inspecting the analog module before installing it in the SLC 500 system. Inspection should include the following steps:

1. Make sure that all voltage/current mode selection DIP switches are set properly (inputs only).
2. Make sure that all analog module wiring connections are correct and that there are no missing or broken wires. Check the tightness of all terminals to make certain wires are secure.



**ATTENTION:** Care should be taken to avoid connecting a voltage source to a channel configured for a current input. Improper module operation or damage to the module can occur.

---

3. Make sure that the shield for the cable used to wire the analog module is properly grounded. Refer to chapter 3 for additional information.



**ATTENTION: Do not** connect the Belden #8761 foil shield and drain wire to the analog module terminal block. The foil shield and drain wire must be connected to earth ground, which is not available on the analog module terminal block.

---

4. Make certain that the removable terminal block on the analog module is secured on the module.

### Disconnect Prime Movers (Motion Devices)

During the following test procedures the processor is energized. As a safety precaution, make sure that machine motion does not occur. To achieve this:

Disconnect the motor wires at the motor starter or the motor itself. This allows you to test the operation of the starter coil, verifying that your output circuit is wired correctly and functioning.

To disconnect a solenoid, disengage the valve, leaving the coil connected.

In some instances, you may not be able to disconnect a device the preferred way. In these cases, open the output circuit at a point as close as possible to the motion-causing device. For example, your output might be a relay coil which in turn energizes a motor starter. If you cannot disconnect the motor wires, open the circuit at a point between the motor starter and the relay contact.



**ATTENTION:** Machine motion during system checkout can be hazardous to personnel. During all checkout procedures, you must disconnect all devices which, when energized, might cause machine motion.

### Power Up the SLC 500 System

Apply power to the fixed or modular system. The analog module LED (red) should be illuminated, indicating that the module is receiving 24V dc power.

While an illuminated analog module LED does not ensure that the module is operating properly, a non-illuminated LED indicates that the analog module is not functional. Do not continue with the test procedures until the LED is illuminated.

The four most probable causes of a non-illuminated LED are:

- The SLC 500 system is not receiving power from its power supply. Check the POWER LED on the fixed system unit or the power supply on the modular system. If the LED is not illuminated, refer to the Fixed Hardware Style Installation & Operation Manual or the Modular Hardware Style Installation & Operation Manual. If the module is a 1746- NO4I or NO4V, check the state of the optional 24V dc power switch. If external power is selected, but not connected to the front of the module, the power LED will not illuminate.
- The power from the supply is not being received by the remainder of the SLC 500 system. You can test this by attempting to go online with the programming device.
- The slot in the chassis where the analog module is located is not operational. Remove the power from the SLC 500 system, move the analog module to another slot and restore power. If it appears that the slot is defective, replace the chassis.
- The analog module is defective.



### Testing Analog Inputs

Before testing the analog module input channels, the SLC 500 system must be installed and tested according to the SLC 500 Fixed or Modular Style Installation & Operation Manual. The processor must be connected to a programming device, properly configured, and must have no rungs in its ladder program. The analog module LED must also be illuminated.



**ATTENTION:** The procedure described in this section for testing analog module input channels assumes that all I/O module outputs that normally activate prime movers or other potentially dangerous devices have been disconnected from these devices.

**Do not** attempt to test the analog module input channels unless prime movers and/or other potentially dangerous devices are disconnected from the I/O modules.

---

The devices connected to the analog module input channels are referred to as “sensors.” If the sensors can be manually varied over their normal operating range, use these devices to test the analog module input channels.

If the sensors cannot be manually varied, a voltage source or current source is necessary to test the input channels. In this case, disconnect the analog module input channels at the sensor to test the terminal block wiring. The following steps apply to either test procedure.

**Important:** The following procedure does not ensure that the input mode DIP switch is properly configured. Visually inspect the input mode DIP switch before installing the analog module in the chassis.

---



**ATTENTION:** Care should be taken to avoid connecting a voltage source to a channel configured for a current input. Improper module operation or damage to the module can occur.

---

To test the analog inputs follow these steps:

1. Determine the boundary conditions for the analog module input channel. For example, if the input channel is connected to a sensor that has an output range of 1 mA to 5 mA, the boundary conditions would be 1 mA (lower) and 5 mA (upper).
2. Using the formulas from page 4–7, calculate the input decimal values that should appear in the processor image table when the boundary conditions are present on the analog module input channel.

For example, if 1 mA and 5 mA are boundary conditions, the decimal values would be 819 and 4096.

3. Assuming that the programming device is on-line with the processor, select the test mode and continuous scan mode function.
4. Display the data in File 1 (Input Image Table).
5. Change the radix of the display to decimal.
6. If the input channel of the module has been disconnected from its sensor, attach a voltage source (voltage input) or current source (current input) to the input and set the source to the *lower boundary* condition.

If the input channel is connected to its sensor, set the sensor to its lower boundary condition.

7. Locate the input channel image data in the image table. The input image word for the input channel being tested should read approximately the lower boundary calculated in step 2.

The exact value of the image word is affected by the accuracy of the analog module and the input sensor. Ensure that the deviation from the boundary value is within tolerances for the analog application.

8. If the input channel has been disconnected from its sensor, attach the voltage source (voltage input) or current source (current input) to the input and set the source to the *upper boundary* condition.

If the input channel is connected to its sensor, set the sensor to its upper boundary condition.

9. Repeat step 7 for the upper boundary condition.
10. Repeat steps 1 through 8 for the remaining analog inputs.

11. If any of the analog input channels do not pass the start-up procedure, check for the following potential causes:
- The processor is not in the TEST/CONTINUOUS scan mode.
  - The terminal block is not secured on the analog module.
  - The analog module terminal block is not wired properly or wires are broken. See chapter 3 for details on wiring the analog module.
  - The analog module input channel sensor (or test voltage or current source) is not operating properly.

If a current source is not available to test a current input channel, a test voltage can be applied to the current input channel to achieve the input boundary conditions. In normal operation, a voltage source should not be connected to an analog input channel in the current mode. To determine the boundary conditions use the following equation:

$$\text{Voltage Input (V)} = \text{Current Input (mA)} \times 0.25$$

**Example** – If the current input boundary conditions are 1 mA and 5 mA, the boundary conditions in volts would be 0.25 volts and 1.25 volts. If this calculation is done correctly, the test voltage should never exceed 5 volts.

### Testing Analog Outputs

Before testing the analog module output channels, the SLC 500 system must be installed and tested according to the SLC 500 Fixed or Modular Style Installation & Operation Manual. The processor must be connected to a programming device, properly configured, and must have no rungs in its ladder program. The analog module LED must be illuminated.



**ATTENTION:** The procedure described in this section for testing analog module output channels assumes that all I/O module outputs that normally activate prime movers or other potentially dangerous devices have been disconnected from these devices.

*Do not* attempt to test the analog module output channels unless prime movers and/or other potentially dangerous devices are disconnected from the I/O modules.

---

The devices connected directly to the analog module outputs are referred to as “actuators.” If the actuators do not affect prime movers or initiate any other potentially dangerous operation, use these devices to test the outputs.

If the actuators affect prime movers or initiate a potentially dangerous operation, use a voltmeter to test the voltage outputs and an ammeter to test the current outputs. Note that these meters have some inherent error of their own.

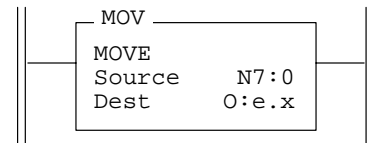
In the latter case, disconnect actuators at the analog module outputs to test the terminal blocks.

The following procedure applies to either of the previous situations.

1. Determine the boundary conditions for the analog module output channel. For example, if the output channel is connected to an actuator that has an input range of 1 volt to 5 volts, the boundary conditions are 1 volt (lower) and 5 volts (upper).
2. Using the formulas from page 4-9, calculate the output decimal values that must be entered into the processor image table to produce the analog module output channel boundary conditions determined in step 1.

For example, if 1 volt and 5 volts are boundary conditions, the decimal values would be 3277 and 16384.

3. Create and save the test rung shown below.



“e” is the slot number of the analog module

“x” is the number of the analog module output channel being tested

4. Download the program to the processor and enter the RUN mode.
5. Display the data in address N7:0.
6. Enter lower boundary condition value in N7:0. For example, if the lower boundary condition is 1 volt, enter 3277 into N7:0.
7. If the output channel has not been disconnected from its actuator, the actuator should assume its lower boundary condition.

If the output channel has been disconnected from its actuator, connect either the ammeter (current output) or voltmeter (voltage output) to the analog module output channel. The exact value of the meter reading is affected by the accuracy of the analog module and the meter. Ensure that the deviation from the lower boundary condition is within tolerances for the application in which the analog module is used.

For example, if 1 volt was the lower boundary condition, the voltmeter should read approximately 1 volt.

8. Enter upper boundary condition value in N7:0. For example, if the upper boundary condition is 5 volts, enter 16384 into N7:0.
9. Repeat step 7 for the upper boundary condition.
10. Repeat steps 1 through 9 for each output channel.
11. If any of the output channels do not pass the start-up procedure, check for the following potential causes:
  - The processor is not in the RUN mode.
  - The terminal block is not secured in the analog module.
  - The analog module terminal block is not wired properly or wires are broken. See chapter 3 for details on wiring the analog module.
  - The actuator or test ammeter/voltmeter is not operating properly.

## Programming Examples

This chapter shows several programming examples that provide additional capabilities such as:

- Addressing, Out-of-Range Detection, and Scaling of Analog Inputs
- Addressing and Scaling of Analog Outputs
- Scaling Offsets when  $> 32,767$  or  $< -32,768$
- Scaling and Range Checking of Analog Inputs and Outputs

**Important:** The programming examples in this chapter are for informational purposes only. Because of the many variables and requirements associated with any application, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on these examples.

### Addressing, Out-of-Range Detection, and Scaling of Analog Inputs

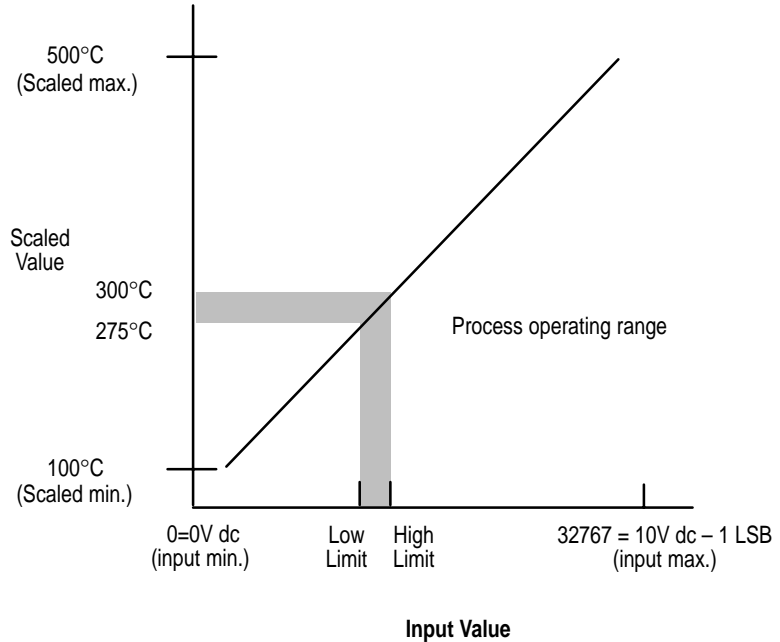
The following example uses an NI4 analog input module to show input addressing, range checking and scaling of analog inputs into engineering units.

We are making the following assumptions:

- The NI4 is located in slot 3 of a modular system.
- A temperature transducer with a 0 to 10V dc output is wired to the second input channel on the analog module.
- The transducer voltage signal is proportional to a range of 100° C to 500° C (212° F to 932° F).
- The process temperature must stay between 275° and 300° C (527° F to 572° F). If the temperature deviates from this range, a flag is set and this out-of-range value is not processed. The data is presented in degrees C for monitoring and display purposes.

The scaling operation is displayed in the following graph. It displays the linear relationship between the input and the resulting scaled values.

**Figure 6.1**



### Calculating the Linear Relationship

Use the following equations to express the linear relationship between the input value and the resulting scaled value.

**Scaled value** = (input value x slope) + offset

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$(500 - 100) / (32,767 - 0) = 400/32,767$$

$$\text{Offset} = \text{scaled min.} - (\text{input min.} \times \text{slope})$$

$$100 - (0 \times (400/32,767)) = 100$$

$$\text{Scaled value} = (\text{input value} \times (400 / 32767)) + 100$$

## Calculating the Out-of-Range Flag Using the Scale Instruction

Use the following equation to calculate the low and high limit input values which determine the out-of-range flag.

$$\text{Input value} = (\text{scaled value} - \text{offset}) / \text{slope}$$

$$\text{low limit} \quad (275 - 100) / (400/32,767) = 14,344$$

$$\text{high limit} \quad (300 - 100) / (400/32,767) = 16,393$$

Once you have calculated the linear relationship and the out-of-range flag value, this example allows you to:

- Turn on a heater or fan to maintain the process temperature between 275° and 300° C by using the out-of-range flags.
- Monitor the process temperature using a Data Table Access Module (DTAM) or Hand-Held Terminal (HHT).
- *Output* the process temperature for operation interface purposes by:
  - MOVing the scaled value to an output module as variable data to a Dataliner
  - Converting the scaled value to BCD (using TOD instruction) and MOVing it to an LED display

The following ladder diagrams show how to program the processor. The first example uses standard math instructions available in any SLC 500 processor. The ladder diagram prevents a processor fault by unlatching the mathematical overflow bit S2:5/0 before the end of the scan.

The second example uses the scaling instruction (SCL)<sup>①</sup> available in the 5/02 and higher processors. The rate parameter is calculated by multiplying the slope by 10,000.

$$\text{rate} = (400/32767) \times 10,000 = 122$$

The third example uses the SCP (scale with parameters) instruction available in the SLC 5/03 (OS302 or later) and SLC 5/04 (OS401 or later) only.

① If the result of the Source times the Rate, divided by 10000 is greater than 32767, the SCL instruction overflows, causing error 0020 (Minor Error Bit), and places 32767 in the Destination. This occurs regardless of the current offset. For an alternate method, see page 6-14.



## Using Standard Math

```

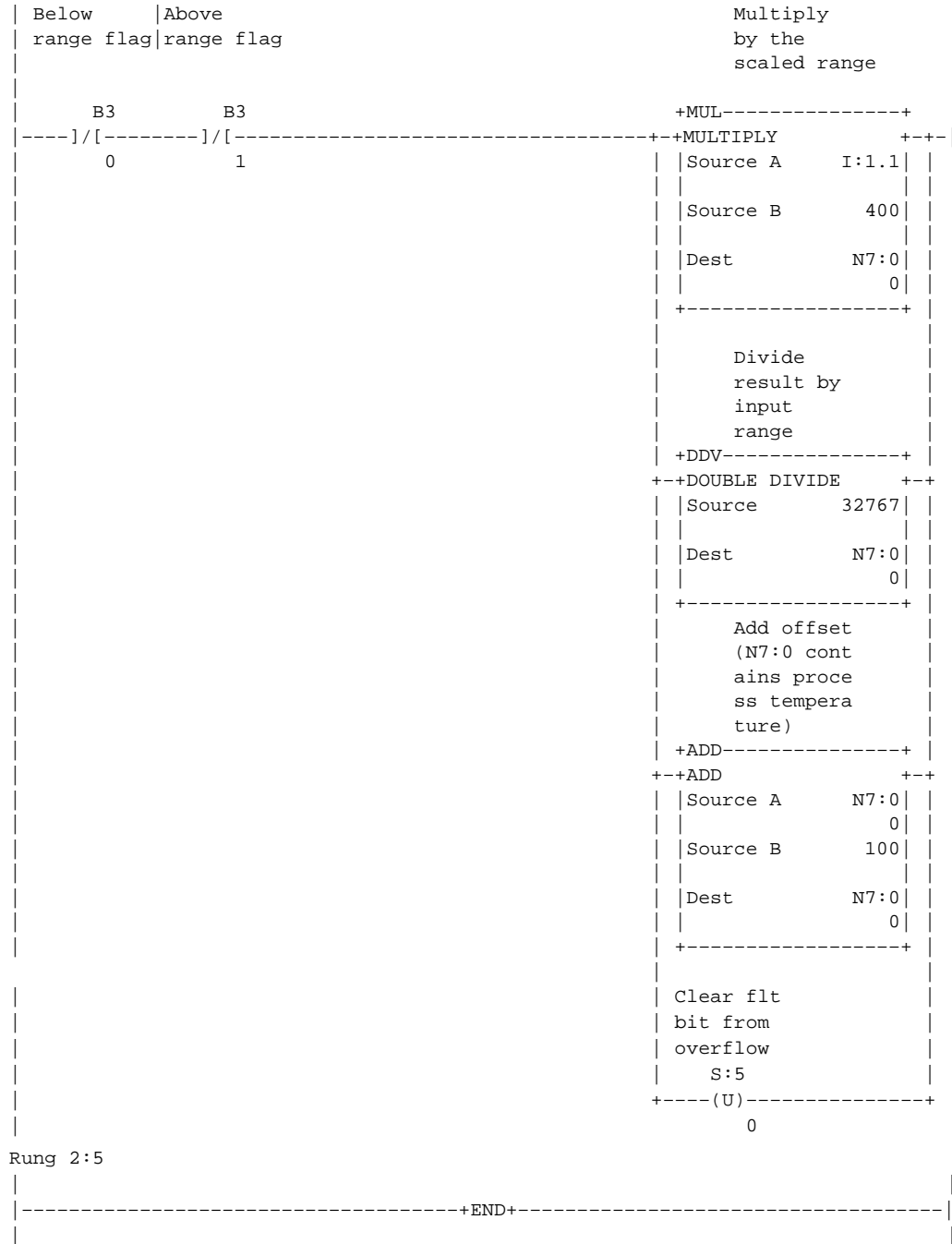
Rung 2:0
Check for below allowable range
|
|                                     Below
|                                     range flag
|                                     B3
| +LES-----+
| -+LESS THAN +------( )-----|
| |Source A   I:1.1|                | 0
| |           |                    |
| |Source B   14344|                |
| |           |                    |
| +-----+
|
Rung 2:1
Check for above allowable range
|
|                                     Above
|                                     range flag
|                                     B3
| +GRT-----+
| -+GREATER THAN +------( )-----|
| |Source A   I:1.1|                | 1
| |           |                    |
| |Source B   16383|                |
| |           |                    |
| +-----+
|
Rung 2:2
Turn on the below range alarm output when analog
input is below acceptable range
| Below |                                     Below
| range flag|                                     range alarm
|       B3|                                     O:2
|-----] [------( )-----|
|       0|                                     0
|
Rung 2:3
Turn on the above range alarm output when analog
input is above acceptable range
| Above |                                     Above
| range flag|                                     range alarm
|       B3|                                     O:2
|-----] [------( )-----|
|       1|                                     1

```

*Ladder logic continued on the next page.*

Rung 2:4

Scale the analog input value and process the result only when it is within the acceptable range



Rung 2:5

### Using the Scale (SCL) Instruction

```

Rung 2:0
Check for below allowable range.
|
|                                     Below
|                                     range flag
| +LES-----+                                     B3
| -+LESS THAN +-----+-----+-----+-----+-----+-----+-----+-----+-----+
| |Source A      I:1.1|                                     0
| |               0|
| |Source B      14344|
| |               |
| +-----+
|
Rung 2:1
Check for above allowable range.
|
|                                     Above
|                                     range flag
| +GRT-----+                                     B3
| -+GREATER THAN +-----+-----+-----+-----+-----+-----+-----+-----+-----+
| |Source A      I:1.1|                                     1
| |               0|
| |Source B      16383|
| |               |
| +-----+
|
Rung 2:2
Turn on the below range alarm output when the analog
input is below the acceptable range.
| Below                                     Below
| range flag                               range alarm
|      B3                                  O:2
| ----] [-----] [-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      0                                     0
|
Rung 2:3
Turn on the above range alarm output when the analog
input is above the acceptable range.
| Above                                     Above
| range flag                               range alarm
|      B3                                  O:2
| ----] [-----] [-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      1                                     1
|
Rung 2:4
Scale analog input value and process the result only
when it is within acceptable range.
| Below      |Above
| range flag |range flag
|      B3    |B3
| ----] [-----] [-----+-----+-----+-----+-----+-----+-----+-----+-----+
|      0      1                                     +SCALE +
| (2:0)      (2:1)                               |Source      I:1.1|
|                                                    |               0|
|                                                    |Rate [ /10000] 122|
|                                                    |               |
|                                                    |Offset        100|
|                                                    |               |
|                                                    |Dest          N7:0|
|                                                    |               0|
|                                                    +-----+
|
Rung 2:5
|
|-----+-----+-----+-----+-----+-----+-----+-----+-----+
|
+END+

```

### Using Scale with Parameters (SCP) Instruction

```

Rung 2:0
Check for below allowable range.
|
|                                     Below
|                                     range flag
| +LES-----+
| -+LESS THAN +------( )-----|
| |Source A   I:1.1|                0
| |           0|
| |Source B   14344|
| |           |
| +-----+
|
Rung 2:1
Check for above allowable range.
|
|                                     Above
|                                     range flag
| +GRT-----+
| -+GREATER THAN +------( )-----|
| |Source A   I:1.1|                1
| |           0|
| |Source B   16383|
| |           |
| +-----+
|
Rung 2:2
Turn on the below range alarm output when the analog
input is below the acceptable range.
| Below                                     Below
| range flag                               range alarm
|   B3                                     0:2
| ----] [------( )-----|
|   0                                     0
|
Rung 2:3
Turn on the above range alarm output when the analog
input is above the acceptable range.
| Above                                     Above
| range flag                               range alarm
|   B3                                     0:2
| ----] [------( )-----|
|   1                                     1
|
Rung 2:4
| Below   |Above
| range flag |range flag
|   B3     B3
| ----]/[-----]/[-----+SCALE W/PARAMETERS+-----|
|   0     1     |Input   I:1.1|
|                 |           0|
|                 |Input Min.  0|
|                 |Input Max. 32767|
|                 |Scaled Min.  100|
|                 |Scaled Max.  500|
|                 |Scaled Output N7:0|
|                 |           0|
|                 +-----+
|
Rung 2:5
|
|-----+END+-----|

```

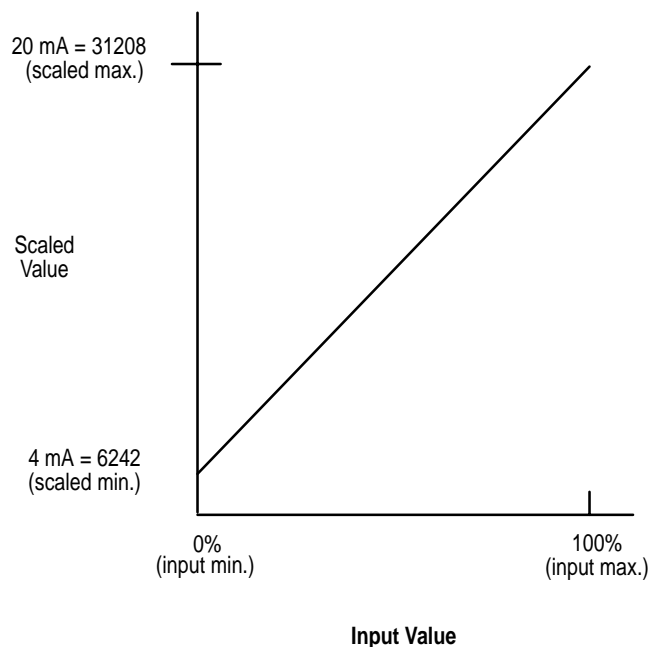
## Addressing and Scaling Outputs

We are making the following assumptions:

- The NIO4I is located in slot 2 of a SLC 500 system.
- An actuator from a flow control valve is wired to output channel 0.
- The actuator accepts a 4 mA to 20 mA signal proportional to 0 to 100% of the valve's opening. For this example the signal actuator can not receive a signal out of the 4 mA to 20 mA range.
- The percentage of valve opening is manually input to the SLC.

The following graph displays the linear relationship.

**Figure 6.2**



### Calculating the Linear Relationship

Use the following equations to calculate the scaled output value:

$$\text{Scaled value} = (\text{input value} \times \text{slope}) + \text{offset}$$

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$(31,208 - 6,242) / (100 - 0) = 24,966/100$$

$$\text{Offset} = \text{scaled min.} - (\text{input min.} \times \text{slope})$$

$$6,242 - (0 \times (24,966/100)) = 6,242$$

$$\text{Scaled value} = (\text{input value} \times (24,966/100)) + 6,242$$

The out-of-range limits are predetermined because any value less than 0% is 6,242 and any value greater than 100% is 31,208. The ladder logic checks for the out-of-range flag to verify that not less than 4 mA and not more than 20 mA is provided out of the analog output channel.

The percentage of valve opening may be *input* to the processor by:

- entering the data through a DTAM or HHT
- MOVing the data from thumbwheels or a keypad (possibly converting the data from BCD using FRD instruction)

The percentage of valve opening may be *output* for operator interface by:

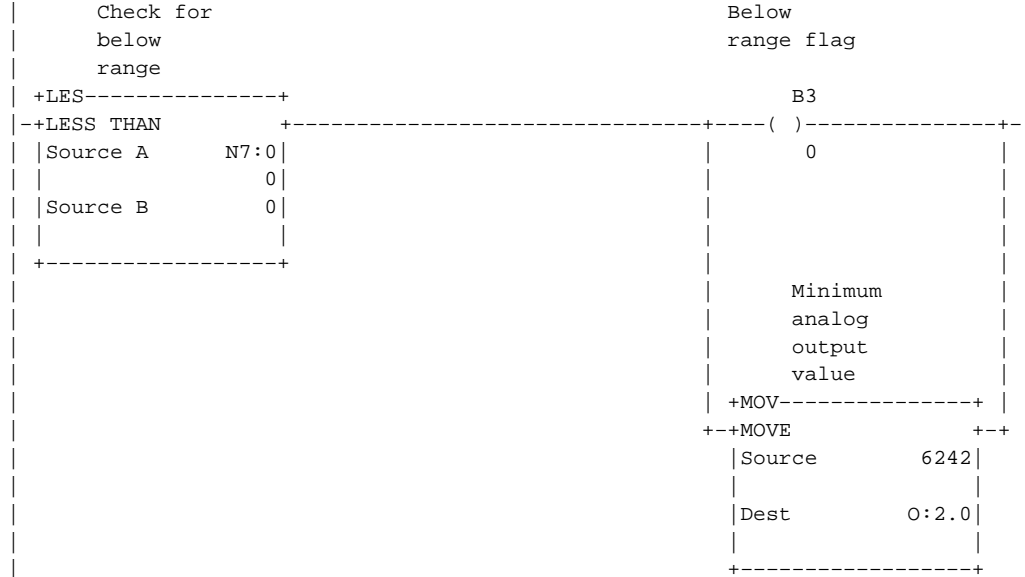
- monitoring the data using a DTAM or HHT
- MOVing the data to an output module as variable data to a Dataliner
- converting the data to BCD (using TOD instruction) and MOVing it to an LED display

Since the slope is greater than 3.2767 only standard math can be used for the ladder diagram with SLC 500 fixed, SLC 5/01, 5/02, 5/03 (OS300 or OS301), and 5/04 (OS400) processors. The ladder diagram prevents a processor fault by unlatching the mathematical overflow bit S2:5/0 before the end of the scan. Refer to the example ladder diagram on the next page. Following the standard math example is a ladder diagram using the SCP instruction, available only in the SLC 5/03 (OS302 or later) and the SLC 5/04 (OS401 or later).

### Using Standard Math

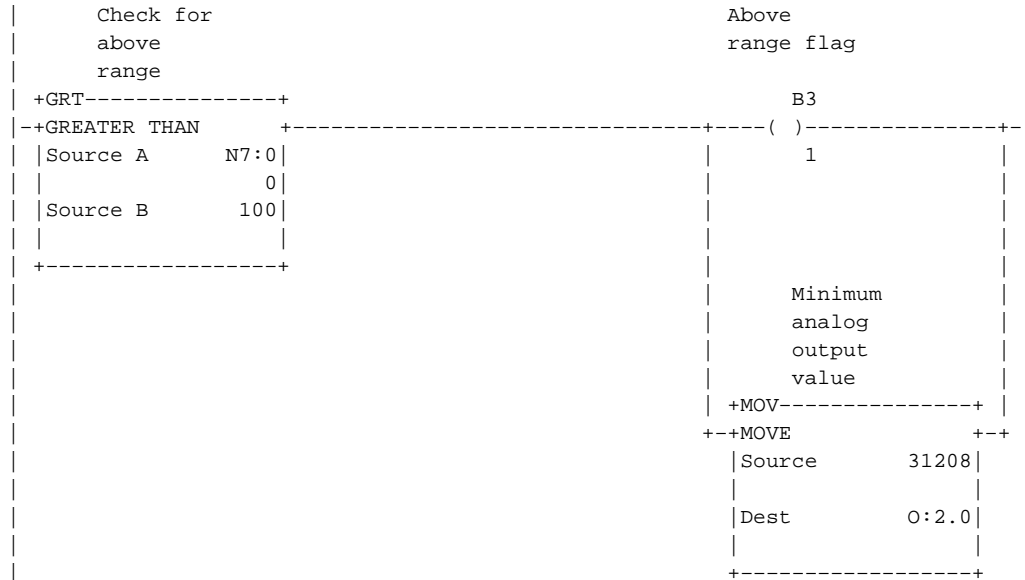
Rung 2:0

N7:0 contains percentage of valve open. If this value is less than 0, move the minimum value to the analog output (6242 decimal = 4 mA at the analog output).



Rung 2:1

N7:0 contains percentage of valve open. If this value is greater than 100, move the maximum value to the analog output (31208 decimal = 20 mA at the analog output).



Ladder logic continued on the next page.

Rung 2:2

Scale values in the 0 to 100% range to the decimal range for the 4-20 mA analog output.

```

| Below      |Above
| range flag|range flag
|
|          B3      B3
|-----] / [-----] / [-----]
|          0          1
|
|                               Multitply
|                               by scaled
|                               range
|                               +MUL-----+
|-----] / [-----] / [-----] +MULTIPLY +--+
|          0          1
|
| |Source A      N7:0|
| |              0|
| |Source B      24966|
| |              |
| |Dest          N7:1|
| |              0|
| |-----+
|
|          Divide by
|          input
|          range
|          +DDV-----+
|-----+DOUBLE DIVIDE +--+
| |Source          100|
| |              |
| |Dest           N7:1|
| |              0|
| |-----+
|
|          Add offset
|          +ADD-----+
|-----+ADD +--+
| |Source A      N7:1|
| |              0|
| |Source B      6242|
| |              |
| |Dest          0:2.0|
| |-----+
|
| Clear math
| overflow
| bit
|          S:5
|-----+(U)-----+
|
|                               0
|
Rung 2:3
|-----+END+-----|

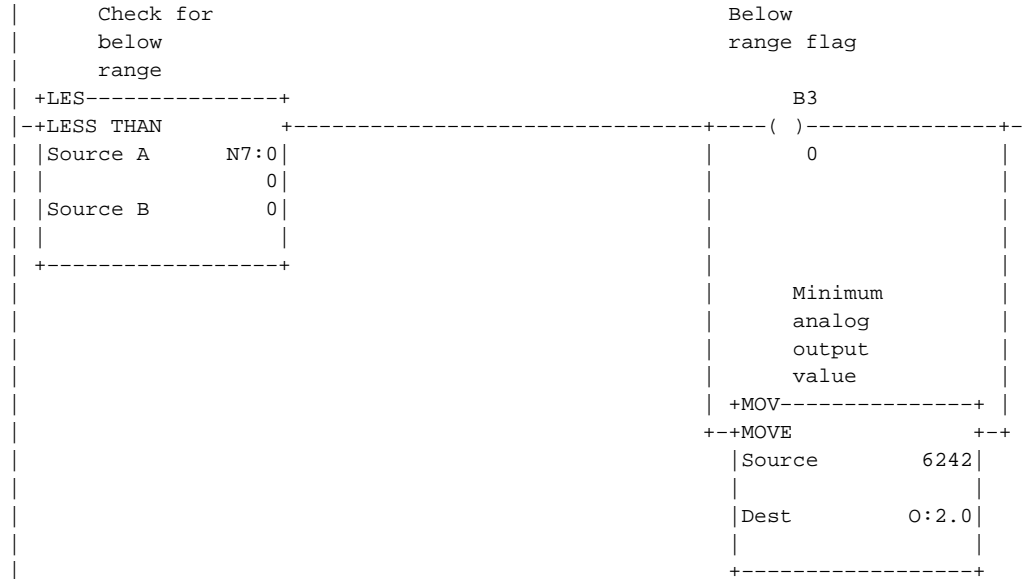
```



## Using the Scale with Parameters (SCP) Instruction

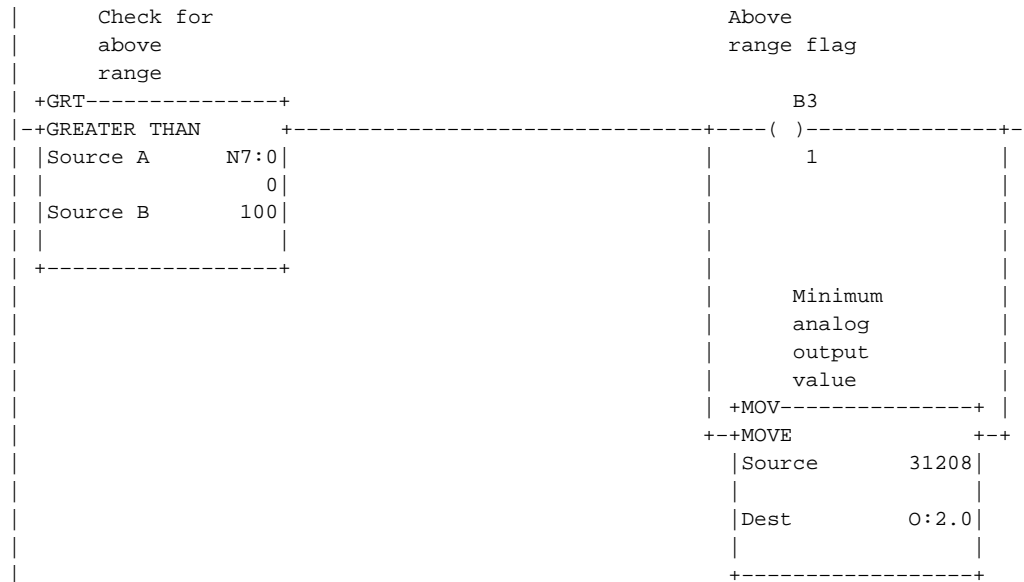
Rung 2:0

N7:0 contains percentage of valve open. If this value is less than 0, move the minimum value to the analog output (6242 decimal = 4 mA at the analog output).



Rung 2:1

N7:0 contains percentage of valve open. If this value is greater than 100, move the maximum value to the analog output (31208 decimal = 20 mA at the analog output).



*Ladder logic continued on the next page.*



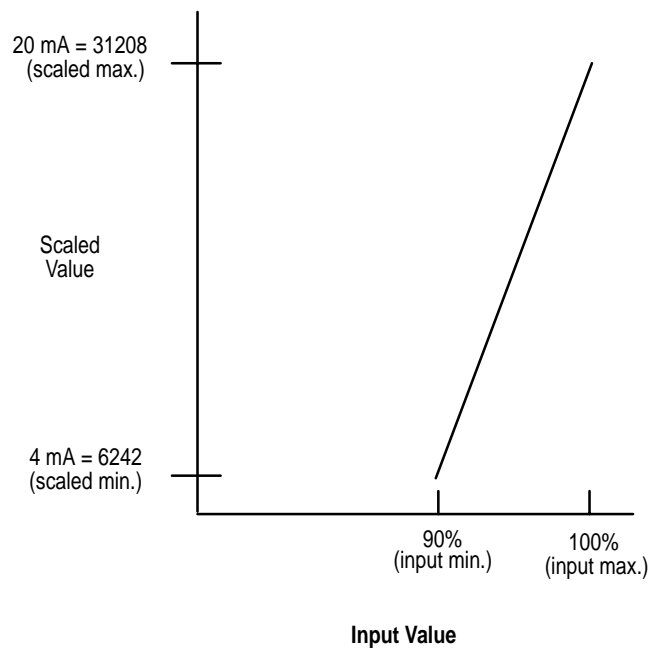
## Scaling Offset when >32,767 or < -32,768

There may be applications when the offset value put into standard math instructions is greater than 32,767 or less than -32,768. In these cases, it is easier to shift the linear relationship along the input value axis and reduce the values.

This example is similar to the situation described in Example 2, except the 4 mA to 20 mA signal is scaled to a value between 90–100%. The NIO4I is located in slot 2 and the output device is wired to channel 0.

The following graph displays the linear relationship.

**Figure 6.3**



### Calculating the Linear Relationship

Use the following equations to calculate the scaled units:

$$\text{Scaled value} = (\text{input value} \times \text{slope}) + \text{offset}$$

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$(31,208 - 6,242) / (100 - 90) = 24,966/10$$

$$\text{Offset} = \text{scaled min.} - (\text{input min.} \times \text{slope})$$

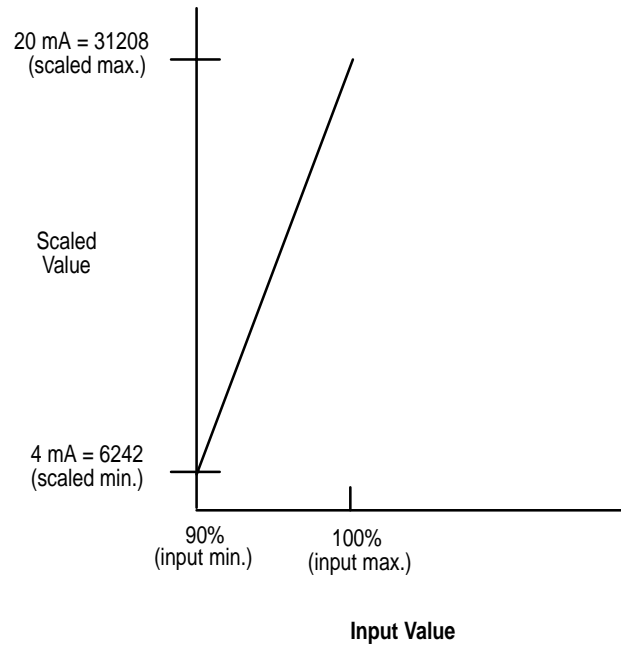
$$6242 - (90 \times (24,966/10)) = -218,452$$

$$\text{Scaled value} = (\text{input value}) \times (24,966/10) - 218,452$$

Notice the offset value is less than -32,768.

The following graph shows the shifted linear relationship. Notice that the resulting offset value is reduced.

**Figure 6.4**



### Calculating the Shifted Linear Relationship

Use the following equations to recalculate the linear relationship:

$$\text{Scaled value} = ((\text{input value} - \text{input min.}) \times \text{slope}) + \text{offset}$$

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$(31,208 - 6,242) / (100 - 90) = 24,966/10$$

$$\text{Offset} = \text{scaled min.}$$

$$6,242$$

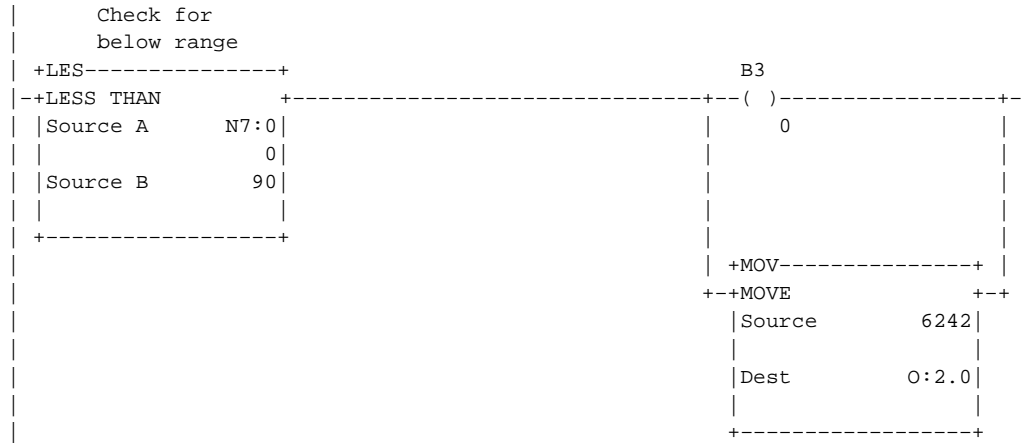
$$\text{Scaled value} = ((\text{input value} - 90) \times (24,966/10)) + 6242$$

Since the slope is greater than 3.2767, only standard math can be used for the ladder diagram with SLC 500 fixed, SLC 5/01, 5/02, 5/03 (OS300 and 301) and 5/04 (OS400). The following ladder diagram prevents a processor fault by unlatching the mathematical overflow bit S2:5/0 before the end of the scan. Refer to the example ladder diagram on the next page. Following this example is another ladder diagram performing the same function, but using the SCP (scale with parameters) instruction available only in the SLC 5/03 (OS302) and SLC 5/04 (OS401).

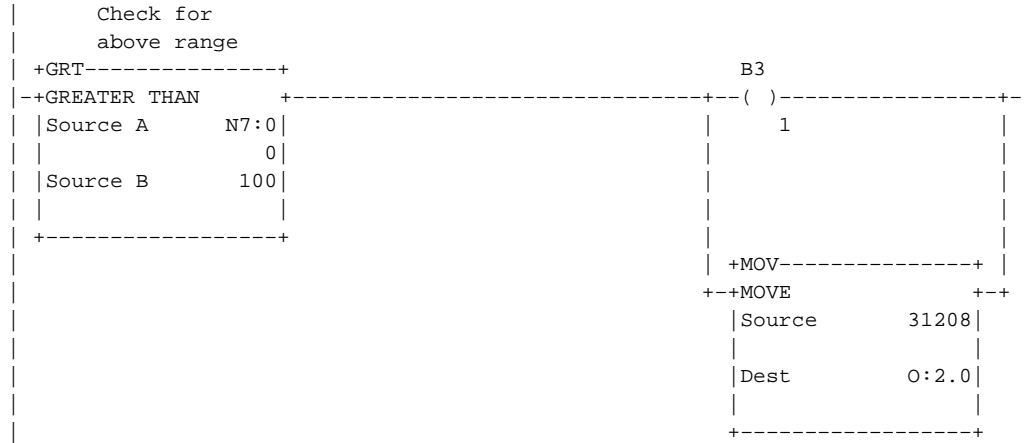
### Using Standard Math

Rung 2:0

N7:0 contains the percentage of the valve open.



Rung 2:1



Ladder logic continued on the next page.

Rung 2:2

Scale values in the 90-100% range to the decimal range for the 4-20 mA analog output.

```

      Subtract
      the input
      min.
      +SUB-----+
      ]/[-----]/[-----]
      0      0
      +SUBTRACT +--+
      |Source A   N7:0|
      |           0  |
      |Source B   90  |
      |Dest       N7:1|
      |           0  |
      +-----+
      Multiply
      by the
      scaled
      range
      +MUL-----+
      +-+MULTIPLY +-+
      |Source A   N7:1|
      |           0  |
      |Source B   24966|
      |Dest       N7:1|
      |           0  |
      +-----+
      Divide
      result by
      input
      range
      +DDV-----+
      +-+DOUBLE DIVIDE +-+
      |Source     10  |
      |Dest       N7:1|
      |           0  |
      +-----+
      Add offset
      +ADD-----+
      +-+ADD +-+
      |Source A   N7:1|
      |           0  |
      |Source B   6242|
      |Dest       0:2.0|
      +-----+
      Clear flt
      bit from
      overflow
      S:5
      +---(U)-----+
      0
  
```

Rung 2:3

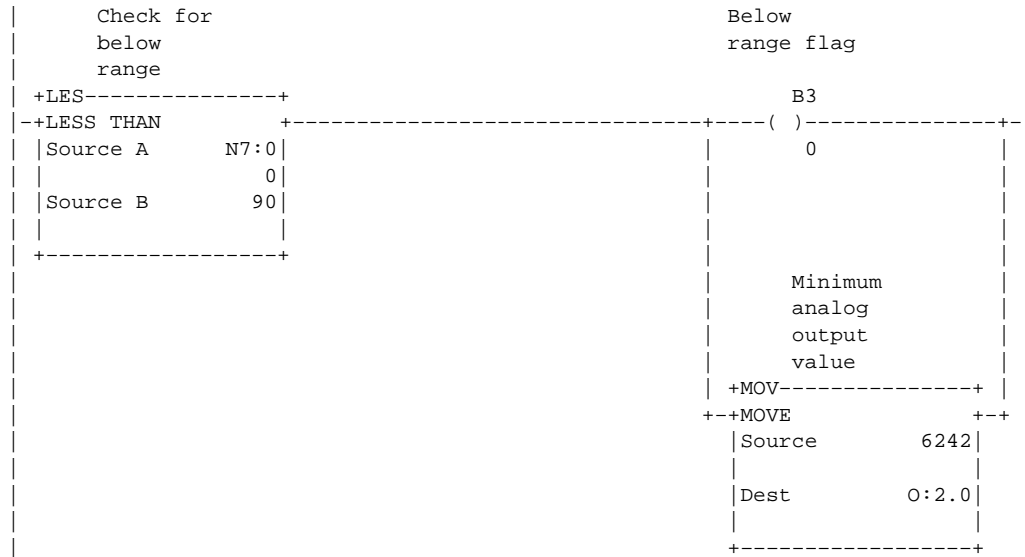
```

      +-----+
      +END+
  
```

### Using the Scale with Parameters (SCP) Instruction

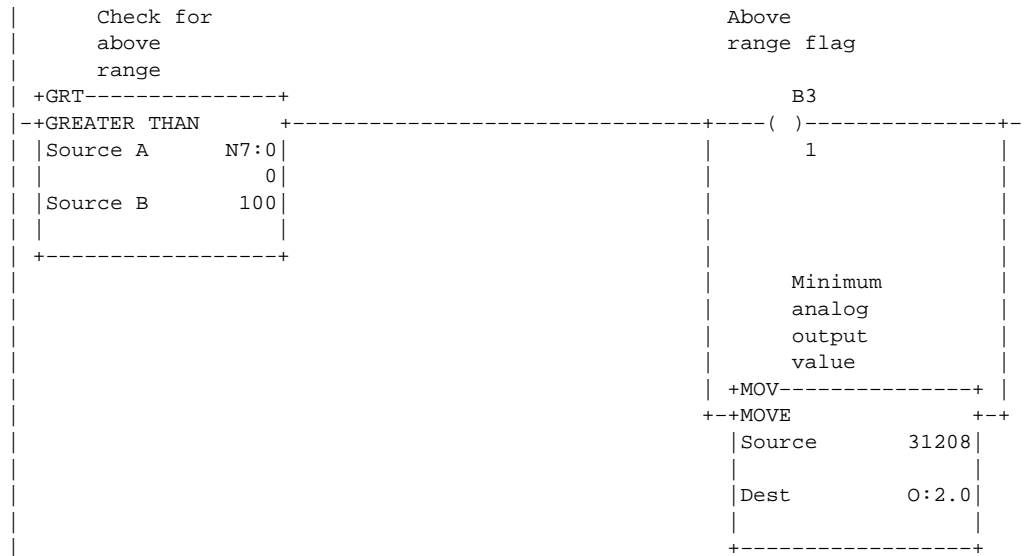
Rung 2:0

N7:0 contains percentage of valve open. If this value is less than 90, move the minimum value to the analog output (6242 decimal = 4 mA at the analog output).



Rung 2:1

N7:0 contains percentage of valve open. If this value is greater than 100, move the maximum value to the analog output (31208 decimal = 20 mA at the analog output).



Ladder logic continued on the next page.





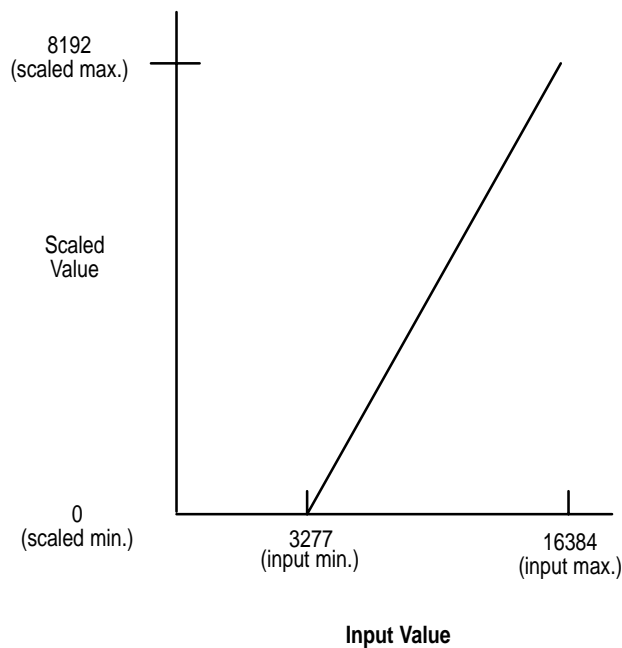
## Scaling and Range Checking of Analog Inputs and Outputs

This example demonstrates the addressing of analog I/O and the scaling and range checking of analog input and output values. An NIO4V is placed in slot 1 of an SLC 500 system. A 0 to 200 psi pressure sensor is input as a 4 mA to 20 mA signal to input channel 0. The input value is checked to ensure it remains within the 4 mA to 20 mA range.

It is then scaled and output as a 0 to 2.5 volt signal to a panel meter pressure display connected to output channel 0. If an out-of-range condition is detected a flag bit will be set. The scaling operation is shown below.

The graph displays the linear relationship between the input value and the resulting scaled value.

Figure 6.5



### Calculating the Linear Relationship

Use the following equations to express the linear relationship between the input value and the resulting scaled value:

$$\text{Scaled value} = (\text{input value} \times \text{slope}) + \text{offset}$$

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$(8192 - 0) / (16384 - 3277) = 8192/13107$$

$$\text{Offset} = \text{scaled min.} - (\text{input min.} \times \text{slope})$$

$$0 - 3277 (8192/13,107) = -2048$$

$$\text{Scaled value} = (\text{input value} \times (8192/13017)) - 2048$$





## Scaling and Range Checking of Analog Inputs and Outputs

The scaling instruction available in the SLC 5/02 processor is used to realize a more efficient program. The scaling instruction uses the same multiply, divide and add algorithm but it does so with a single rate instead of the scaled range and input range values. The rate is determined by:

$$\text{Rate} = (\text{scaled range} / \text{input range}) \times 10,000$$

For the programming example the rate = 6250

### Using SCL Instruction

```

Rung 2:0
Check for below range.
| +LES-----+
| -+LESS THAN |-----+-----+
| |Source A   I:1.0|
| |           |
| |Source B   3277|
| |           |
| +-----+
|
|                                     B3
|                                     ( )
|                                     0
|
| +MOV-----+
| +-+MOVE      +-+
| |Source      0
| |Dest       O:1.0
| +-----+

Rung 2:1
Check for above range.
| +GRT-----+
| -+GREATER THAN |-----+-----+
| |Source A   I:1.0|
| |           |
| |Source B   16384|
| |           |
| +-----+
|
|                                     B3
|                                     ( )
|                                     1
|
| +MOV-----+
| +-+MOVE      +-+
| |Source      8192|
| |Dest       O:1.0
| +-----+

Rung 2:2
Scale the analog input for the analog output.
|          B3          B3
|-----]/[-----] [-----+-----+
|          0          1
|
|                                     +SCL-----+
|                                     +SCALE      +
| |Source      I:1.0|
| |Rate [ /10000] 6250|
| |Offset      -2048|
| |Dest       O:1.0|
| +-----+

Rung 2:3
|-----+-----+-----+-----+
|                                     +END+

```



## Maintenance and Safety

This chapter provides preventive maintenance information and safety considerations when troubleshooting your SLC 500 system.

### Preventative Maintenance

The printed circuit boards of the analog modules must be protected from dirt, oil, moisture and other airborne contaminants. To protect these boards, the SLC 500 system must be installed in an enclosure suitable for the environment. The interior of the enclosure should be kept clean and the enclosure door should be kept closed whenever possible.

Regularly inspect your terminal connections for tightness. Loose connections may cause improper functioning of the SLC 500 system or damage the components of the system.



**ATTENTION:** To ensure personal safety and to guard against damaging equipment, inspect connections with incoming power OFF.

---

For general maintenance procedures for electrical equipment, refer to the requirements specific to your region.

- *Europe:* Refer to the standards found in EN 60204 and your national regulations.
- *United States:* Refer to article 70B of the National Fire Protection Association (NFPA). It describes general requirements regarding safety related work practices.

## Safety Considerations When Troubleshooting

Safety considerations are an important element of proper troubleshooting procedures. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance. Refer to the Fixed or Modular I/O Hardware Installation and Operation manual for additional information on troubleshooting.

The following section describes several safety areas you should be aware of when troubleshooting your SLC 500 system.

**Indicator Lights** – When the red LED on the analog module is illuminated it indicates that 24V dc power is applied to the module.

**Activating Devices When Troubleshooting** – When troubleshooting, never reach into the machine to actuate a device. Unexpected machine motion could occur. Use a wooden stick.

**Stand Clear of Machine** – When troubleshooting any SLC 500 system problem, have all personnel remain clear of the machine. The problem could be intermittent, and sudden unexpected machine motion could occur. Have someone ready to operate an emergency stop switch in case it becomes necessary to shut off power to the machine.

When troubleshooting, pay careful attention to this general warning:



**ATTENTION:** Never reach into a machine to actuate a switch since unexpected machine motion can occur and cause injury.

Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

---

**Program Alteration** – There are several causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect the program has been altered, check it against a previously saved program on an EEPROM or UV PROM memory module.

**Safety Circuits** – Circuits installed on the machine for safety reasons, like over travel limit switches, stop push buttons, and interlocks, should always be hard-wired to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

## Specifications

### Analog Module Specifications

This section lists the specifications for the 1746-NI4, NIO4I, NIO4V, NO4I and NO4V analog modules. They include:

- General specifications
- Current and Voltage input specifications
- Current and Voltage output specifications

### General Specifications for NI4, NIO4I, NIO4V, NO4I, and NO4V

Table A.A

Description	Specification
SLC Communication Format	16 Bit Two's Complement Binary
Field Wiring to Backplane Isolation	500V dc
Update Time	512 $\mu$ s for all channels in parallel
Recommended Cable	Shielded Belden #8761
Maximum Wire Size	#14 AWG (maximum)
Terminal Block	Removable
Location	1746 chassis
Calibration	Factory Calibrated (Refer to calibration procedure, pg. C-2)
Noise Immunity	NEMA Standard ICS 2-230
Environmental Conditions	
Operating Temperature	0° to +60° C (+32° to +140° F)
Storage Temperature	-40° to +85° C (-40° to +185° F)
Relative Humidity	5 to 95% (non-condensing)
Agency Certification (when product or packaging is marked)	<ul style="list-style-type: none"> <li>• CSA certified</li> <li>• CSA Class I, Division 2 Groups A, B, C, D certified</li> <li>• UL listed</li> <li>• CE marked for all applicable directives</li> </ul>



Table A.B

Catalog 1746-	Input Channels per Module	Output Channels per Module	Backplane Current Draw		External 24V dc Power Supply Tolerance
			5V (max.)	24V (max.)	
NI4	4 differential, voltage or current selectable per channel, not individually isolated	NA	35 mA	85 mA	NA
NIO4I	2 differential, voltage or current selectable per channel, not individually isolated	2 current outputs, not individually isolated	55 mA	145 mA	NA
NIO4V	2 differential, voltage or current selectable per channel, not individually isolated	2 voltage outputs, not individually isolated	55 mA	115 mA	NA
NO4I	NA	4 current outputs, not individually isolated	55 mA	195 mA	24 ±10% at 195 mA max. (21.6 to 26.4V dc) <sup>①</sup>
NO4V	NA	4 voltage outputs, not individually isolated	55 mA	145 mA	24 ±10% at 145 mA max. (21.6 to 26.4V dc) <sup>①</sup>

<sup>①</sup> Required for some applications if SLC 24V power is at a premium.

## General Analog Input Specifications for NI4, NIO4I, NIO4V

Table A.C

Description	Specification
Converter Resolution	16 bit
Repeatability	±1 LSB
Location of LSB in I/O image word	0000 0000 0000 0001
Non-linearity	0.01%
Common Mode Voltage Range	-20 to +20 volts
Common Mode Rejection at 0 to 10 Hz (min.)	50 dB
Common Mode Rejection at 60 Hz (min.)	105 dB
Normal Mode Rejection at 60 Hz (min.)	55 dB
Channel Bandwidth	10 Hz
Step Response	60 ms at 95%
Conversion Method	Delta-Sigma Modulation
Impedance to ANL COM	500K ohms
Impedance channel to channel	1M ohms

## Current-Loop Input Specifications for NI4, NIO4I, and NIO4V

Table A.D

Description	Specification
Input Range (Normal Operation)	-20 to +20 mA
Absolute Maximum Input Current	-30 to +30 mA
Absolute Maximum Input Voltage	±7.5V dc or 7.5V ac RMS
Current Input Coding -20 to +20 mA	-16,384 to +16,384
Input Impedance	250 Ohms
Resolution	1.22070 $\mu$ A per LSB
Full Scale	20 mA
Overall Accuracy at +25° C (77° F) (max.)	±0.365% of full scale
Overall Accuracy at 0° to +60° C (32° to 140° F) (max.)	±0.642% of full scale <sup>①</sup>
Overall Accuracy Drift (max.)	+79ppm/5 C of full scale
Gain Error at +25° C (77° F) (max.)	+0.323%
Gain Error at 0° to +60° C (32° to 140° F) (max.)	±0.556%
Gain Error Drift (max.)	±67ppm/° C
Offset Error at +25° C (77° F) (max.) (lin = 0, Vcm = 0)	±7 LSB
Offset Error at 0° to +60° C (32° to 140° F) (max.) (lin = 0, Vcm = 0)	±14 LSB
Offset Error Drift (max.) (lin = 0, Vcm = 0)	±0.20 LSB/° C

<sup>①</sup> Refer to Appendix C for a method to improve accuracy over temperature.

## Voltage Input Specifications for NI4, NIO4I, and NIO4V

Table A.E

Description	Specification
Input Range	-10 to +10V dc – 1 LSB
Voltage Input Coding (-10 to +10V dc – 1 LSB)	-32,768 to +32,767
Input Impedance	1M ohms
Resolution	305.176 $\mu$ V per LSB
Full Scale	10V dc
Overall Accuracy at +25° C (77° F) (max.)	$\pm 0.284\%$ of full scale
Overall Accuracy at 0° to +60° C (32° to 140° F) (max.)	$\pm 0.504\%$ of full scale <sup>①</sup>
Overall Accuracy Drift (max.)	$\pm 63$ ppm/° C of full scale
Gain Error at +25° C (77° F) (max.)	$\pm 0.263\%$
Gain Error at 0° to +60° C (32° to 140° F) (max.)	$\pm 0.461\%$
Gain Error Drift (max.)	$\pm 57$ ppm/° C
Offset Error at +25° C (77° F) (max.)	$\pm 7$ LSB
Offset Error at 0° to +60° C (32° to 140° F) (max.)	$\pm 14$ LSB
Offset Error Drift (max.)	$\pm 0.20$ LSB/° C
Overvoltage Protection (max. across IN+ to IN- terminals)	either 220V ac RMS continuously or 220V dc continuously

<sup>①</sup> Refer to Appendix C for a method to improve accuracy over temperature.

## Current Output Specifications for NIO4I and NO4I

Table A.F

Description	Specification
Converter Resolution	14 bit
Location of LSB in I/O image word	0000 0000 0000 01XX
Non-linearity	0.05%
Conversion Method	R-2R Ladder
Step Response	2.5 ms (at 95%)
Load Range	0 to 500 Ohms
Maximum Load Reactance	100 $\mu$ H
Current Output Coding (0 to +21 mA – 1 LSB)	0 to +32764
Output Range (Normal)	0 to +20 mA
Overrange Capability	5% (0 to +21 mA – 1 LSB)
Resolution	2.56348 $\mu$ A per LSB
Full Scale	21 mA
Overall Accuracy at +25° C (77° F) (max.)	$\pm$ 0.298% of full scale
Overall Accuracy at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 0.541% of full scale
Overall Accuracy Drift (max.)	$\pm$ 70ppm/° C of full scale
Gain Error at +25° C (77° F) (max.)	$\pm$ 0.298%
Gain Error at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 0.516%
Gain Error Drift (max.)	$\pm$ 62ppm/° C
Offset Error at +25° C (77° F) (max.)	$\pm$ 10 LSB
Offset Error at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 12 LSB
Offset Error Drift (max.)	$\pm$ 0.06 LSB/° C

## Voltage Output Specifications for NIO4V and NO4V

Table A.G

Description	Specification
Converter Resolution	14 bit
Location of LSB in I/O image word	0000 0000 0000 01XX
Non-linearity	0.05%
Conversion Method	R-2R Ladder
Step Response	2.5 ms (at 95%)
Load Range	1K to $\infty$ Ohms
Maximum Load Current	10 mA
Maximum Load Reactance	1 $\mu$ F
Voltage Output Coding (-10 to +10V dc - 1 LSB)	-32,768 to +32,764
Output Range (Normal)	-10 to +10 volts - 1 LSB
Resolution	1.22070 mV per LSB
Full Scale	10V dc
Overall Accuracy at +25° C (77° F) (max.)	$\pm$ 0.208% of full scale
Overall Accuracy at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 0.384% of full scale
Overall Accuracy Drift (max.)	$\pm$ 54ppm/° C of full scale
Gain Error at +25° C (77° F) (max.)	$\pm$ 0.208%
Gain Error at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 0.374%
Gain Error Drift (max.)	$\pm$ 47ppm/° C
Offset Error at +25° C (77° F) (max.)	$\pm$ 9 LSB
Offset Error at 0° to +60° C (32° to 140° F) (max.)	$\pm$ 11 LSB
Offset Error Drift (max.)	$\pm$ 0.05 LSB/° C

## Two's Complement Binary Numbers

The SLC 500 processor memory stores 16-bit binary numbers. Two's complement binary is used when performing mathematical calculations internal to the processor. Analog input values from the analog modules are returned to the processor in 16-bit two's complement binary format. For positive numbers, the binary notation and two's complement binary notation are identical.

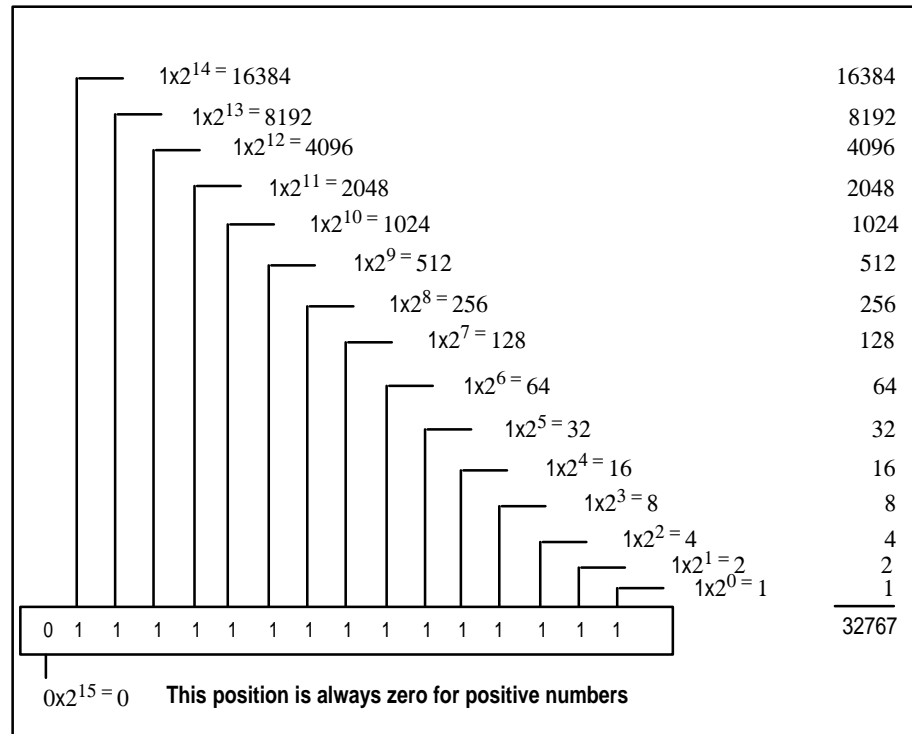
As indicated in the figure on the next page, each position in the number has a decimal value, beginning at the right with  $2^0$  and ending at the left with  $2^{15}$ . Each position can be 0 or 1 in the processor memory. A 0 indicates a value of 0; a 1 indicates the decimal value of the position. The equivalent decimal value of the binary number is the sum of the position values.

### Positive Decimal Values

The far left position is always 0 for positive values. As indicated in the figure on the next page, this limits the maximum positive decimal value to 32767 (all positions are 1 except the far left position). For example:

$$\begin{aligned}0000\ 1001\ 0000\ 1110 &= 2^{11}+2^8+2^3+2^2+2^1 \\ &= 2048+256+8+4+2 = 2318 \\ 0010\ 0011\ 0010\ 1000 &= 2^{13}+2^9+2^8+2^5+2^3 \\ &= 8192+512+256+32+8 = 9000\end{aligned}$$

Figure B.1



### Negative Decimal Values

In two's complement notation, the far left position is always 1 for negative values. The equivalent decimal value of the binary number is obtained by subtracting the value of the far left position, 32768, from the sum of the values of the other positions. In the figure on the next page (all positions are 1), the value is  $32767 - 32768 = -1$ . For example:

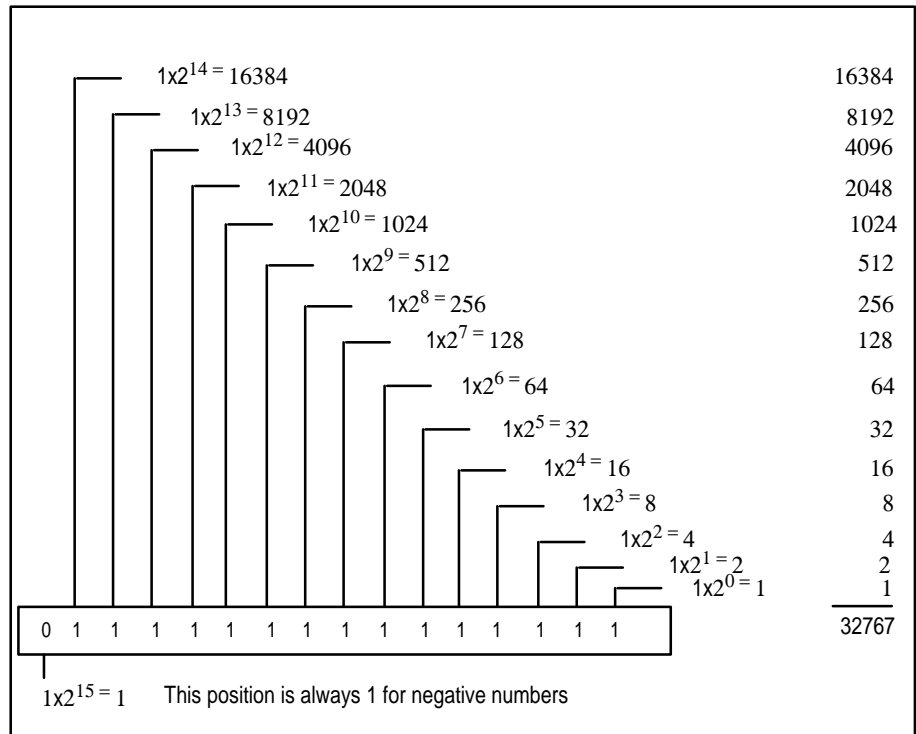
$$1111\ 1000\ 0010\ 0011 =$$

$$(2^{14} + 2^{13} + 2^{12} + 2^{11} + 2^5 + 2^1 + 2^0) - 2^{15} =$$

$$(16384 + 8192 + 4096 + 2048 + 32 + 2 + 1) - 32768 =$$

$$30755 - 32768 = -2013.$$

Figure B.2





---

## Optional Analog Input Software Calibration

This appendix helps you calibrate an analog input channel using software offsets to increase the expected accuracy of an analog input circuit. Examples of equations and a ladder diagram are provided for your reference. A software calibration reduces the offset error and gain error at a given temperature by scaling the values read at calibration time. (Refer to the Preface for a definition of terms).

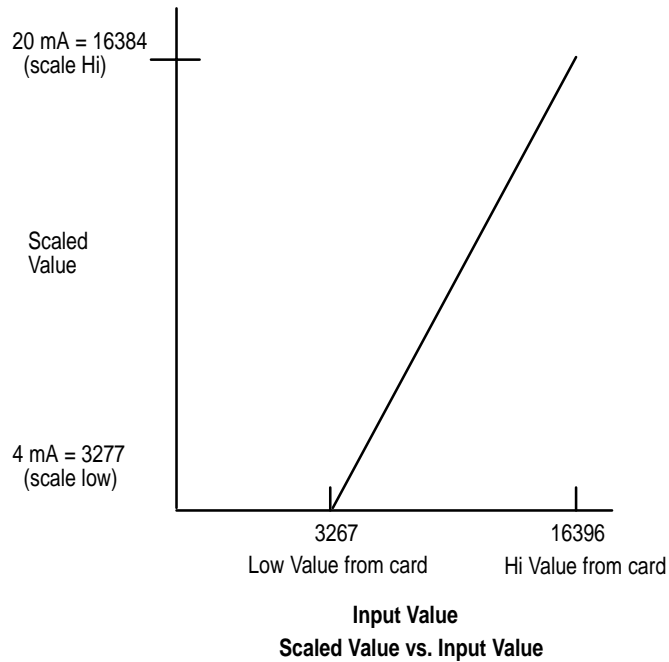
### Calibrating an Analog Input Channel

The following procedure can be adapted to all analog inputs; current or voltage. For this example the 1746-NI4 with a 4 mA to 20 mA input is used. Refer to the 1746-NI4 specifications in appendix A. These specifications represent the worst case values. The overall error for the NI4, which is guaranteed to be not more than  $\pm 0.365\%$  includes non-linearity, repeatability, offset error and gain error at a given temperature.

The overall error of  $\pm 0.365\%$  at 20 mA equates to  $\pm 60$  LSB of error, or a code range of 16324 to 16444. Any value in this range is returned by an analog input channel at 20 mA. The expected nominal value at 20 mA is 16384. After performing a software calibration the overall error is reduced to 3 LSB, or a code range of 16381 to 16387.

The graph on the next page shows the linear relationship between the input value and the resulting scaled value. The values in this graph are from the example program.

Figure C.1



### Calculating the Software Calibration

Use the following equation to perform the software calibration:

$$\text{Scaled Value} = (\text{input value} \times \text{slope}) + \text{offset}$$

$$\text{Slope} = (\text{scaled max.} - \text{scaled min.}) / (\text{input max.} - \text{input min.})$$

$$\text{Offset} = \text{Scaled min.} - (\text{input min.} \times \text{slope})$$

### Procedure

1. Place your SLC 500 system in the normal operating temperature. Ensure that adjacent I/O modules in your system do not cause temperature fluctuations. For example, place high power and random load I/O modules away from your analog input module.
2. Determine the scaled high and low values you wish to use in your application. In this example, scaled high is 16384 and scaled low is 3277.
3. Using an analog input calibration source or your system's input device placed at the 4 mA position, capture the low value by energizing the calibrate low input. Ensure that your low value lies within the conversion range of your analog input.
4. Using an analog input calibration source or your system's input device placed at the 20 mA position, capture the high value by energizing the calibrate high input. Ensure that your high value lies within the conversion range of your analog input.

5. Energize the calibrate input. This causes the SLC to calculate the slope and offset values used to perform the error correction to the analog input.

The analog channel is now calibrated to  $\pm 3$  LSB at the calibration temperature. Use the offset error drift and gain error drift to calculate the amount of additional error that can be introduced into your system due to temperature variation.

The recommended calibration period is once every 6 months. If an application has a wide range of operating temperatures, a software calibration should be performed every 3 to 4 months.

### Example Ladder Diagram

The following ladder diagram requires 3 external inputs that are used to perform the calibration procedure. Lo causes the ladder to capture the 4 mA calibration value and Hi causes the ladder to capture the 20 mA calibration value. Cal causes the ladder diagram to scale the Hi and Lo values to the nominal values, which provides the slope and offset values used to calibrate the analog input channel.

The following symbols are used in this example:

Cal_Lo	= I:1.0/0
Cal_Hi	= I:1.0/1
Calibrate	= I:1.0/2
Conversion Enable	= N10:0/3
Analog_In	= I:2.0
Lo_Value	= N10:1
Hi_Value	= N10:2
Scale_Hi	= N10:3
Scale_Lo	= N10:4
Scale_Span	= N10:7
Span	= N10:9
Slope_x10K	= N10:18
Offset	= N10:19
Analog_Scl	= N10:20



```

+MUL-----+
+-+MULTIPLY +-+
| Source A      LO_VALUE |
|                3267 |
| Source B      SLOPE_X10K |
|                9983 |
| Dest          N10:5 |
|                32767 |
+-----+
+DDV-----+
+-+DOUBLE DIVIDE +-----+
| Source        10000 |
|                |
| Dest          N10:6 |
|                3261 |
+-----+
+SUB-----+
+-+SUBTRACT +-----+
| Source A      SCALE_LO |
|                3277 |
| Source B      N10:6 |
|                3261 |
| Dest          OFFSET |
|                16 |
+-----+
S:5
+--(U)-----+
0

Rung 2:3
| Conversion
| Enable
| N10:0
+-----+
+MUL-----+
+-+MULTIPLY +-+
| Source A      ANALOG_IN |
|                8000 |
| Source B      SLOPE_X10K |
|                9983 |
| Dest          N10:8 |
|                0 |
+-----+
S:5
+--(U)-----+
0
+DDV-----+
+-+DOUBLE DIVIDE +-----+
| Source        10000 |
|                |
| Dest          N10:12 |
|                0 |
+-----+
+ADD-----+
+-+ADD +-----+
| Source A      N10:12 |
|                0 |
| Source B      OFFSET |
|                16 |
| Dest          ANALOG_SCL |
|                8002 |
+-----+

Rung 2:4
+-----+
+END+
    
```

## Module Input and Output Circuits

Figure D.1

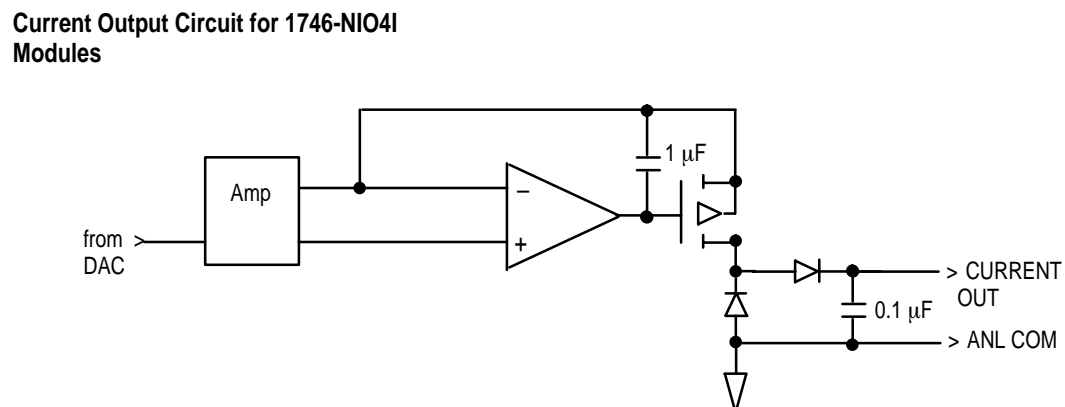
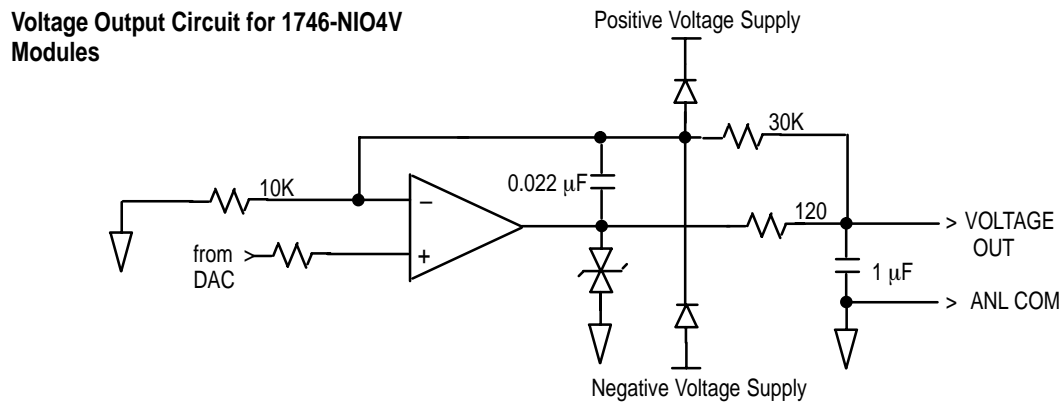
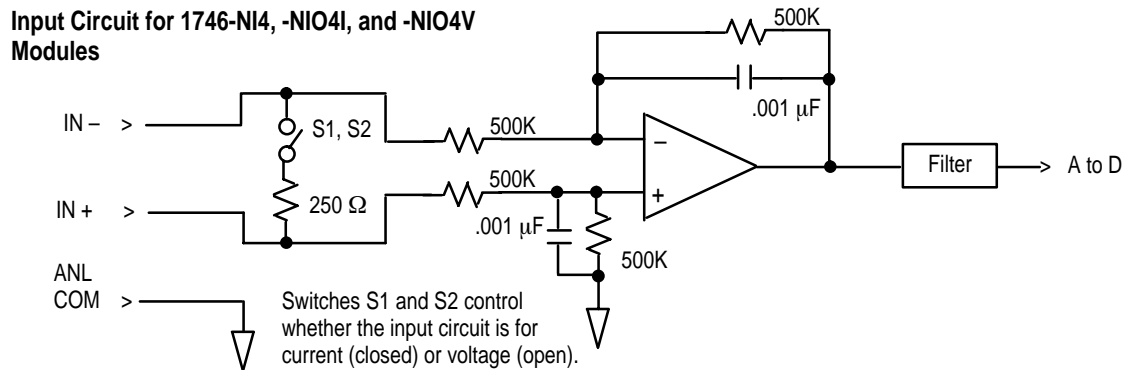
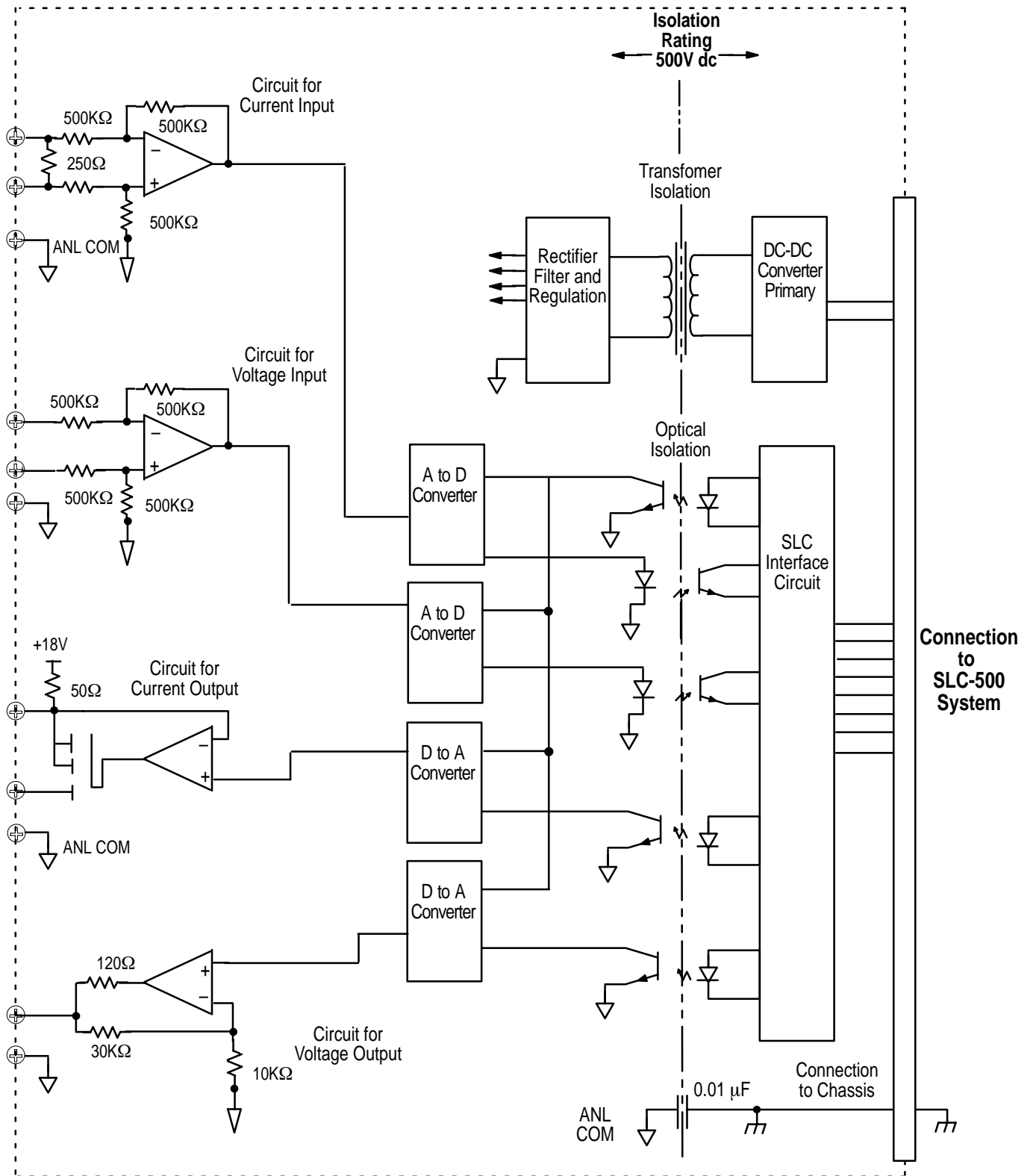


Figure D.2  
Isolation Diagram



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**W**

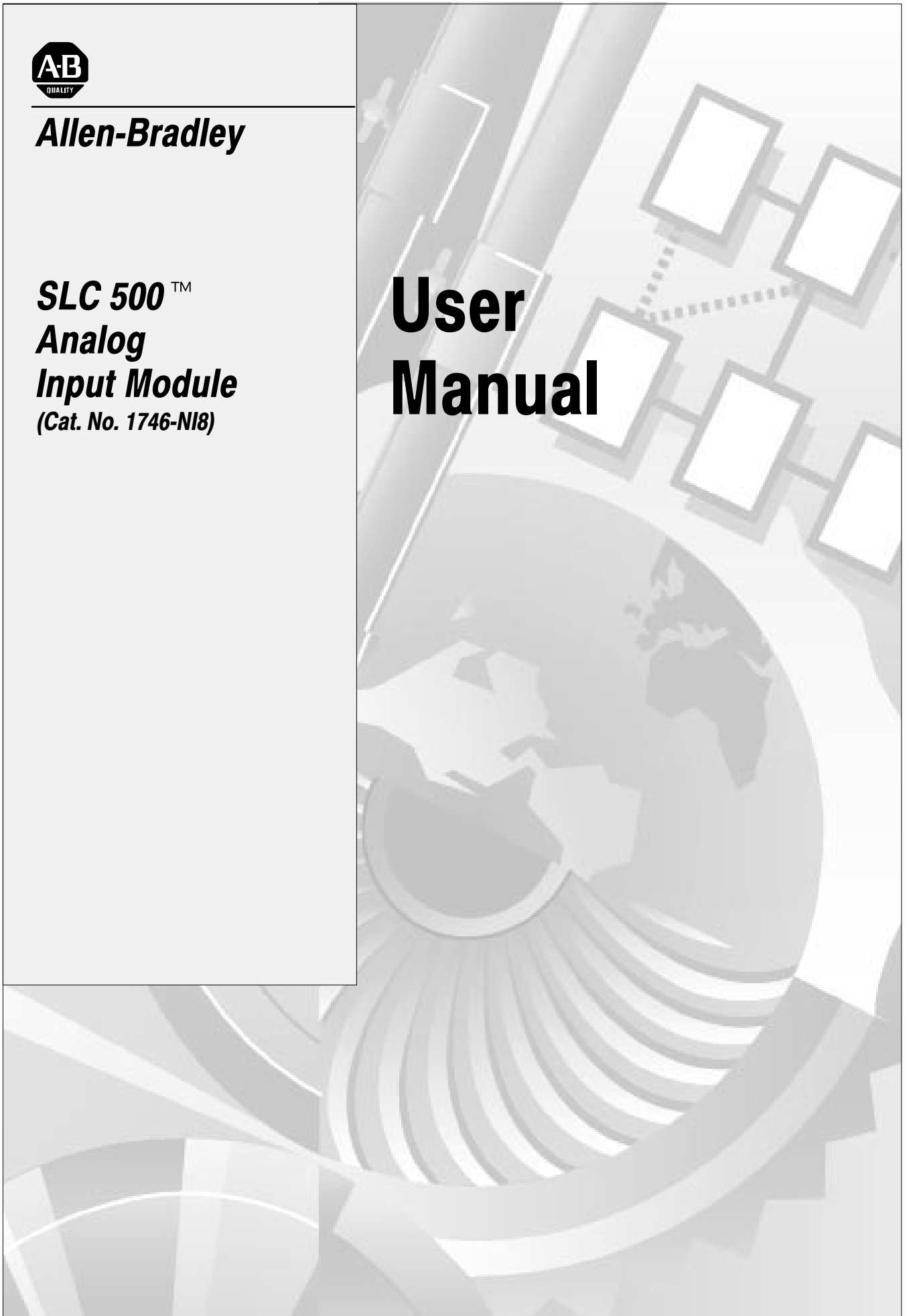
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**Allen-Bradley**

**SLC 500™**  
**Analog**  
**Input Module**  
*(Cat. No. 1746-NI8)*

# User Manual



## Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

---

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

**Important:** Identifies information that is critical for successful application and understanding of the product.

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# Preface

Read this preface to familiarize yourself with the rest of the manual. This preface covers the following topics:

- who should use this manual
- the purpose of this manual
- contents of this manual
- related documentation
- common techniques used in this manual
- Allen-Bradley support

## Who Should Use this Manual

Use this manual if you are responsible for the design, installation, programming, or maintenance of an automation control system that uses Allen-Bradley small logic controllers.

You should have a basic understanding of SLC 500 products. You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application.

If you do not, contact your local Allen-Bradley representative for the proper training before using this product.

## Purpose of this Manual

This manual is a learning and reference guide for the 1746-NI8 Analog Input Module. It contains the information you need to install, wire, and configure the module. It also provides diagnostic and troubleshooting information, and application examples.

## Contents of this Manual

Chapter	Title	Content
	Preface	Describes the purpose, background, and scope of this manual. Also specifies the audience for whom this manual is intended and gives directions to using Allen-Bradley support services. Provides listing of related documentation.
1	Overview	Provides a hardware and system overview. Explains and illustrates the theory behind the input module.
2	Quick Start for Experienced Users	Serves as a <i>Quick Start Guide</i> for the experienced user.
3	Installation and Wiring	Provides installation information and wiring guidelines.
4	Preliminary Operating Considerations	Gives you the background information you need to understand how to address and configure the module for optimum operation as well as how to make changes once the module is in a run state.
5	Channel Configuration, Data, and Status	Examines the channel configuration word and the channel status word, bit by bit, and explains how the module uses configuration data and generates status during operation.
6	Ladder Programming Examples	Gives an example of the ladder logic required to define the channel for operation. Also includes representative examples for unique programming requirements such as PID.
7	Module Diagnostics and Troubleshooting	Explains how to interpret and correct problems that may occur while using the module.
8	Application Examples	Examines both basic and supplementary applications and gives examples of the ladder logic necessary to achieve the desired result.
Appendix A	Specifications	Provides physical, electrical, environmental, and functional specifications for the module.
Appendix B	Configuration Worksheet	Provides a worksheet to help you configure the module for operation.
Appendix C	Converting from 1746-NI4 to 1746-NI8	Describes how to reconfigure a system using 1746-NI4 modules to one with that uses 1746-NI8 modules.
Appendix D	Two's Complement Binary Numbers	Describes the two's complement binary number system.
	Glossary	Lists key terms and abbreviations.

## Related Documentation

The following documents contain information that may be helpful to you as you use Allen-Bradley SLC products. To obtain a copy of any of the Allen-Bradley documents listed, contact your local Allen-Bradley office or distributor.

For	Read This Document	Document Number
An overview of the SLC 500 family of products	SLC 500 System Overview	1747-2.30
A description on how to install and use your <i>Modular</i> SLC 500 programmable controller	Installation & Operation Manual for Modular Hardware Style Programmable Controllers	1747-6.2
A description on how to install and use your <i>Fixed</i> SLC 500 programmable controller	Installation & Operation Manual for Fixed Hardware Style Programmable Controllers	1747-6.21
A procedural manual for technical personnel who use APS to develop control applications	Rockwell Software Advanced Programming Software (APS) User Manual	9399-APSUM
An introduction to APS for first-time users, containing basic concepts but focusing on simple tasks and exercises, and allowing the reader to quickly begin programming	APS Quick Start for New Users	9399-APSQS
A training and quick reference guide to APS	SLC 500 Software Programmer's Quick Reference Guide Using APS – available on PASSPORT, list price \$50.00	ABT-1747-TSG001
A training and quick reference guide to A.I.	SLC 500 Troubleshooting Guide Using A.I. Series – available on PASSPORT, list price \$50.00	ABT-1747-TSJ21
A common procedures guide to APS	SLC 500 Family Common Procedures Guide Using APS – available on PASSPORT, list price \$50.00	ABT-1747-T550
A common procedures guide to A.I.	SLC 500 Family Common Procedures Guide Using A.I. Series – available on PASSPORT, list price \$50.00	ABT-1747-TSJ51
A procedural and reference manual for technical personnel who use the APS import/export utility to convert APS files to ASCII and conversely ASCII to APS files	APS Import/Export User Manual	9399-APSie
A procedural and reference manual for technical personnel who use an HHT to develop control applications	Allen-Bradley Hand-Held Terminal User Manual	1747-NP002
An introduction to HHT for first-time users, containing basic concepts but focusing on simple tasks and exercises, and allowing the reader to quickly begin programming	Getting Started Guide for HHT	1747-NM009
A reference manual that contains status file data and instruction set information for the SLC 500 processors and MicroLogix 1000 controllers.	SLC 500 / MicroLogix 1000 Instruction Set Reference Manual	1747-6.15
In-depth information on grounding and wiring Allen-Bradley programmable controllers	Allen-Bradley Programmable Controller Grounding and Wiring Guidelines	1770-4.1
A description on how to install a PLC-5® system	PLC-5 Family Programmable Controllers Hardware Installation Manual	1785-6.6.1
A description of important differences between solid-state programmable controller products and hard-wired electromechanical devices	Application Considerations for Solid-State Controls	SGL-1.1
An article on wire sizes and types for grounding electrical equipment	National Electrical Code	Published by the National Fire Protection Association of Boston, MA.
A complete listing of current Allen-Bradley documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages.	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Allen-Bradley Industrial Automation Glossary	AG-7.1

## Common Techniques Used in this Manual

The following conventions are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- Text in **this font** indicates words or phrases you should type.
- Key names appear in bold, capital letters within brackets (for example, [**ENTER**]).

## Allen-Bradley Support

Allen-Bradley offers support services worldwide, with over 75 Sales/Support Offices, 512 authorized Distributors and 260 authorized Systems Integrators located throughout the United States alone, plus Allen-Bradley representatives in every major country in the world.

### Local Product Support

Contact your local Allen-Bradley representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

### Technical Product Assistance

If you need to contact Allen-Bradley for technical assistance, please review the information in the *Troubleshooting* chapter first. Then call your local Allen-Bradley representative.

### Your Questions or Comments on this Manual

If you find a problem with this manual, please notify us of it on the enclosed Publication Problem Report.

If you have any suggestions for how this manual could be made more useful to you, please contact us at the address below:

Allen-Bradley  
Control and Information Group  
Technical Communication, Dept. A602V, T122  
P.O. Box 2086  
Milwaukee, WI 53201-2086

## Overview

This chapter describes the 1746-NI8 analog input module and explains how the SLC 500™ processor gathers analog input from the module. Included is information about:

- the module's hardware and diagnostic features
- an overview of system operation

## General Description

The module receives and stores digitally converted analog data into its image table for retrieval by all fixed and modular SLC 500 processors. The module supports connections from any combination of up to eight voltage or current analog sensors.

The 1746-NI8 is a multiclass (Class 1 or Class 3) single-slot module. Class 1<sup>①</sup> configuration utilizes 8 input words and 8 output words. Class 3 configuration utilizes 16 input words and 12 output words. Fixed and SLC 5/01™ processors can only operate as Class 1. The SLC 5/02™, SLC 5/03™, and SLC 5/04™ processors can be configured for either Class 1 or Class 3.

The 8 high-impedance input channels can be wired as either single-ended or differential inputs. The module provides a direct interface to the following input types:

- ±10V dc
- 1–5V dc
- 0–5V dc
- 0–10V dc
- 0–20 mA
- 4–20 mA
- ±20 mA
- 0–1 mA

The data presented to the processor can be configured as:

- Engineering Units
- Scaled-for-PID
- Proportional Counts (–32,768 to +32,767 range)
- Proportional Counts with User Defined Range (Class 3 only)
- 1746-NI4 Data Format

<sup>①</sup> Requires use of Block Transfer in a remote configuration.

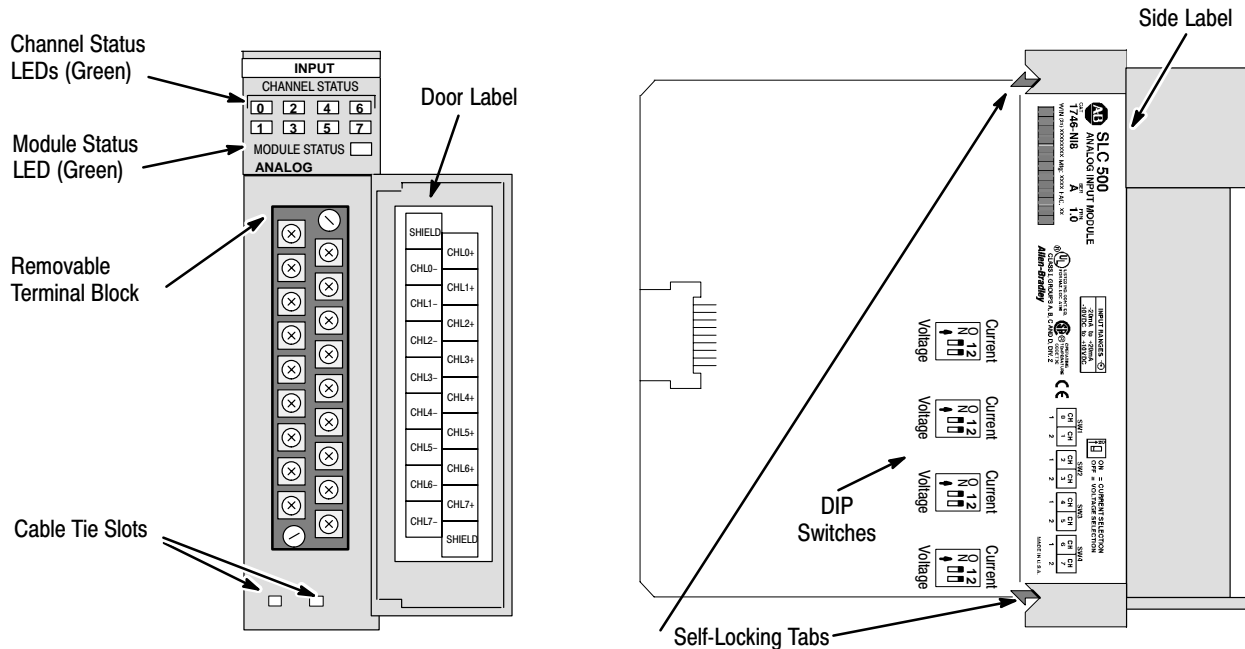
Each input channel also provides open-circuit, out-of-range, and invalid configuration indication via the LEDs. In Class 3 operation these conditions are also in the channel status word.

**Important:** Status words are only available when the module is configured for Class 3.

### Hardware Features

The module fits into any slot, except the processor slot (0), in either an SLC 500 modular system or an SLC 500 fixed system expansion chassis (1746-A2).

The module contains a removable terminal block providing connection for eight analog input channels, which is specifically designed to interface with analog current and voltage input signals. The channels can be wired as either single-ended or differential inputs. There are no output channels on the module. Module configuration is done via the user program. There are DIP switches on the circuit board for selecting voltage or current input.



Hardware Feature	Function
Channel Status LED Indicators	Displays channel operating and fault status.
Module Status LED	Displays module operating and fault status.
Side Label (Nameplate)	Provides module information.
Removable Terminal Block	Provides physical connection to input devices.
Door Label	Permits easy terminal identification.
Cable Tie Slots	Secures and route wiring from module.
Self-Locking Tabs	Secures module in chassis slot.
Voltage/current Selection DIP Switches	Selects voltage or current input type to match the analog sensor.

## General Diagnostic Features

The 1746-NI8 module contains diagnostic features that can help you identify the source of problems that may occur during power-up or during normal channel operation. These power-up and channel diagnostics are explained in chapter 7, *Module Diagnostics and Troubleshooting*.

## System Overview

The module communicates to the SLC 500 processor through the parallel backplane interface and receives power from the SLC 500 power supply through the backplane. The +5V dc backplane supply powers the SLC circuitry, and the +24V dc backplane supply powers the module analog circuitry. No external power supply is required. You may install as many 1746-NI8 analog modules in your system as the power supply can support.

Each channel on the module can receive input signals from voltage or current analog input devices. You configure each channel individually to accept either a voltage or current input signal.

## System Operation

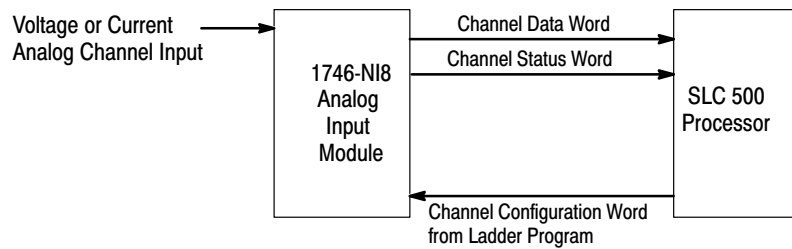
At power-up, the module performs a check of its internal circuits, memory, and basic functions. During this time the module status LED remains off. If no faults are found during the power-up diagnostics, the module status LED is turned on.

After power-up checks are complete, the module waits for valid channel configuration data from your SLC ladder logic program (channel status LEDs off). After configuration data is written to one or more channel configuration words and the channel enable status bits are set, the channel status LEDs go on and the module continuously converts the analog input to a value within the range you selected.

Each time a channel is read by the module, that data value is tested by the module for a fault condition (i.e., open-circuit, over-range, and under-range). If such a condition is detected, a unique bit is set in the channel status word and the channel status LED blinks.

The SLC processor reads the converted analog data from the module at the end of the program scan, or when commanded by the ladder program. The processor and module determine that the backplane data transfer was made without error, and the data is used in your ladder program. A graphic representation of this is shown below.

**Data Transfer Between the Module and Processor  
(shown for one channel)**



### Module Operation

The 1746-NI8 module's input circuitry consists of eight differential analog inputs multiplexed into a single analog-to-digital (A/D) converter.

The A/D converter reads the selected input signal and converts it to a digital value. The multiplexer sequentially switches each input channel to the module's A/D converter. Multiplexing provides an economical means for a single A/D converter to convert multiple analog signals. However, multiplexing also affects the speed at which an input signal can change and still be detected by the converter.

### Module Calibration

The module performs continuous autocalibration for all the channels that are enabled. There is no need to invoke a calibration cycle to compensate for changes in temperature.



## Quick Start for Experienced Users

This chapter can help you to get started using the 1746-NI8 analog input module. We base the procedures here on the assumption that you have an understanding of SLC 500 products. You should understand electronic process control and be able to interpret the ladder logic instructions required to generate the electronic signals that control your application.

Because it is a start-up guide for experienced users, this chapter *does not* contain detailed explanations about the procedures listed. It does, however, reference other chapters in this book where you can get more information about applying the procedures described in each step. It also references other documentation that may be helpful if you are unfamiliar with programming techniques or system installation requirements.

If you have any questions or are unfamiliar with the terms used or concepts presented in the procedural steps, *always read the referenced chapters* and other recommended documentation before trying to apply the information.

This chapter will:

- tell you what equipment you need
- explain how to install and wire the module
- show you how to set up one channel for analog input
- examine the state of the LEDs at normal startup
- examine the channel status word

### Required Tools and Equipment

Have the following tools and equipment ready:

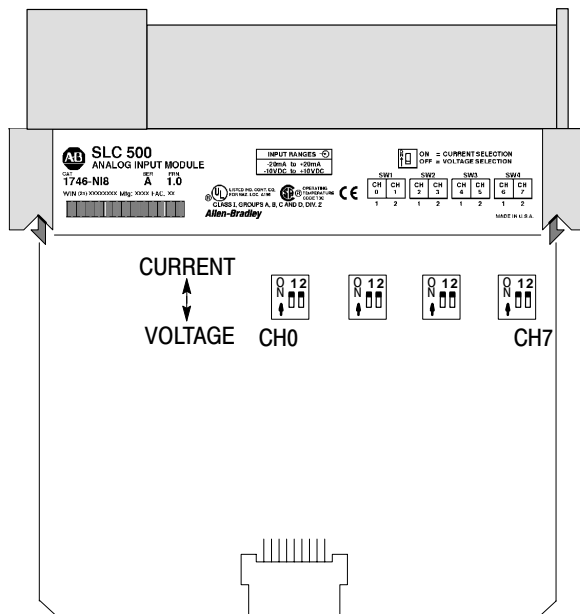
- medium blade screwdriver
- medium cross-head screwdriver
- analog input device
- cable for wiring inputs to module
- SLC processor and power supply installed in chassis
- analog input module (1746-NI8)
- programming device and software

## Procedures

<b>1.</b>	<b>Check the contents of shipping box.</b>	<b>Reference</b>
<p>Unpack the shipping box making sure that the contents include:</p> <ul style="list-style-type: none"> <li>• analog input module (Catalog Number 1746-NI8)</li> <li>• removable terminal block (factory-installed)</li> </ul> <p>If the contents are incomplete, call your local Allen-Bradley representative for assistance.</p>		-
<b>2.</b>	<b>Ensure that your chassis and power supply support the 1746-NI8 module.</b>	<b>Reference</b>
<p>Review the power requirements of your system to see that your chassis supports the module:</p> <ul style="list-style-type: none"> <li>• If combining a 1746-NI8 module with another I/O module in a fixed controller, refer to the I/O module compatibility table found in chapter 3.</li> <li>• For modular style systems, calculate the total load on the system power supply using the procedure described in the <i>SLC Installation &amp; Operation Manual for Modular Style Controllers</i> (publication 1747-6.2) or the <i>SLC 500 Family System Overview</i> (publication 1747-2.30).</li> <li>• The 1746-NI8 backplane current consumption is 200 mA at 5V dc and 100 mA at 24V dc.</li> </ul>		<p><b>Chapter 3</b> <i>(Installation and Wiring)</i></p> <p><b>Appendix A</b> <i>(Specifications)</i></p>
<b>3.</b>	<b>Select voltage or current input type to match the analog sensor.</b>	<b>Reference</b>

The voltage/current selection DIP switches are located on the side of the module. The switch settings are OFF = VOLTAGE INPUT and ON = CURRENT INPUT.

**Chapter 3**  
*(Installation and Wiring)*



**4. Insert the 1746-NI8 module into the chassis.****Reference**

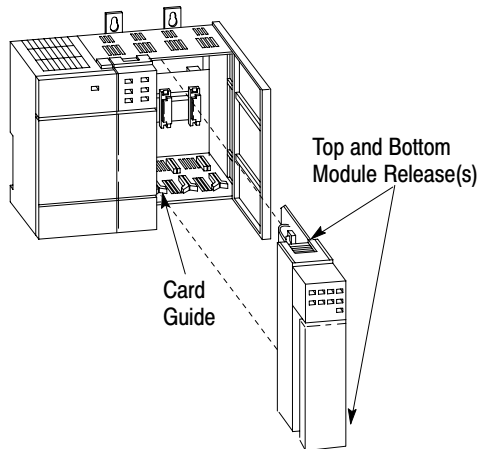
**ATTENTION:** Never install, remove, or wire modules with power applied to the chassis or devices wired to the module.

Make sure system power is off; then insert the module into your 1746 chassis. In this example procedure, local slot 1 is selected.

**Important:** For applications using the upper limit of the operating temperature range, the 1746-NI8 module (or multiple 1746-NI8 modules) should be placed in the right most slot(s) of the chassis. The specification for operating temperature is:

0°C to 55°C (32°F to 131°F) in any slot except slot 0

0°C to 60°C (32°F to 140°F) in right most slot of chassis



**Chapter 3**  
*(Installation and Wiring)*

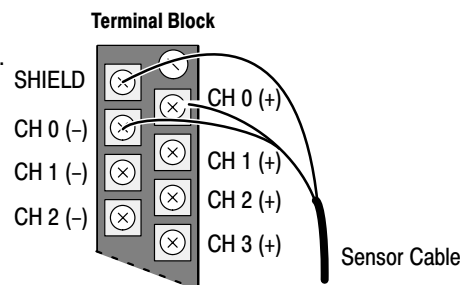
**5. Connect sensor cable.****Reference**

Connect sensor cable to the module's terminal block.

**Important:** Follow these guidelines when wiring the module.

- Use shielded communication cable (Belden 8761) and keep length as short as possible.
- Connect only one end of the cable shield to earth ground.
- Connect the shield drain wires for channels 0-3 to the top shield terminal.
- Connect the shield drain wires for channels 4-7 to the bottom shield terminal.
- Shield terminals are internally connected to chassis ground which is connected to earth ground via the SLC backplane.
- Single-ended source commons may be jumpered together at the terminal block.
- Channels are not isolated from each other. All analog commons are connected together internally.
- If a differential signal source has an analog common, it can not and must not be connected to the module.
- Common mode voltage range is  $\pm 10.5$  volts. The voltage between any two terminals must be less than 21 volts.
- The module does not provide power for the analog inputs.
- Use a power supply that matches the transmitter (sensor) specifications.

**Chapter 3**  
*(Installation and Wiring)*



<b>6. Configure the system.</b>	<b>Reference</b>
---------------------------------	------------------

Configure your system I/O for the particular slot the 1746-NI8 is in (slot 1 in this example). Enter the module ID code. The ID code is 3526 for Class 1 interface, and 12726 for Class 3 interface. See chapter 4 for more information on Class 1 and Class 3 interfaces.

**Chapter 4**  
*(Preliminary Operating Considerations)*

**Important:** All programming software does not support configuration for Class 3 operation.

- Advanced Programming Software (APS) supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- SLC 500 A.I. Series™ Programming Software supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- RSLogix 500™, version 1.30 or later, supports Class 3 configuration. After entering the ID code (12726), select Class 3 operation.
- Earlier versions of RSLogix 500 will only support configuration for Class 1 operation. Contact Rockwell Software for information on upgrading your software.

**Appendix C**  
*(Converting from 1746-NI4 to 1746-NI8)*

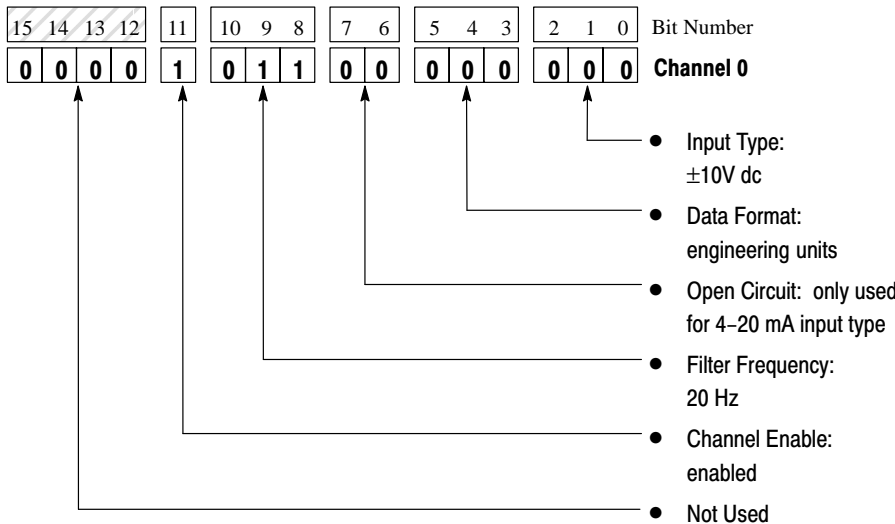
Your programming device's user manual.

If you are converting from a 1746-NI4 to a 1746-NI8 based system, see Appendix C.

<b>7. Determine the operating parameters.</b>	<b>Reference</b>
---	------------------

Determine the operating parameters for channel 0. This example shows the channel 0 configuration word. The module is in slot 1. The default configuration word is all zero's.

**Chapter 4**  
*(Preliminary Operating Considerations)*



**Chapter 5**  
*(Channel Configuration, Data, and Status)*

**Appendix B**  
*(NI8 Configuration Worksheet)*

**Appendix C**  
*(Converting from 1746-NI4 to 1746-NI8)*

1746-NI8 Module Output Image - Channel Configuration			Class 1	Class 3
O:1.0	channel 0 configuration word	bit mapped field	•	•
O:1.1	channel 1 configuration word	bit mapped field	•	•
O:1.2	channel 2 configuration word	bit mapped field	•	•
O:1.3	channel 3 configuration word	bit mapped field	•	•
O:1.4	channel 4 configuration word	bit mapped field	•	•
O:1.5	channel 5 configuration word	bit mapped field	•	•
O:1.6	channel 6 configuration word	bit mapped field	•	•
O:1.7	channel 7 configuration word	bit mapped field	•	•
O:1.8	lower scale limit range 0	16 bit integer		•
O:1.9	upper scale limit range 0	16 bit integer		•
O:1.10	lower scale limit range 1	16 bit integer		•
O:1.11	upper scale limit range 1	16 bit integer		•

<b>8.</b>	<b>Program the configuration.</b>	<b>Reference</b>
-----------	-----------------------------------	------------------

Do the programming necessary to establish the new configuration word setting in the previous step.

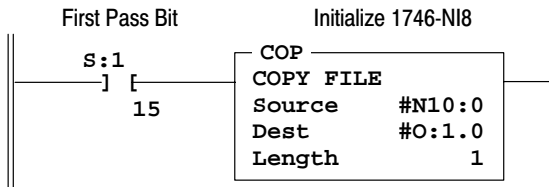
1. Create integer file N10. Integer file N10 should contain one element for each channel used.  
(For this example we only need one, N10:0.)
2. Enter the configuration parameters from step 7 for channel 0 into integer N10:0.
3. Program an instruction in your ladder logic to copy the contents of N10:0 to output word O:1.0.

**Chapter 6**  
*(Ladder Logic Configuration Examples)*

**Chapter 8**  
*(Application Examples)*

**DATA FILE N10**

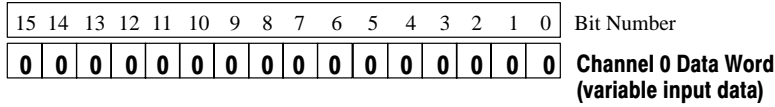
Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0



On power up, the first pass bit (S:1/15) is set for one scan, enabling the COPY instruction that transfers the channel configuration word 0. This configures and enables the channel.

<b>9.</b>	<b>Write the ladder program.</b>	<b>Reference</b>
-----------	----------------------------------	------------------

Write the remainder of the ladder logic program that specifies how your analog input data will be processed for your application. In this procedure the module is located in slot 1.



**Chapter 5**  
*(Channel Configuration, Data, and Status)*

**Chapter 6**  
*(Ladder Logic Configuration Examples)*

**Chapter 8**  
*(Application Examples)*

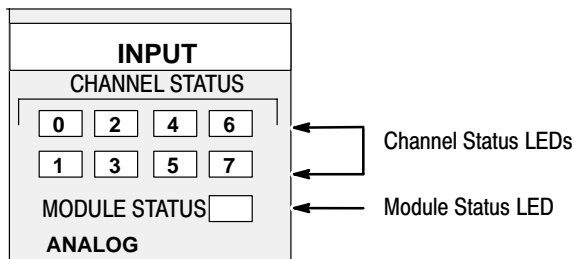
Your programming device's user manual.

1746-NI8 Module Input Image - Data Word			Class 1	Class 3
I:1.0	channel 0 data word	16 bit integer	•	•
I:1.1	channel 1 data word	16 bit integer	•	•
I:1.2	channel 2 data word	16 bit integer	•	•
I:1.3	channel 3 data word	16 bit integer	•	•
I:1.4	channel 4 data word	16 bit integer	•	•
I:1.5	channel 5 data word	16 bit integer	•	•
I:1.6	channel 6 data word	16 bit integer	•	•
I:1.7	channel 7 data word	16 bit integer	•	•

<b>10.</b>	<b>Go through the system start-up procedure.</b>	<b>Reference</b>
------------	--	------------------

Apply power. Download your program to the SLC processor and put the controller into Run mode. During a normal start up, the module status LED and any enabled channel status LED turn on.

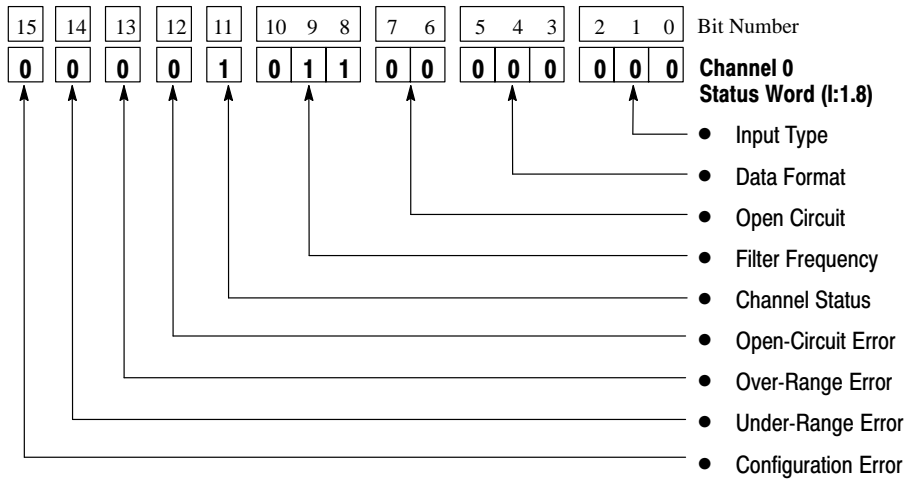
**Chapter 7**  
*(Module Diagnostics and Troubleshooting)*



<b>11. Check that the module is operating correctly.</b>	<b>Reference</b>
--	------------------

(Optional) If the Module Status LED is off, or if the Channel 0 LED is off or blinking, refer to chapter 7.

Class 3 Interface – Monitor the status of input channel 0 to determine its configuration setting and operational status. This is useful for troubleshooting when the blinking channel LED indicates that an error has occurred. The example below shows the configuration for channel 0 with no errors.



**Chapter 5**  
*(Channel Configuration, Data, and Status)*

**Chapter 7**  
*(Module Diagnostics and Troubleshooting)*

**Chapter 8**  
*(Application Examples)*

## Installation and Wiring

This chapter tells you how to:

- avoid electrostatic damage
- determine the chassis power requirement for the module
- choose a location for the module in the SLC chassis
- set the channels for voltage or current analog input
- install the module
- wire the module's terminal block
- wire input devices

### Electrostatic Damage

Electrostatic discharge can damage semiconductor devices inside this module if you touch backplane connector pins. Guard against electrostatic damage by observing the following precautions.



**ATTENTION:** Electrostatic discharge can degrade performance or cause permanent damage. Handle the module as stated below.

- Wear an approved wrist strap grounding device when handling the module.
- Touch a grounded object to rid yourself of electrostatic charge before handling the module.
- Handle the module from the front, away from the backplane connector. Do not touch backplane connector pins.
- Keep the module in its static-shield bag when not in use, or during shipment.

### 1746-NI8 Power Requirements

The 1746-NI8 module receives its power through the SLC 500 chassis backplane from the fixed or modular +5V dc/+24V dc chassis power supply. The +5V dc backplane supply powers the SLC circuitry, and the +24V dc backplane supply powers the module analog circuitry. The maximum current drawn by the module is shown in the table below.

5V dc Amps	24V dc Amps
0.200	0.100

When you are using a *modular system* configuration, add the values shown in the table above to the requirements of all other modules in the SLC chassis to prevent overloading the chassis power supply.

When using a *fixed system* controller, refer to the **Important** note about compatibility in a 2-slot expansion chassis on page 3–2.



## Module Location in Chassis

Fixed Controller Compatibility Table

	NI8	5V dc (Amps)	24V dc (Amps)
IA4	•	0.035	-
IA8	•	0.050	-
IA16	•	0.085	-
IM4	•	0.035	-
IM8	•	0.050	-
IM16	•	0.085	-
OA8		0.185	-
OAP12		0.370	-
OA16		0.370	-
IB8	•	0.050	-
IB16	•	0.085	-
IC16	•	0.085	-
ITB16	•	0.085	-
ITV16	•	0.085	-
IV8	•	0.050	-
IV16	•	0.085	-
IG16	•	0.140	-
OV8	•	0.135	-
OV16		0.270	-
OB8	•	0.135	-
OBP8	•	0.135	-
OBP16		0.250	-
OVP16		0.250	-
OG16		0.180	-
OW4	•	0.045	0.045
OW8		0.085	0.090
OW16		0.170	0.180
IO4	•	0.030	0.025
IO8	•	0.060	0.045
IO12		0.090	0.070
NI4		0.025	0.085
NI8		0.200	0.100
NIO4I		0.055	0.145
FIO4I		0.055	0.150
FIO4V		0.055	0.120
NIO4V		0.055	0.115
NT4	•	0.060	0.040
NR4	•	0.050	0.050
HSTP1		0.200	-
IH16	•	0.085	-
DCM		0.360	-
HS		0.300	-
OB16		0.280	-
IN16	•	0.085	-
<b>BASn</b>		0.150	0.125
BAS		0.150	0.040
OB32		0.452	-
OV32		0.452	-
IV32		0.106	-
IB32		0.106	-
OX8		0.085	0.090
NO4I	▽	0.055	0.195
NO4V	▽	0.055	0.145
<b>KE<sub>n</sub></b>		0.150	0.125
KE		0.150	0.040

## Modular Chassis Considerations

Place your 1746-NI8 module in any slot of an SLC 500 modular, or modular expansion chassis, except for the extreme left slot (slot 0) in the first chassis. This slot is reserved for the processor or adapter modules.

**Important:** For applications using the upper limit of the operating temperature range, the 1746-NI8 module (or multiple 1746-NI8 modules) should be placed in the right most slot(s) of the chassis. The specification for operating temperature is:

---

### Operating Temperature Range

---

0°C to 55°C (32°F to 131°F) in any slot except slot 0

0°C to 60°C (32°F to 140°F) in right most slot of chassis

---

## Fixed Expansion Chassis Considerations

**Important:** The 2-slot, SLC 500 fixed I/O expansion chassis (1746-A2) will support only specific combinations of modules. If you are using the 1746-NI8 module in a 2-slot expansion chassis with another SLC I/O or communication module, refer to the table at the left to determine whether the combination can be supported. In the table:

- A dot indicates a valid combination.
- No symbol indicates an invalid combination.
- A triangle indicates an external power supply is required. (Refer to the Analog I/O Module User Manual, publication 1746-6.4.)

When using the table, be aware that there are certain conditions that affect the compatibility characteristics of the BASIC module (**BAS**) and the DH-485/RS-232C module (**KE**).

When you use the BAS module or the KE module to supply power to a 1747-AIC Link Coupler, the Link Coupler draws its power through the module. The higher current drawn by the AIC at 24V dc is calculated and recorded in the table for the modules identified as **BASn** (BAS networked) or **KE<sub>n</sub>** (KE networked). Make sure to refer to these modules if your application uses the BAS or KE module in this way.

## General Considerations

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. Analog inputs are highly susceptible to electrical noise. Electrical noise coupled to the analog inputs will reduce the performance (accuracy) of the module.

Group your modules to minimize adverse effects from radiated electrical noise and heat. Consider the following conditions when selecting a slot for the analog input module. Position the module:

- in a slot away from sources of electrical noise such as hard-contact switches, relays, and AC motor drives
- away from modules which generate significant radiated heat, such as the 32-point I/O modules

In addition, route shielded twisted pair analog input wiring away from any high voltage I/O wiring.

## Compliance to European Union Directives

This product is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

### EMC Directive

The 1746-NI8 analog input module is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2  
EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2  
EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This product is intended for use in an industrial environment.

## Module Installation and Removal

When installing the module in a chassis, it is not necessary to remove the terminal block from the module. However, if the terminal block is removed, use the write-on label located on the side of the terminal block to identify the module location and type.

### Terminal Block Removal

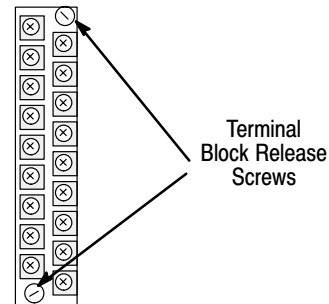
SLOT _____	RACK _____
● MODULE _____	



**ATTENTION:** Never install, remove, or wire modules with power applied to the chassis or devices wired to the module.

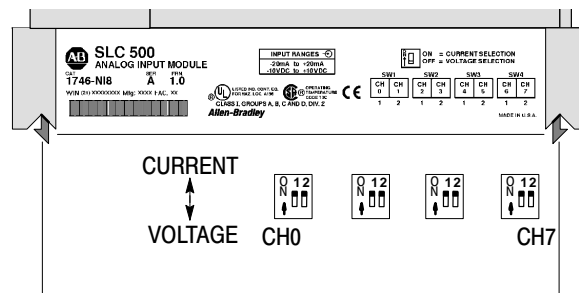
To remove the terminal block:

1. Loosen the two terminal block release screws.
2. Grasp the terminal block at the top and bottom and pull outward and down.



### Switch Settings to Select Voltage or Current Input

Select between voltage and current inputs before installing the module in the chassis. Use the DIP switches on the module circuit board. The switch settings are OFF = VOLTAGE INPUT and ON = CURRENT INPUT. Do this for channels 0-7.



## Module Installation Procedure

1. Align the circuit board of the analog input module with the card guides located at the top and bottom of the chassis.
2. Slide the module into the chassis until both top and bottom retaining clips are secured. Apply firm even pressure on the module to attach it to its backplane connector. Never force the module into the slot.
3. Cover all unused slots with the Card Slot Filler, Catalog Number 1746-N2.

**Important:** For applications using the upper limit of the operating temperature range, the 1746-NI8 module (or multiple 1746-NI8 modules) should be placed in the right most slot(s) of the chassis. The specification for operating temperature is:

---

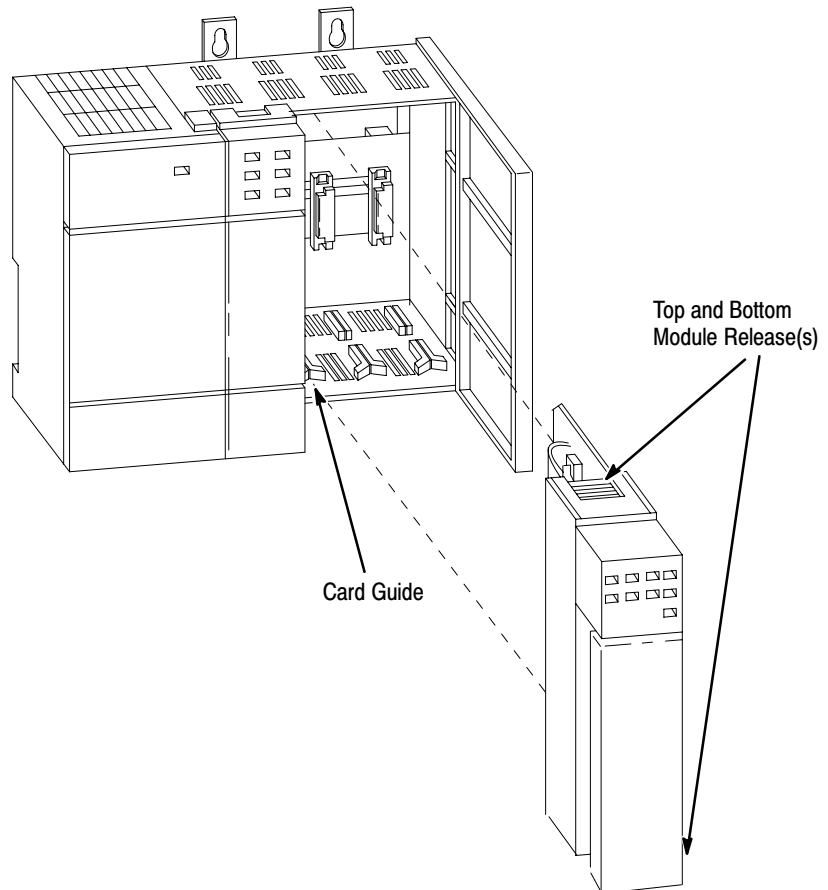
**Operating Temperature Range**

---

0°C to 55°C (32°F to 131°F) in any slot except slot 0

0°C to 60°C (32°F to 140°F) in right most slot of chassis

---



## Module Removal Procedure

1. Press the releases at the top and bottom of the module and slide the module out of the chassis slot.
2. Cover all unused slots with the Card Slot Filler, Catalog Number 1746-N2.

## Terminal Wiring

The 1746-NI8 module contains an 18-position, removable terminal block. The terminal pin-out is shown below.

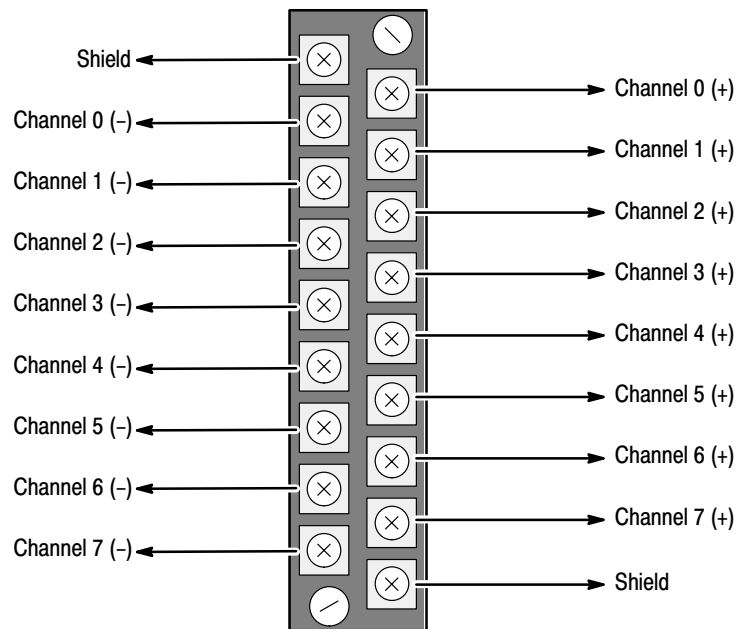


**ATTENTION:** Disconnect power to the SLC before attempting to install, remove, or wire the removable terminal wiring block.

To avoid cracking the removable terminal block, alternate the removal of the slotted terminal block release screws.

## Terminal Block

(Terminal Block Spare Part Catalog Number 1746-RT25G)

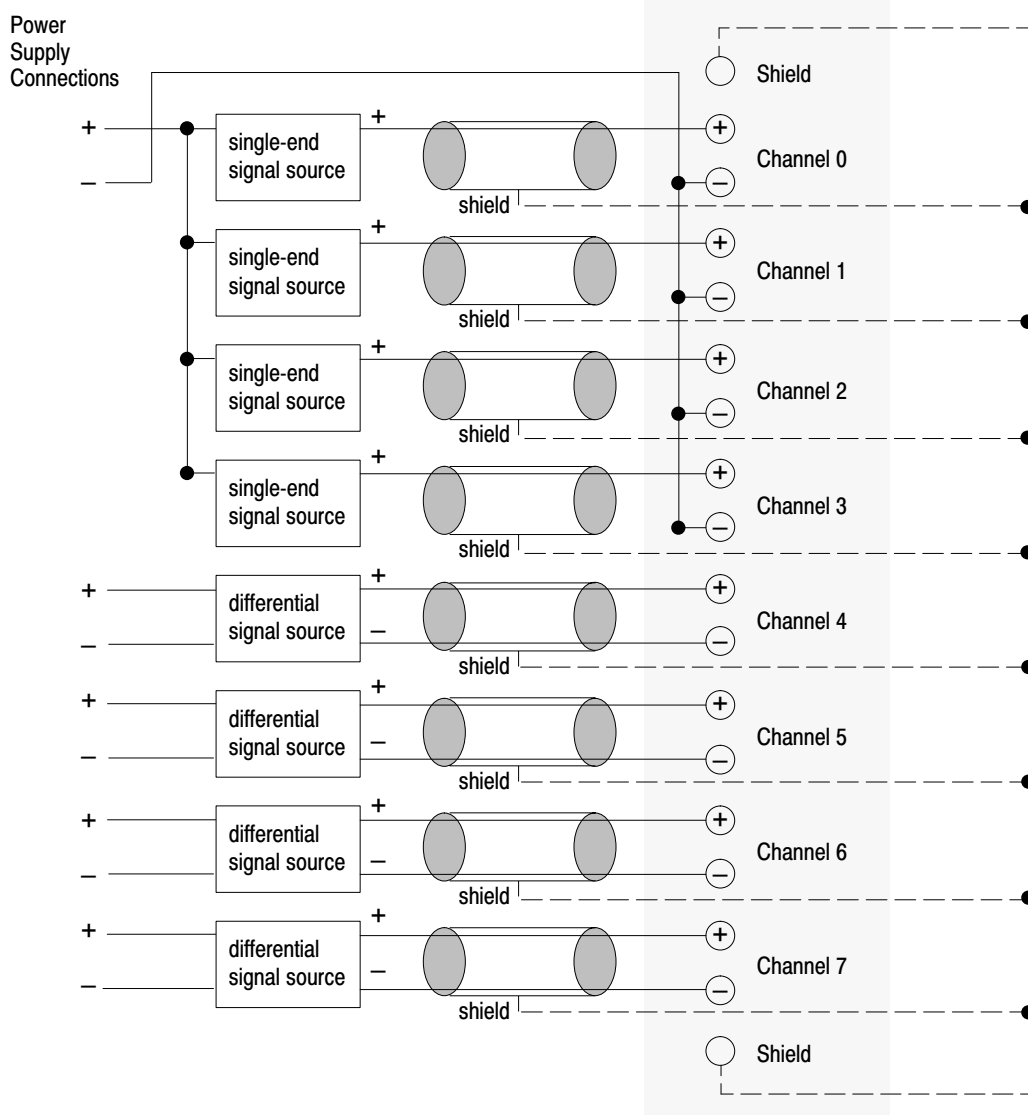


## Wiring Single-Ended and Differential Inputs

The diagram below shows typical wiring for the module.

**Important:** Follow these guidelines when wiring the module.

- Use shielded communication cable (Belden 8761) and keep length as short as possible.
- Connect only one end of the cable shield to earth ground.
- Connect the shield drain wires for channels 0-3 to the top shield terminal.
- Connect the shield drain wires for channels 4-7 to the bottom shield terminal.
- Shield terminals are internally connected to chassis ground which is connected to earth ground via the SLC backplane.
- Single-ended source commons may be jumpered together at the terminal block.
- Channels are not isolated from each other.
- If a differential signal source has an analog common, it can not and must not be connected to the module.
- Common mode voltage range is  $\pm 10.5$  volts. The voltage between any two terminals must be less than 21 volts.
- The module does not provide power for the analog inputs.
- Use a power supply that matches the transmitter (sensor) specifications.

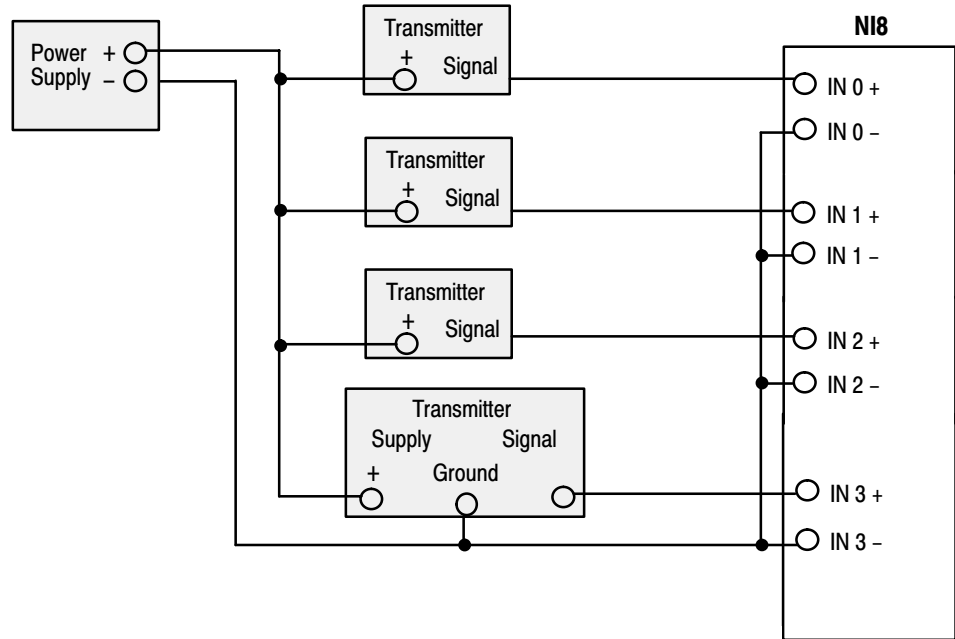


**Wiring Schematic for Single-ended Analog Input Connections**

When wiring single-ended analog input devices to the analog input module, the number of total wires necessary can be limited by jumpering all "IN-" terminals together. Note that differential inputs are more immune to noise than single-ended inputs.

**Important:** The module does *not* provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.

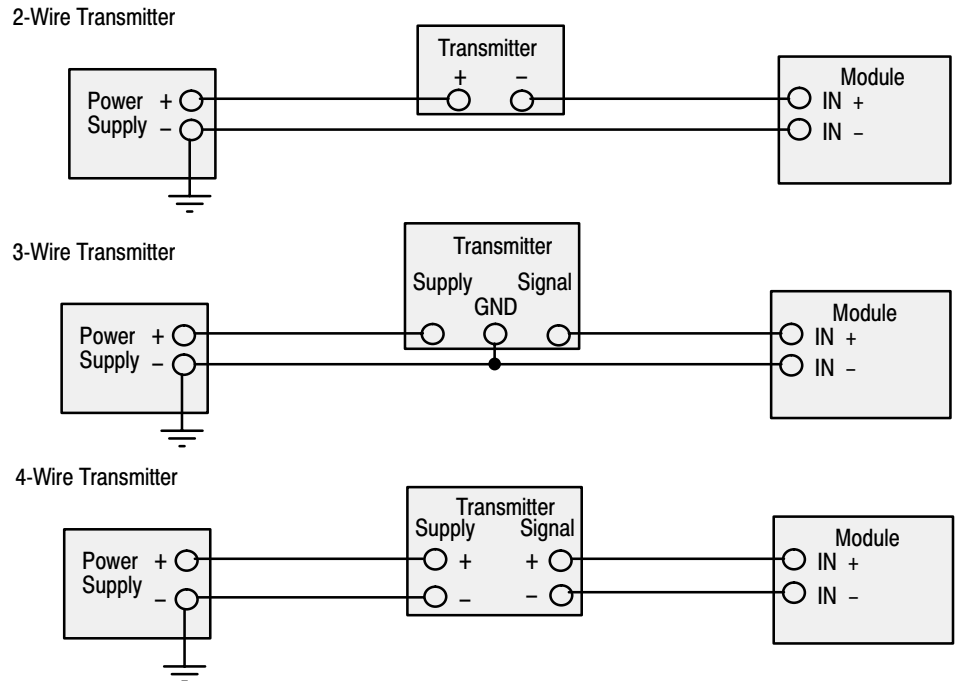
**Important:** Follow the guidelines on pages 3-7 and 3-9 when wiring the module.



**Wiring Schematics for 2, 3, and 4-Wire Analog Input Devices**

**Important:** The module does *not* provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.

**Important:** Follow the guidelines on pages 3-7 and 3-9 when wiring the module.



## Wiring Guidelines



**ATTENTION:** To prevent shock hazard, care should be taken when wiring the module to analog signal sources. Before wiring any analog module, disconnect power from the SLC 500 system and from any other source to the analog module.

Follow the guidelines below when planning your system wiring.

- To limit noise, keep signal wires as far away as possible from power and load lines.
- To ensure proper operation and high immunity to electrical noise, always use Belden 8761 (shielded, twisted pair) or equivalent wire.
- Connect the shield drain wire to the shield terminal on the 1746-NI8 module. Up to four shield wires may be connected to each shield connection screw terminal that provides a connection to chassis ground.
- Tighten terminal screws using a flat or cross-head screwdriver. Each screw should be turned tight enough to immobilize the wire's end. Excessive tightening can strip the terminal screw. The torque applied to each screw should not exceed 5 lb-in (0.565 Nm) for each terminal.
- Follow system grounding and wiring guidelines found in your SLC 500 Modular Hardware Style Installation and Operation Manual, publication 1747-6.2.

## Input Devices

### Transducer Source Impedance

If the source impedance of the input device and associated cabling is too high, it will affect the accuracy of the channel data word. Source impedance of 500 ohms will produce up to 0.05% of module error over and above the specified accuracy of the module.

You can compensate for device impedance error by implementing the following equation in your ladder program:

$$V_S - V_{measured} \times \left[ \frac{(R_s + R_{in})}{R_{in}} \right]$$

where:

- $V_S$  = input device voltage
- $R_s$  = input device source impedance
- $R_{in}$  = 1746-NI8 input impedance (1 M $\Omega$ )

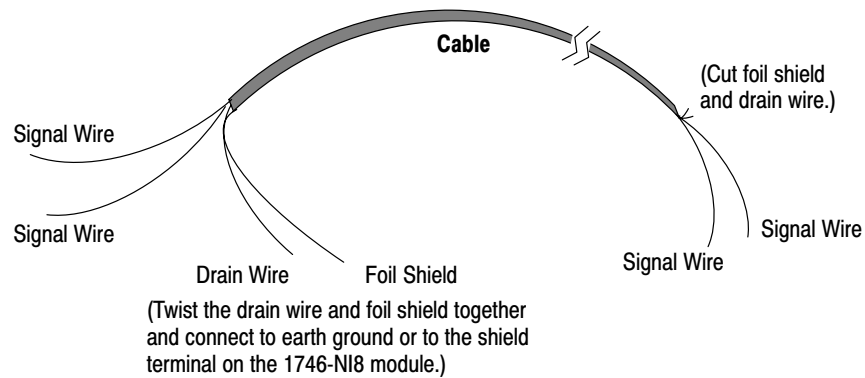


### Wiring Input Devices to the 1746-NI8

After the analog input module is properly installed in the chassis, follow the wiring procedure below using Belden 8761 cable.



**ATTENTION:** Care should be taken to avoid connecting a voltage source to a channel configured for current input. Improper module operation or damage to the voltage source can occur.



To wire your 1746-NI8 module follow these steps.

1. At each end of the cable, strip some casing to expose the individual wires.
2. Trim the signal wires to 2-inch lengths. Strip about 3/16 inch (5 mm) of insulation away to expose the end of the wire.
3. At one end of the cable, twist the drain wire and foil shield together. This end of the cable will be connected to one of the shield terminals on 1746-NI8 module. Connect shields for channels 0-3 to the upper shield terminal, and shields for channels 4-7 to the lower shield terminal.
4. At the other end of the cable, cut the drain wire and foil shield back to the cable.
5. Connect the signal wires and the shield drain wire to the 1746-NI8 terminal block. Connect the other end of the cable to the input device.
6. Repeat steps 1 through 6 for each channel on the module.

## Preliminary Operating Considerations

This chapter explains how the analog input module and the SLC 500 processor communicate through the module's input and output image. It lists the preliminary setup and operation required before the module can function in a 1746 I/O system. Topics discussed include how to:

- enter the module ID code
- select the Class 1 or Class 3 interface
- address your 1746-NI8 module
- select the proper input filter for each channel
- calculate the module update time
- interpret the module response to slot disabling

### Module ID Code

The module identification code is a unique number encoded for each 1746 I/O module. The code defines for the processor the type of I/O or specialty module residing in a specific slot in the 1746 chassis.

Catalog Number	ID Code
1746-NI8	3526 - Class 1 interface 12726 - Class 3 interface

**Important:** All programming software does not support configuration for Class 3 operation.

- Advanced Programming Software (APS) supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- SLC 500 A.I. Series™ Programming Software supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- RSLogix 500™, version 1.30 or later, supports Class 3 configuration. After entering the ID code (12726), select Class 3 operation.
- Earlier versions of RSLogix 500 will only support configuration for Class 1 operation. Contact Rockwell Software for information on upgrading your software.

## Class 1 and Class 3 Interface

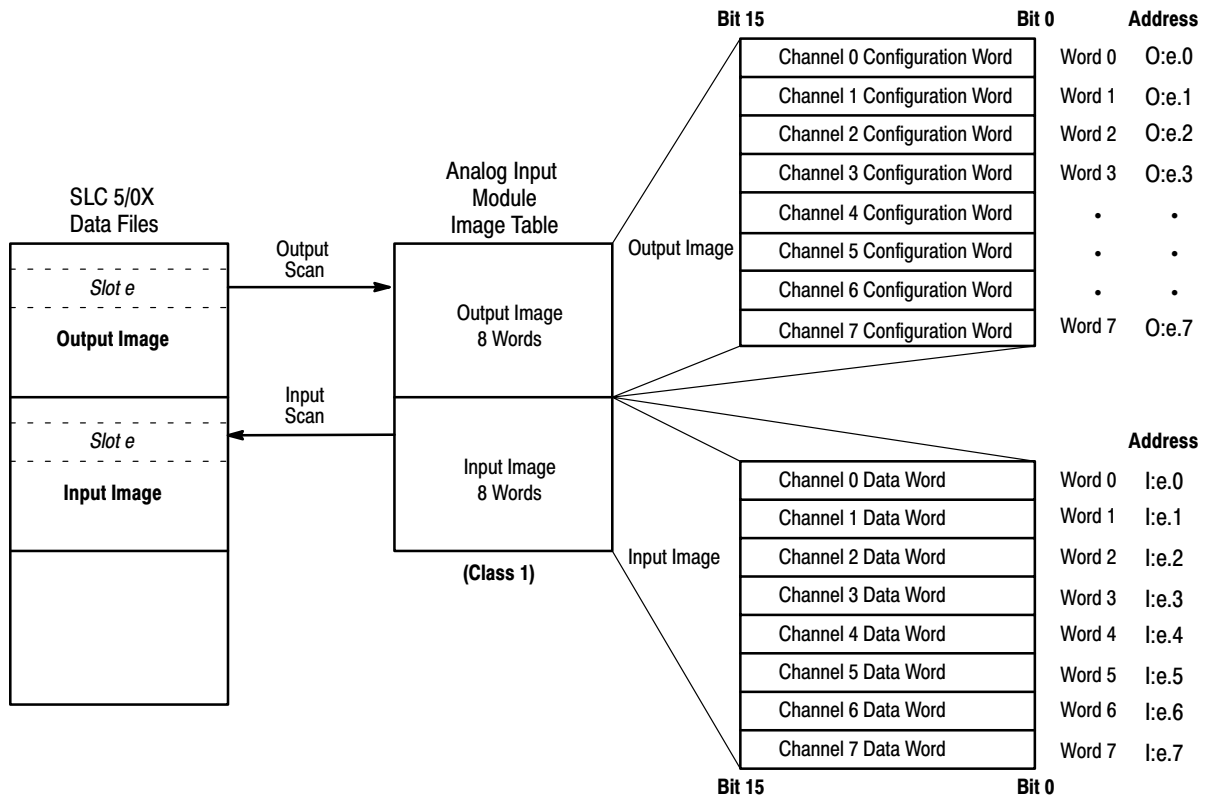
The 1746-NI8 analog input module has multiclass interface capabilities. Class 1 is the standard configuration. The module can be configured through the user program for Class 3 which enables user-defined data scaling and monitoring of channel status words.

Configuration	Class 1	Class 3
<b>Compatible SLC Processors</b>	SLC 500 fixed, SLC 5/01, SLC 5/02, SLC 5/03, and SLC 5/04	SLC 5/02, SLC 5/03, and SLC 5/04
<b>Compatible Chassis</b>	local chassis or remote chassis with a 1747-ASB module	local chassis
<b>Input and Output Images</b>	<b>output image:</b> 8 channel configuration words <b>input image:</b> 8 channel data words	<b>output image:</b> 8 channel configuration words and 4 limit ranges for user-defined scaling data format <b>input image:</b> 8 channel data words and 8 channel status words
<b>Default</b>	Class 1 is the default on power-up	Class 3 is programmable by user

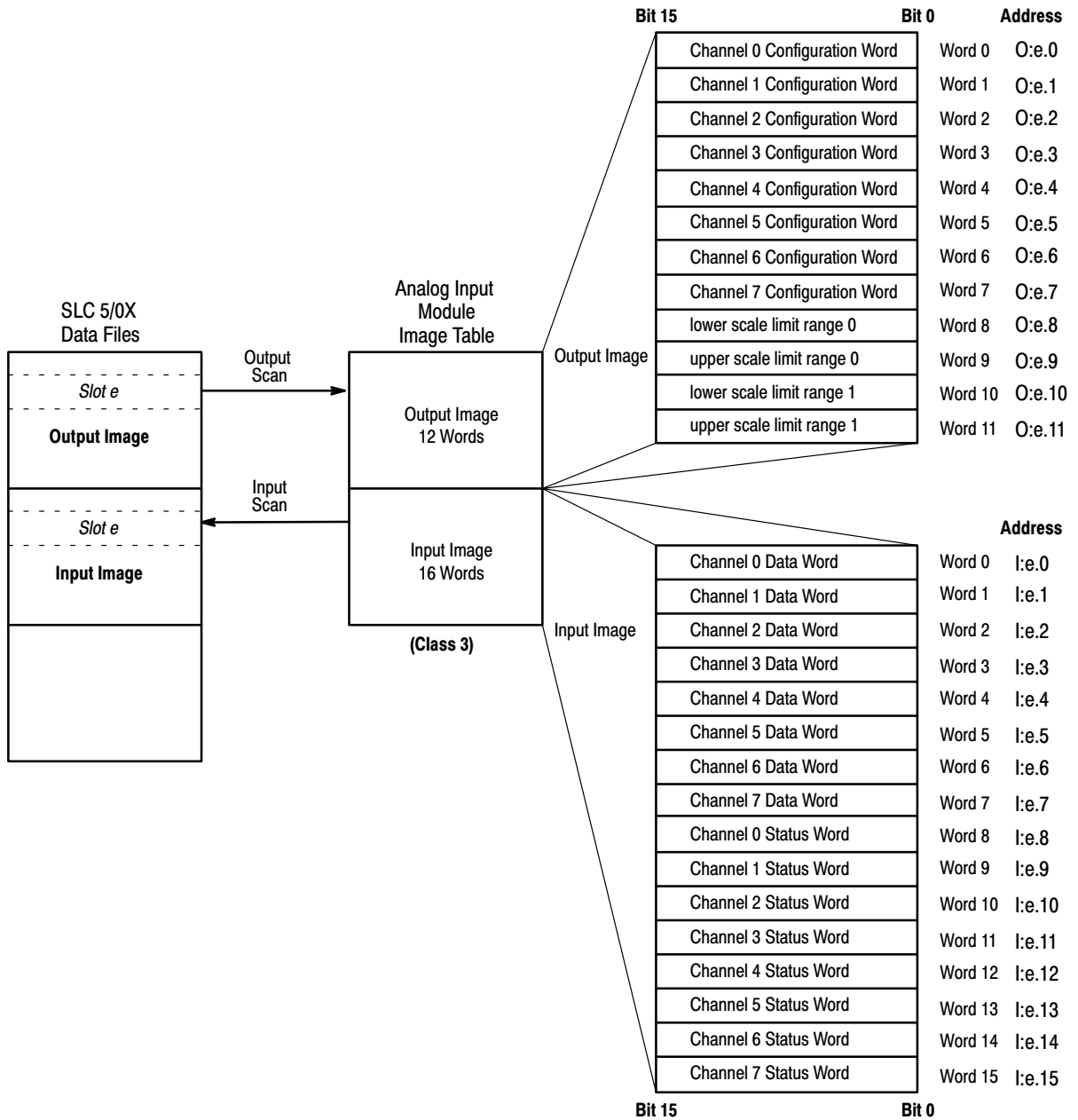
## Module Addressing

The following memory maps show you how the input and output input image tables are defined for Class 1 and Class 3.

### Class 1 Memory Map



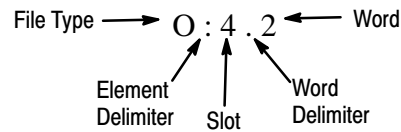
### Class 3 Memory Map



### Output Image - Configuration Words

The module output image (defined as the output from the processor to the module) contains information that you configure to define the way a specific module channel will work. Each output word configures a single channel.

**Example** – If you want to configure channel 2 on the analog module located in slot 4 in the chassis, your address would be O:4.2.



Chapter 5, *Channel Configuration, Data, and Status*, gives you detailed bit information about the data content of the configuration word.

### Input Image – Data Words and Status Words

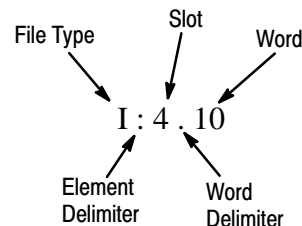
The input image (defined as the input from the module to the processor) represents data words and status words.

**Important:** Status words are only available when the module is configured for Class 3.

Input words 0–7 (data words) hold the input data that represent the value of analog inputs for channels 0–7. This data word is valid only when the channel is enabled and there are no channel errors.

Input words 8–15 (status words) contain the status of channels 0–7 respectively. The status bits for a particular channel reflect the configuration settings that you entered into the output image configuration word for that channel and provide information about the channel’s operational state. To receive valid status information the channel must be enabled, and the channel must have processed any configuration changes that may have been made to the configuration word.

**Example** – To obtain the status of channel 2 (input word 10) of the analog module located in slot 4 in the SLC chassis, use address I:4.10.

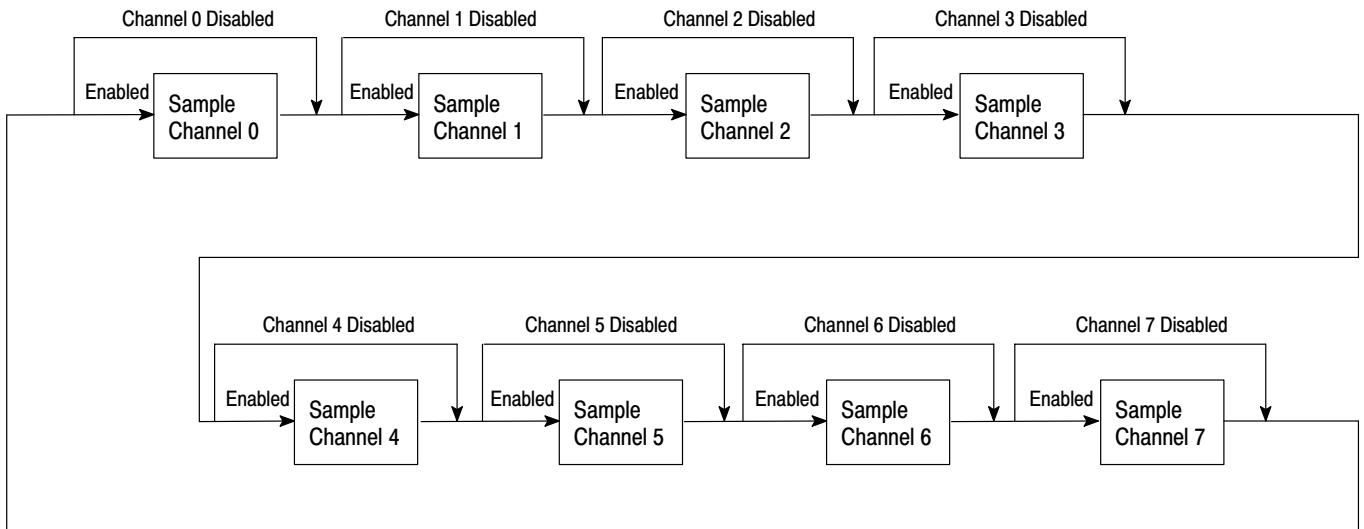


Chapter 5, *Channel Configuration, Data, and Status*, gives you detailed bit information about the content of the data word and the status word.

## Module Update Time

The module update time is defined as the time required for the module to sample and convert the input signals of all enabled input channels and provide the resulting data values to the SLC processor. Module update time can be calculated by adding the the sum of all enabled channel sample times (0.75 msec per channel).

The 1746-NI8 module sequentially samples the channels in a continuous loop.



The following table shows the module update time. The module update time is the same regardless of the filter frequency. The fastest module update time occurs when only one channel is enabled. The slowest module update time occurs when 8 channels are enabled.

Module Update Time	
Number of Channels Enabled	Update Time
1	0.75 msec
2	1.50 msec
3	2.25 msec
4	3.00 msec
5	3.75 msec
6	4.50 msec
7	5.25 msec
8	6.00 msec

## Channel Turn-On, Turn-Off, and Reconfiguration Times

The table below gives you the turn-on, turn-off, and reconfiguration times for enabling or disabling a channel.

	Description	Duration <sup>①</sup>
<b>Turn-On Time</b>	The time it takes to set the status bit (transition from 0 to 1) in the status word, after setting the enable bit in the configuration word.	101 to 107 msec maximum
<b>Turn-Off Time</b>	The time it takes to reset the status bit (transition from 1 to 0) in the status word, after resetting the enable bit in the configuration word.	1 to 7 msec maximum
<b>Reconfiguration Time</b>	The time it takes to change a channel configuration if the device type, filter frequency, or configuration error bits are different from the current setting. The enable bit remains in a steady state of 1. Changing data format does not require reconfiguration time.	101 to 107 msec maximum

<sup>①</sup> The duration varies with the number of channels that are enabled.

## Response to Slot Disabling

By writing to the status file in your modular SLC processor you can disable any chassis slot. Refer to your programming device's manual for the slot disable/enable procedure.



**ATTENTION:** Always understand the implications of disabling a module before using the slot disable feature.

## Input Response

When a slot is disabled, the 1746-NI8 module continues to update its input image table. However, the SLC processor does not read inputs from a module that is disabled. Therefore, when the processor disables the module slot, the module inputs appearing in the processor image table remain in their last state, and the module's updated image table is not read. When the processor re-enables the module slot, the current state of the module inputs are read by the processor during the subsequent scan.

## Output Response

The SLC processor may change the module output data (configuration) as it appears in the processor output image. However, this data is not transferred to the module. The outputs are held in their last state. When the slot is re-enabled, the current data in the processor image is transferred to the module.

## Channel Filter Frequency Selection

The module uses a digital low pass filter that provides noise rejection for the input signals. The digital filter is programmable, allowing you to select from eight filter frequencies for each channel.

Selecting a low value (i.e., 1 Hz) for the channel filter frequency provides the best noise rejection for a channel. Selecting a high value for the channel filter frequency provides lower noise rejection and faster step response time. See page 4-10 for more information on noise rejection.

The following table shows the available filter frequencies and step response for each filter frequency.

Filter Frequency	Step Response Time		
	1% Accuracy <sup>①</sup>	0.1% Accuracy <sup>①</sup>	0.05% Accuracy <sup>①</sup>
1 Hz	730 msec + module update time	1100 msec + module update time	1200 msec + module update time
2 Hz	365 msec + module update time	550 msec + module update time	600 msec + module update time
5 Hz	146 msec + module update time	220 msec + module update time	240 msec + module update time
10 Hz	73 msec + module update time	110 msec + module update time	120 msec + module update time
20 Hz	36.5 msec + module update time	55 msec + module update time	60 msec + module update time
50 Hz	14.5 msec + module update time	22 msec + module update time	24 msec + module update time
75 Hz	10 msec + module update time	15 msec + module update time	18 msec + module update time
no filter	0.5 msec + module update time	0.75 msec + module update time	0.75 msec + module update time

<sup>①</sup> The module accuracy for current inputs is 0.05%, and for voltage inputs is 0.1%.

## Channel Step Response

The channel filter frequency determines the channel's step response. The step response is time required for the channel data word to reach a specified percentage of its expected final value. This means that if an input signal changes faster than the channel step response, a portion of that signal will be attenuated by the channel filter. The table above shows the step response for each filter frequency.

## Channel Frequency

### Channel Cut-Off Frequency

The channel filter frequency selection determines a channel's cut-off frequency, also called the -3 dB frequency. The cut-off frequency is defined as the point on the input channel frequency response curve where frequency components of the input signal are passed with 3 dB of attenuation. All frequency components at or below the cut-off frequency are passed by the digital filter with less than 3 dB of attenuation. All frequency components above the cut-off frequency are increasingly attenuated.



The cut-off frequency for each input channel is defined by its filter frequency selection. Choose a filter frequency so that your fastest changing signal is below that of the filter's cut-off frequency. The cut-off frequency should not be confused with update time. The cut-off frequency relates how the digital filter attenuates frequency components of the input signal. The update time defines the rate at which an input channel is scanned and its channel data word is updated.

### Aliasing Frequency

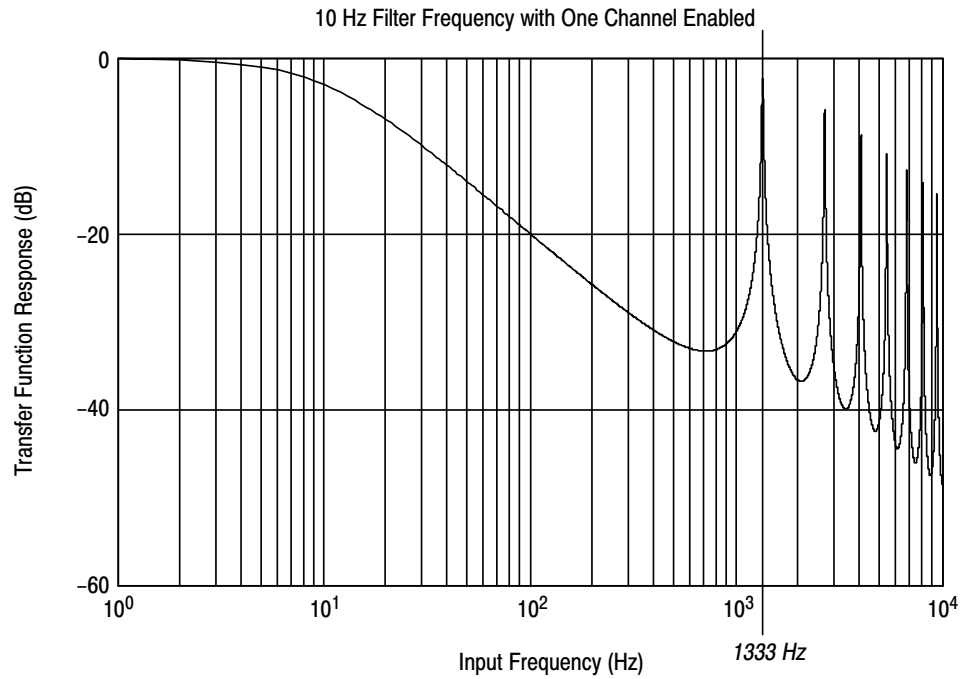
Aliasing is a natural characteristic of discrete time sampling of analog signals. This can result in erroneous data in the data channel word. Aliasing is usually not a problem because the duration of the high frequency signal is much shorter than the program scan time.

Aliasing begins at a lower frequency when more channels are enabled. Anti-aliasing filters are available, but it is recommended that you first check your transducer for malfunctions as the filters are fairly expensive.

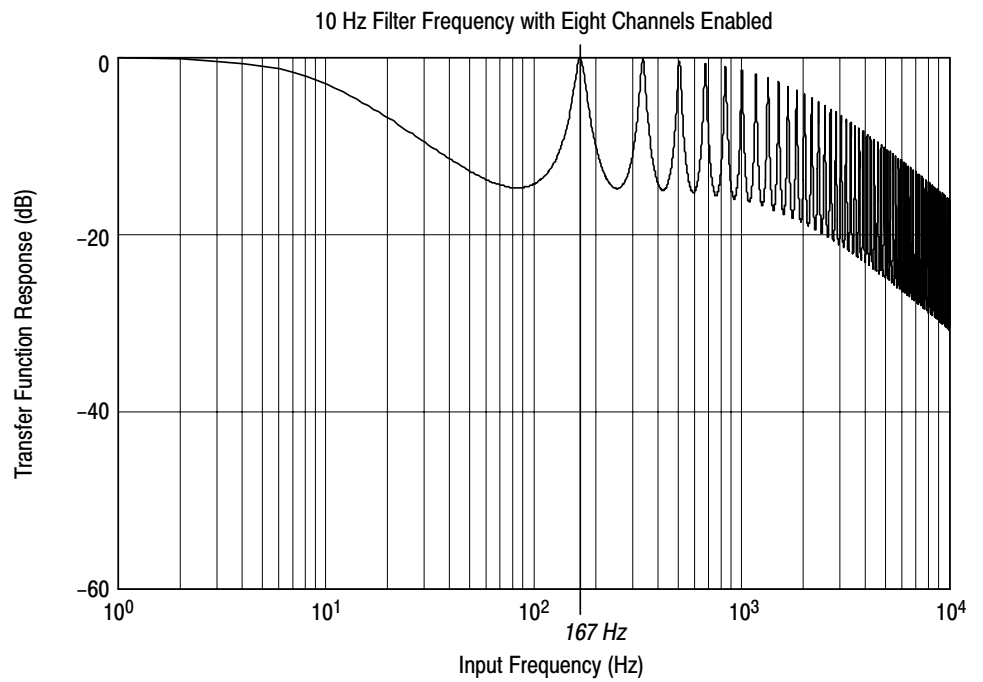
Aliasing occurs when unwanted signals, at a frequency greater than the effective sampling rate, are present. The effective sampling rate is determined by the number of enabled channels (n). The first aliasing frequency occurs at:  $f_a = 1 / (n * 0.00075)$ . Subsequent aliasing frequencies occur at integer multiples of  $f_a$ . The following table shows the first alias frequency, based on the number of channels enabled.

Aliasing Frequency for Number of Channels Enabled							
1 Channel	2 Channels	3 Channels	4 Channels	5 Channels	6 Channels	7 Channels	8 Channels
1333 Hz	666 Hz	444 Hz	333 Hz	267 Hz	222 Hz	190 Hz	167 Hz

The graph below shows the aliasing characteristic at a filter frequency of 10 Hz with one channel enabled.



The graph below shows the aliasing characteristic at a filter frequency of 10 Hz with eight channels enabled.



**Noise Rejection**

Rejection of common mode noise is inherent in the hardware design of the module. Common Mode Rejection is better than  $-75$  dB for common mode DC signals and better than  $-100$  dB for common mode 50 Hz and 60 Hz AC signals. The module performs well in the presence of common mode noise as long as the signals applied to the user terminals do not exceed the common mode voltage rating ( $\pm 10.5$  Volts) of the module. Improper earth/chassis ground connections may be a source of common mode noise.

Rejection of normal mode noise is implemented in the firmware and is a function of the filter frequency selected by the user. A lower frequency filter will reject more normal mode noise than a higher frequency filter. Transducer power supply noise, transducer circuit noise, or process variable irregularities may be sources of normal mode noise.

## Channel Configuration, Data, and Status

This chapter examines the channel configuration word and the channel status word bit by bit, and explains how the module uses configuration data and generates status during operation. It gives you information about how to:

- configure a channel
- scale the channel data
- check a channel's status

### Channel Configuration

The channel configuration word is a part of the 1746-NI8 module's output image as shown below. The module output image uses 8 word values when the module is in Class 1 mode, and 12 word values when the module is in Class 3 mode. A description of the output image is shown below.

1746-NI8 Module Output Image – Channel Configuration			Class 1	Class 3
O:e.0	channel 0 configuration word	bit mapped field	•	•
O:e.1	channel 1 configuration word	bit mapped field	•	•
O:e.2	channel 2 configuration word	bit mapped field	•	•
O:e.3	channel 3 configuration word	bit mapped field	•	•
O:e.4	channel 4 configuration word	bit mapped field	•	•
O:e.5	channel 5 configuration word	bit mapped field	•	•
O:e.6	channel 6 configuration word	bit mapped field	•	•
O:e.7	channel 7 configuration word	bit mapped field	•	•
O:e.8	lower scale limit range 0	16 bit integer		•
O:e.9	upper scale limit range 0	16 bit integer		•
O:e.10	lower scale limit range 1	16 bit integer		•
O:e.11	upper scale limit range 1	16 bit integer		•

After module installation (and voltage or current is selected via the DIP switches) each channel must be configured to establish the way the channel operates. You configure the channel by entering bit values into the configuration word using your programming device. A bit-by-bit examination of the configuration word is provided in the chart on page 5–2. Programming is discussed in chapter 6. Addressing is explained in chapter 4.

The configuration word default setting is all zeros.

## Channel Configuration Procedure

The channel configuration word consists of bit fields, the settings of which determine how the channel will operate. See the chart below and the descriptions that follow for configuration information. Appendix B contains a configuration worksheet.

After determining the configuration for each channel, follow the steps outlined in chapter 2, *Quick Start*, or in chapter 6, *Ladder Logic Configuration Examples*, to enter this configuration data into your ladder program and copy it to the 1746-NI8 module.

**Channel Configuration Word (O:e.0 through O:e.11) – Bit Definitions**

Bit(s)	Define	To Select <sup>①</sup>	Make these bit settings in the Channel Configuration Word																	
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
0-2	Input Type	SET DIP SWITCH TO "OFF" FOR VOLTAGE INPUT	± 10V dc														0	0	0	
			1-5V dc															0	0	1
			0-5V dc															0	1	0
			0-10V dc															0	1	1
		SET DIP SWITCH TO "ON" FOR CURRENT INPUT	0-20 mA															1	0	0
			4-20 mA															1	0	1
			± 20 mA															1	1	0
			0-1 mA															1	1	1
3-5	Data Format	Engineering Units													0	0	0			
		Scaled-for-PID													0	0	1			
		Proportional Counts													0	1	0			
		1746-NI4 Data Format													0	1	1			
		User Defined (Class 3)													1	0	0			
		User Defined (Class 3)													1	0	1			
		Illegal (configuration error)																		
		Illegal (configuration error)																		
6 and 7	Open Circuit	Zero												0	0					
		Upscale												0	1					
		Downscale												1	0					
		Illegal																		
8-10	Filter Frequency	No Filter						0	0	0										
		75 Hz						0	0	1										
		50 Hz						0	1	0										
		20 Hz						0	1	1										
		10 Hz						1	0	0										
		5 Hz						1	0	1										
		2 Hz						1	1	0										
		1 Hz						1	1	1										
11	Channel Enable	Channel Disabled					0													
		Channel Enabled					1													
12-15	Unused	Unused <sup>②</sup>	0	0	0	0														

<sup>①</sup> In addition to programming the configuration word, you must also use the DIP switches to select voltage or current.

<sup>②</sup> Ensure unused bits 12-15 are always be set to zeros.

### Select Input Type (Bits 0-2)

The input type bit field lets you configure the channel for the type of input device you have connected to the module. Valid input is an analog voltage or current that provides a signal within one of the specified ranges.

Determine the input device type for a channel and enter its respective 3-digit binary code in bit field 0-2 of the channel configuration word. You must also set the DIP switches of the module for voltage or current.

### Select Data Format (Bits 3-5)

Select a data format for the data word value. Your selection determines how the analog input value from the A/D converter will be expressed in the data word. Enter your 3-digit binary code in bit field 3-5 of the channel configuration word.

The data types are engineering units, scaled-for-PID, proportional counts, 1746-NI4 data format, and user defined scaling for Class 3 operation only. For all data types, the channel data word is proportional to the analog input signal.

To have the data in “real” units, the channel data word must be scaled mathematically. See *Channel Data Word* on page 5-5 for the default scaling values and *Scaling the Data Channel Word* on page 5-6 for data type descriptions and scaling examples.

### Select Open Circuit State (Bits 6 and 7)

Determine the desired state for the channel data word if an open circuit condition is detected for that channel. Enter the 2-digit binary code in bit field 6-7 of the channel configuration word. Open circuit errors are only detected for 4-20 mA input types (bits 6-7 are ignored for other input types). The open circuit options are zero, upscale, and downscale.

- If zero is selected, the channel data word is forced to 0 during an open-circuit condition.
- Selecting upscale forces the channel data word value to its full scale value during an open-circuit condition. The full scale value is determined by the selected input type and data format.
- Selecting downscale forces the channel data word value to its low scale value during an open-circuit condition. The low scale value is determined by the selected input type and data format.

**Important:** The processor may continue receiving data values for a period of time after the open circuit condition occurs until when the condition is flagged. The module indicates an open circuit within one module scan times. The module response time is shown below.

Module Response to Open Circuit	
Number of Channels Enabled	Response Time (maximum)
1	0.75 msec
2	1.50 msec
3	2.25 msec
4	3.00 msec
5	3.75 msec
6	4.50 msec
7	5.25 msec
8	6.00 msec

### Select Channel Filter Frequency (Bits 8-10)

Determine the desired input filter frequency for the channel and enter the 3-digit binary code in bit field 8-10 of the channel configuration word.

The channel filter frequency bit field lets you select one of 8 filters available for a channel. The filter frequency affects the noise rejection characteristics. A lower filter frequency increases the noise rejection, and a higher filter frequency decreases the noise rejection. Select a filter frequency considering acceptable noise and step response time. See Channel Filter Frequency Selection on page 4-7 for more information on filter frequency.

### Select Channel Enable (Bit 11)

Determine which channels are used in your program and enable them. Place a one in bit 11 if the channel is to be enabled. Place a zero in bit 11 if the channel is to be disabled.

The 1746-NI8 module only scans those channels that are enabled. To optimize module operation and minimize throughput times, *unused channels should be disabled* by setting the channel enable bit to zero.

When set (1) the channel enable bit is used by the module to read the configuration word information you have selected. While the enable bit is set, modification of the configuration word may lengthen the module update time for one cycle. If any change is made to the configuration word, the change must be reflected in the status word before new data is valid.

While the channel enable bit is cleared (0), the channel data word and status word values are cleared. After the channel enable bit is set, the channel data word and status word remain cleared until the module sets the channel status bit (bit 11) in the channel status word. (Refer to Channel Status on page 5-11.)

### Unused Bits (Bits 12-15)

Bits 12-15 are not defined. Ensure these bits are always set to zero.

## Channel Data Word

The module input image uses 8 data word values whether the module is in Class 1 or Class 3 mode. The converted voltage or current input data values reside in I:e.0 through I:e.7 of the module's input image file. When an input channel is disabled, its data word is reset to zero.

1746-NI8 Module Input Image - Data Word				
			Class 1	Class 3
I:e.0	channel 0 data word	16 bit integer	•	•
I:e.1	channel 1 data word	16 bit integer	•	•
I:e.2	channel 2 data word	16 bit integer	•	•
I:e.3	channel 3 data word	16 bit integer	•	•
I:e.4	channel 4 data word	16 bit integer	•	•
I:e.5	channel 5 data word	16 bit integer	•	•
I:e.6	channel 6 data word	16 bit integer	•	•
I:e.7	channel 7 data word	16 bit integer	•	•

The channel data word contains a 16-bit integer that represents the value of the analog input channel. The tables below show the channel data word values for various input types and data formats. The second table shows the default full-scale values for the proportional counts data format. The table does not imply the entire data value range is usable resolution.

Channel Data Word Values for Engineering Units			
Input Type	Signal Range	Engineering Units	Engineering Units Scale
±10V dc	-10.25V to +10.25V	-10250 to +10250	1mV/step
0-5V dc	-0.5V to +5.5V	-500 to +5500	1mV/step
1-5V dc	+0.5V to +5.5V	+500 to +5500	1mV/step
0-10V dc	-0.5V to +10.25V	-500 to +10250	1mV/step
0-20 mA	-0.5 mA to 20.5 mA	-500 to 20500	1.0uA/step
4-20 mA	3.5 mA to 20.5 mA	3500 to 20500	1.0uA/step
±20 mA	-20.5 mA to 20.5 mA	-20500 to 20500	1.0uA/step
0-1 mA	-0.05 mA to 1.05 mA	-50 to 1050	1.0uA/step



Channel Data Word Values for Scaled Data				
Input Type	Signal Range	Scaled-for-PID	Proportional Counts (default)	NI4 Data Format
±10V dc	-10.00V to +10.00V	0 to 16383	-32768 to 32767	-32768 to 32767
0-5V dc	0.0V to +5.00V	0 to 16383	-32768 to 32767	0 to 16384
1-5V dc	+1.00V to +5.00V	0 to 16383	-32768 to 32767	3277 to 16384
0-10V dc	0.0V to +10.00V	0 to 16383	-32768 to 32767	0 to 32767
0-20 mA	0.0 mA to 20.0 mA	0 to 16383	-32768 to 32767	0 to 16384
4-20 mA	4.0 mA to 20.0 mA	0 to 16383	-32768 to 32767	3277 to 16384
±20 mA	-20.0 mA to 20.0 mA	0 to 16383	-32768 to 32767	-16384 to 16384
0-1 mA	0.0 mA to 1.00 mA	0 to 16383	-32768 to 32767	0 to 1000 <sup>①</sup>

<sup>①</sup> This data format is not supported by the 1746-NI4 module, but is available for the 1746-NI8 module.

## Scaling the Channel Data Word

This section provides descriptions of how the data types are expressed in the channel data word and examples of how to mathematically convert the data.

### Data Type Descriptions

The **engineering units** are 1 mV/step for voltage input types, and 1.0  $\mu$ A/step for current input types.

The **scaled-for-PID** value is a 14-bit unsigned integer, with 0 representing the low scale value and 16,383 representing the full scale value minus 1 lsb. The input signal range is proportional to your selected input type and scaled into a 0-16,383 range, which is standard to the SLC PID algorithm.

The **proportional count** value is a 16-bit signed integer. The input signal range is proportional to your selected input and scaled into a -32,768 to 32,767 range.

The **1746-NI4 data format** converts the current and voltage signals into 16-bit 2's complement binary values. The table below identifies the current and voltage input ranges for the input channels, the number of significant bits, and the resolution.

Voltage/Current Range	Decimal Representation	Number of Significant Bits	Resolution per LSB
-10V dc to +10V dc - 1LSB	-32,768 to +32,767	16 bits	305.176 $\mu$ V
0 to 5V dc	0 to 16,384	14 bits	
1 to 5V dc	3,277 to 16,384	13.67 bits	
0 to 10V dc - 1LSB	0 to 32,767	15 bits	

Voltage/Current Range	Decimal Representation	Number of Significant Bits	Resolution per LSB
0 to 20 mA	0 to 16,384	14 bits	1.22070 $\mu$ A
4 to 20 mA	3,277 to 16,384	13.67 bits	
-20 mA to +20 mA	-16,384 to +16,384	15 bits	
0 to 1 mA	0 to 1000	10 bits	1 $\mu$ A <sup>①</sup>

<sup>①</sup> This data format is not supported by the 1746-NI4 module, but is available for the 1746-NI8 module.

**User defined scaling count** (Class 3 operation only) allows the output image data words 8 and 9 (or words 10 and 11) to be selected to represent low scale and high scale limits. The module uses these limits and scales proportionately between them. For example, if words 8 and 9 are selected to represent low and high scaling ranges (data format select bits = 100 binary), and word 8 contains 0000 hex (0 decimal), and word 9 contains 4E20 hex (20000 decimal), this would represent the range of values that the voltage or current readings would be scaled into. The lowest voltage or current reading would be scaled to 0, and the highest voltage or current reading would be scaled to 20000, with other readings scaled proportionately between them.

If the module is in Class 1 mode and you attempt to configure for user defined proportional counting, a configuration error will be generated.

### Using Scaled-for-PID and Proportional Counts

The scaled-for-PID and proportional count selections provide the highest display resolution, but also require you to manually convert the channel data to “real” units.

## Scaling Examples

The following scaling examples show how to convert the channel data word from the configured data type to “real” units. “Real” units are the values being measured such as temperature and pressure. To perform the scaling, you must know the defined voltage or current range for the channel’s input type. The lowest possible value for an input type is  $S_{LOW}$ , and the highest possible value is  $S_{HIGH}$ . Refer to the Channel Data Word Value tables on pages 5-5 and 5-6 for the data channel word ranges.

### Engineering Units to “Real” Units

Situation #1: A transducer is being used to measure temperature.  
The 4–20 mA signal is proportional to 100–500°C (212–932°F).  
The channel data word is in engineering units format.  
The channel data = 5500.

Find: “Real” units equivalent in °F.

$$\text{Equation: } \textit{Real Units Equivalent} [ \textit{channel data value} \times (\textit{scaling factor}) \times \left( \frac{S_{HIGH} - S_{LOW}}{\textit{input range}} \right)$$

where:  $S_{LOW} = 212^{\circ}\text{F}$   
 $S_{HIGH} = 932^{\circ}\text{F}$   
channel data word = 5500  
scaling for engineering units = 1  $\mu\text{A}$  per step

$$\text{Solution: } \textit{Real Units Equivalent} [ 5500 \times (1 \mu\text{A}) \times \left( \frac{932^{\circ}\text{F} - 212^{\circ}\text{F}}{20 \text{ mA} - 4 \text{ mA}} \right) [ 247.5^{\circ}\text{F}$$

Situation #2: A transducer is being used to measure temperature.  
The 0–10V dc signal is proportional to 0–10°C.  
The channel data word is in engineering units format.  
The channel data = 5000.

Find: “Real” units equivalent in °C.

$$\text{Equation: } \textit{Real Units Equivalent} [ \textit{channel data value} \times (\textit{scaling factor}) \times \left( \frac{S_{HIGH} - S_{LOW}}{\textit{input range}} \right)$$

where:  $S_{LOW} = 0^{\circ}\text{C}$   
 $S_{HIGH} = 10^{\circ}\text{C}$   
channel data word = 5000  
scaling for engineering units = 1 mV per step

$$\text{Solution: } \textit{Real Units Equivalent} [ 5000 \times (1 \text{ mV}) \times \left( \frac{10^{\circ}\text{C} - 0^{\circ}\text{C}}{10 \text{ V dc} - 0 \text{ V dc}} \right) [ 5.000^{\circ}\text{C}$$

► **TIP** If you are measuring a “real” voltage or current, then selecting engineering units allows the module to report “real” values without further scaling. For example, a 4.683V dc signal would produce a channel data word of 4683.

**Scaled-for-PID to “Real” Units**

Situation: A transducer is being used to measure temperature.  
The 4–20 mA signal is proportional to 100–500°C (212–932°F).  
The channel data word is in scaled-for-PID format.  
The channel data = 5500.

Find: “Real” units equivalent in °F.

$$\text{Equation: } \textit{Real Units Equivalent} [ S_{LOW} + (S_{HIGH} - S_{LOW}) \times \left( \frac{\textit{channel data value}}{\textit{full scale default PID value}} \right)$$

where:  $S_{LOW} = 212^{\circ}\text{F}$   
 $S_{HIGH} = 932^{\circ}\text{F}$   
channel data word = 5500  
full scale PID default value (from table on page 5–6) = 16383

$$\text{Solution: } \textit{Real Units Equivalent} [ 212^{\circ}\text{F} + (932^{\circ}\text{F} - 212^{\circ}\text{F}) \times \left( \frac{5500}{16383} \right) [ 453.71^{\circ}\text{F}$$

**Proportional Counts to “Real” Units**

Situation: A transducer is being used to measure pressure.  
The –10V dc to +10V dc signal is proportional to 0 to 200 psi.  
The channel data word is in proportional counts data format.  
The channel data = 21567.

Find: “Real” units equivalent in psi.

Equation:

$$\textit{Real Units Equivalent} [ S_{LOW} + (S_{HIGH} - S_{LOW}) \times \frac{(\textit{data value} + |\textit{proportional count low default value}|)}{(\textit{proportional count full scale default value})}$$

where:  $S_{LOW} = 0 \text{ psi}$   
 $S_{HIGH} = 200 \text{ psi}$   
channel data = 21567  
proportional count low default value (from table on page 5–6) = –32768  
proportional count full scale default value (from table on page 5–6) = 65535

$$\text{Solution: } \textit{Real Units Equivalent} [ 0 \text{ psi} + (200 \text{ psi} - 0 \text{ psi}) \times \frac{(21567 + |-32768|)}{(65535)} [ 165.55 \text{ psi}$$

**1746-NI4 Data Format Units to “Real” Units**

Situation: A transducer is being used to measure flow rate.  
 The -10V dc to +10V dc signal is proportional to 0–100 GPM.  
 The channel data word is in 1746-NI4 data format.  
 The channel data = 10000.

Find: “Real” units equivalent in GPM.

$$\text{Equation: } \textit{Real Units Equivalent} [ \textit{channel data value} \times \left( \frac{S_{HIGH} - S_{LOW}}{\textit{input range}} \right)$$

where:  $S_{LOW} = 0 \text{ GPM}$   
 $S_{HIGH} = 100 \text{ GPM}$   
 channel data word = 5500  
 NI4 full scale default value (from table on page 5–6) = 65535

$$\text{Solution: } \textit{Real Units Equivalent} [ 10000 \times \left( \frac{100 \text{ GPM} - 0 \text{ GPM}}{65535} \right) [ 15.26 \text{ GPM}$$

**User Defined Limits Data Format to “Real” Units**

Situation: A transducer is being used to measure pressure.  
 The -10V dc to +10V dc signal is proportional to 0–200 psi.  
 The channel data word is in user defined data format.  
 The lower scale limit (configuration word 8) = 0.  
 The upper scale limit (configuration word 9) = 20000.  
 The channel data word = 16600.

Find: “Real” units equivalent in psi.

$$\text{Equation: } \textit{Real Units Equivalent} [ \textit{channel data word} \times \frac{(S_{HIGH} - S_{LOW})}{(\textit{upper scale limit} - \textit{lower scale limit})}$$

where:  $S_{LOW} = 0 \text{ psi}$   
 $S_{HIGH} = 200 \text{ psi}$

$$\text{Solution: } \textit{Real Units Equivalent} [ 16600 \times \frac{(200 \text{ psi} - 0 \text{ psi})}{(20000 - 0)} [ 166.00 \text{ psi}$$

## Channel Status Checking

If the module is in Class 3 mode, there are an additional 8 input image words available for status information. The channel status word is a part of the module's input image. Input words 8-15 correspond to and contain the configuration status of channels 0-7. You can use the data provided in the status word to determine if the input configuration data for any channel is valid per your configuration in O:e.0 through O:e.7.

For example, whenever a channel is disabled ( $O:e.x/11 = 0$ ), its corresponding status word shows all zeros. This condition tells you that input data contained in the data word for that channel is not valid and should be ignored.

1746-NI8 Module Input Image - Status Word				
			Class 1	Class 3
I:e.8	channel 0 status word	bit mapped field		•
I:e.9	channel 1 status word	bit mapped field		•
I:e.10	channel 2 status word	bit mapped field		•
I:e.11	channel 3 status word	bit mapped field		•
I:e.12	channel 4 status word	bit mapped field		•
I:e.13	channel 5 status word	bit mapped field		•
I:e.14	channel 6 status word	bit mapped field		•
I:e.15	channel 7 status word	bit mapped field		•

The channel status word can be analyzed bit by bit. In addition to providing information about an enabled or disabled channel, each bit's status (0 or 1) tells you how the input data from the voltage or current analog sensor connected to a specific channel will be translated for your application. The bit status also informs you of any error condition and can tell you what type of error occurred.

A bit-by-bit examination of the status word is provided in the chart on the following page.

Channel 0-7 Status Word (I:e.8 through I:e.15) - Bit Definitions

Bit(s)	Define	These bit settings															Indicate this	
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		0
0-2	Input Type														0	0	0	± 10 V dc
															0	0	1	1-5V dc
															0	1	0	0-5V dc
															0	1	1	0-10V dc
															1	0	0	0-20 mA
															1	0	1	4-20 mA
															1	1	0	± 20 mA
													1	1	1	0-1 mA		
3-5	Data Format											0	0	0				Engineering Units
												0	0	1				Scaled-for-PID
												0	1	0				Proportional Counts
												0	1	1				1746-NI4 Data Format
												1	0	0				User Defined (Class 3)
												1	0	1				User Defined (Class 3)
																		Illegal (configuration error)
																Illegal (configuration error)		
6 and 7	Open Circuit									0	0						Zero	
										0	1						Upscale	
										1	0						Downscale	
																	Illegal (configuration error)	
8-10	Filter Frequency						0	0	0								No Filter	
							0	0	1								75 Hz	
							0	1	0								50 Hz	
							0	1	1								20 Hz	
							1	0	0								10 Hz	
							1	0	1								5 Hz	
							1	1	0								2 Hz	
							1	1	1								1 Hz	
11	Channel Status					0											Channel Disabled	
						1											Channel Enabled	
12	Open Circuit Error				0												No Error	
					1												Open Circuit Detected	
13	Over-Range Error			0													No error	
				1													Over-Range Condition	
14	Under-Range Error		0														No Error	
			1														Under-Range Condition	
15	Configuration Error	0															No Error	
		1															Configuration Error	

**Important:** If the channel for which you are seeking status is disabled (bit O:e.x/11 = 0), all bit fields are cleared. The status word for any disabled channel is always 0000 0000 0000 0000 regardless of any previous setting that may have been made to the configuration word.

Explanations of the status conditions follow.

### **Input Type Status (Bits 0-2)**

The input type bit field indicates what type of input signal you have configured for the channel. This field reflects the input type defined in the channel configuration word. The input field is cleared when the channel is disabled.

### **Data Format Type Status (Bits 3-5)**

The data format bit field indicates the data format you have defined for the channel. This field reflects the data type selected in the channel configuration word. The data format field is cleared when the channel is disabled.

### **Open Circuit Type Status (Bits 6 and 7)**

The open circuit bit field indicates how you have defined the response of the module to an open circuit condition. This feature is active for the 4–20 mA input type only. The open circuit field is cleared when the channel is disabled.

### **Channel Filter Frequency (Bits 8-10)**

The channel filter frequency bit field reflects the filter frequency you selected in the configuration word. This feature is active for all current and voltage input types. The filter frequency bit field is cleared while the channel is disabled.

### **Channel Status (Bit 11)**

The channel status bit indicates the operational state of the channel. Once the channel enable bit is set, the module will configure the channel and take the first data sample of the channel data word before setting the channel status bit. The channel status bit is cleared upon power up and reset.



**Open Circuit Error (Bit 12)**

The open circuit error bit is set (1) whenever the channel detects an open circuit condition at its input. The open circuit error is active for the 4–20 mA input type only. The open circuit error state will always take precedence over the out-of-range error states. There will never be an out-of-range error when an open circuit is detected. The open circuit error bit is cleared when the channel is disabled or when the open circuit condition is removed.

**Over-Range Error (Bit 13)**

The over-range error bit is set (1) whenever a configured channel detects an over-range condition for the channel data. An over-range condition exists when the input value is above the specified upper limit of the particular sensor connected to that channel. The over-range bit is cleared when the channel is disabled.

**Under-Range Error (Bit 14)**

The under-range error bit is set (1) whenever a configured channel detects an under-range condition for the channel data. An under-range condition exists when the input value is below the specified lower limit of the particular sensor connected to that channel. The under-range bit is cleared when the channel is disabled.

**Configuration Error (Bit 15)**

The configuration error bit is set (1) whenever a configured channel detects that the channel configuration word is not valid. All other status bits reflect the settings from the configuration word (even those settings that may be in error). The configuration error bit is cleared when the channel is disabled.

## Ladder Logic Configuration Examples

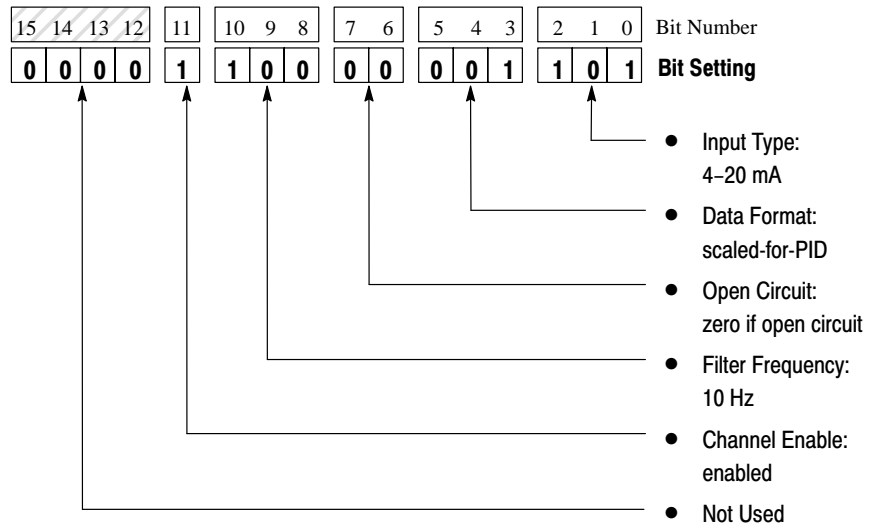
Earlier chapters explained how the configuration word defines the way a channel operates. This chapter shows the programming required to enter the configuration word into the processor memory. It also provides you with segments of ladder logic specific to unique situations that might apply to your programming requirements. The example segments include:

- initial programming of the configuration word
- interfacing the analog module to a PID instruction
- monitoring channel status bits (Class 3 Mode only)

### Initial Programming

To enter data into the channel configuration word (O:e.0 through O:e.7) when the channel is disabled (bit 11 = 0), follow these steps. Refer to page 5–2 for specific configuration details.

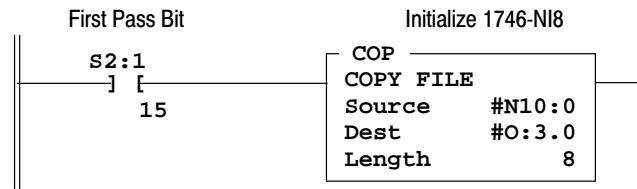
**Example** - A 1746-NI8 analog module is residing in slot 3 of a 1746 chassis. Configure all eight channels with the same parameters.



This example transfers configuration data and sets the channel enable bits of all eight channels with a single File Copy instruction.

## Procedure

1. Create integer file N10. Integer file N10 should contain eight elements (N10:0 through N10:7).
2. Enter the configuration parameters for all eight analog input channels into a source integer data file **N10**. See Appendix B for the channel configuration worksheet.
3. Program a rung in your ladder logic to copy the contents of integer file N10 to the eight consecutive output words of the 1746-NI8 analog module beginning with word O:3.0.



On power up, bit S2:1/15 is set for the first program scan, and integer file N10 is sent to the eight 1746-NI8 channel configuration words.

### DATA FILE N10

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:1	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:2	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:3	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:4	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:5	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:6	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:7	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1

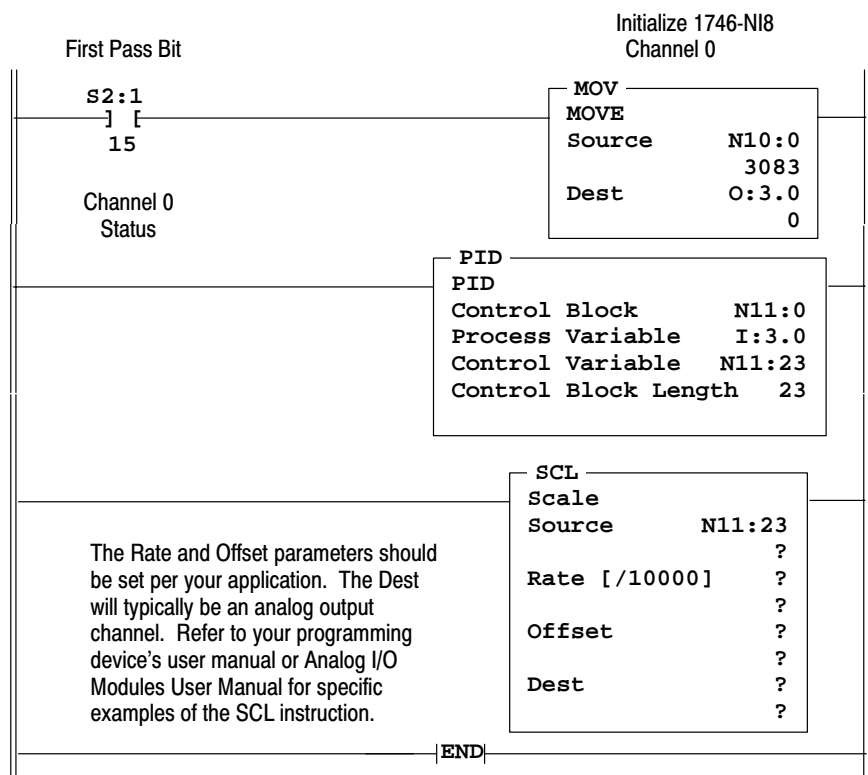
## Interfacing to the PID Instruction

The analog input module was designed to interface directly to the SLC 5/02™ or later processor PID instruction without the need for an intermediate scale operation.

**Example** - Use 1746-NI8 channel data as the process variable in the PID instruction.

1. Select *scaled-for-PID* as the data format in the channel configuration word.
2. Specify the 1746-NI8 channel data word as the process variable for the PID instruction.

### Program Listing



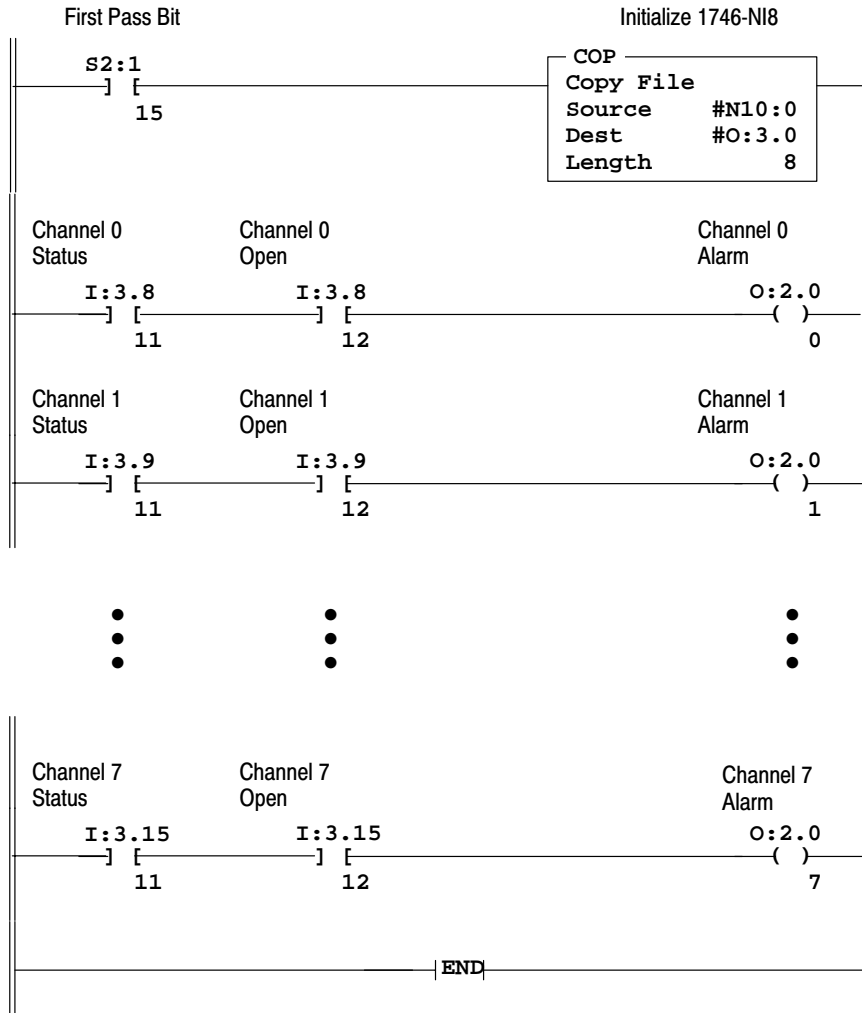
### DATA FILE N10

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1

### Monitoring Channel Status Bits (Class 3 Mode Only)

This example shows how you could monitor the open circuit error bits of each channel and set an alarm in the processor if one of the channels opens. An open circuit error can occur if the analog input device breaks, or one of the sensor wires gets cut or disconnected from the terminal block.

#### Program Listing



#### DATA FILE N10

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:1	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:2	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:3	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:4	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:5	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:6	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1
N10:7	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1

## Module Diagnostics and Troubleshooting

This chapter describes troubleshooting using the channel status LEDs as well as the module status LED. It explains the types of conditions that might cause an error to be reported and gives suggestions on how to resolve the problem. Major topics include:

- module operation vs. channel operation
- power-up diagnostics
- channel diagnostics
- LED indicators
- troubleshooting flowchart
- replacement parts
- contacting Allen-Bradley

### Module Operation vs. Channel Operation

The module performs operations at two levels:

- module level operations
- channel level operations

Module level operations include functions such as power-up configuration and communication with the SLC processor.

Channel level operations describe channel-related functions, such as data conversion and open-circuit detection.

Internal diagnostics are performed at both levels of operation and any error conditions detected are immediately indicated by the module's LEDs.

### Power-Up Diagnostics

At module powerup, a series of internal diagnostic tests is performed. These diagnostic tests must be successfully completed or a module error results and the module status LED remains off.

### Channel Diagnostics

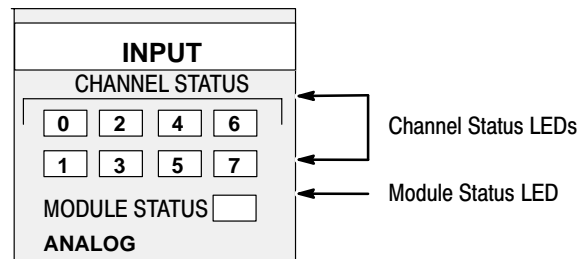
When a channel is enabled (bit 11 = 1), a diagnostic check is performed to see that the channel has been properly configured. In addition the channel is tested on every scan for configuration errors, over-range, under-range, and, for the 4–20 mA input type, open-circuit conditions.

A failure of any channel diagnostic test causes the faulted channel status LED to blink. All channel faults are indicated in bits 12–15 of the channel’s status word. Channel faults are self-clearing. When the fault conditions are corrected, the channel status LED will stop blinking and resume steady illumination.

**Important:** If you clear (0) a channel enable bit (11) all channel status information is reset.

## LED Indicators

The module has nine LEDs. Eight of these are channel status LEDs numbered to correspond to each of the input channels, and one is a module status LED.



LED State Table

If Module Status LED is:	And Channel Status LED is:	Indicated Condition:	Corrective action:
On	On	Channel Enabled	No action required.
	Blinking	Open-Circuit Condition	To determine the exact error, check the error bits in the input image. Check the channel configuration word for valid data. Make sure that the data format is indicated correctly in bits 3–5, and that the open-circuit selection state (bits 6 and 7) is valid. Refer to the troubleshooting flowchart on page 7-5 and to chapter 5 for more information.
		Out-of-Range Condition	
		Channel Configuration Error	
	Off	Power-Up	No action required.
Channel Not Enabled		No action required. For an example of how to enable a channel refer to chapter 2, Quick Start, or chapter 6, Ladder Logic Configuration Examples.	

Module Status LED State Table

If Module Status LED is:	Indicated condition:	Corrective action:
On	Proper Operation	No action required.
Off	Module Fault	Cycle power. If condition persists, call your local distributor or Allen-Bradley for assistance.

## Channel Status LEDs (Green)

The channel status LED is used to indicate channel status and related error information contained in the channel status word. This includes conditions such as:

- normal operation
- channel-related configuration errors
- open-circuit errors
- out-of-range errors

All channel errors are recoverable errors and after corrective action, normal operation resumes.

### Invalid Channel Configuration

Whenever a channel's configuration word is improperly defined, the channel status LED blinks and bit 15 of the channel status word is set. Configuration errors occur when the data format (bits 3–5 in the channel configuration word) is invalid, or when the open-circuit state selection (bits 6 and 7) is invalid.

### Open-Circuit Detection

An open-circuit test is performed on all enabled channels configured for 4–20 mA input. Whenever an open-circuit condition occurs (see possible causes listed below), the channel status LED blinks and bit 12 of the channel status word is set.

Possible causes of an open-circuit include:

- The sensing device may be broken.
- A wire may be loose or cut.
- The sensing device may not have been installed on the configured channel.

If an open-circuit is detected, the channel data word reflects input data as defined by the open-circuit bits (6 and 7) in the channel configuration word.

### Out-Of-Range Detection

Whenever the data received at the channel data word is out of the defined operating range, an over-range or under-range error is indicated and bit 13 (over-range) or bit 14 (under-range) of the channel status word is set.

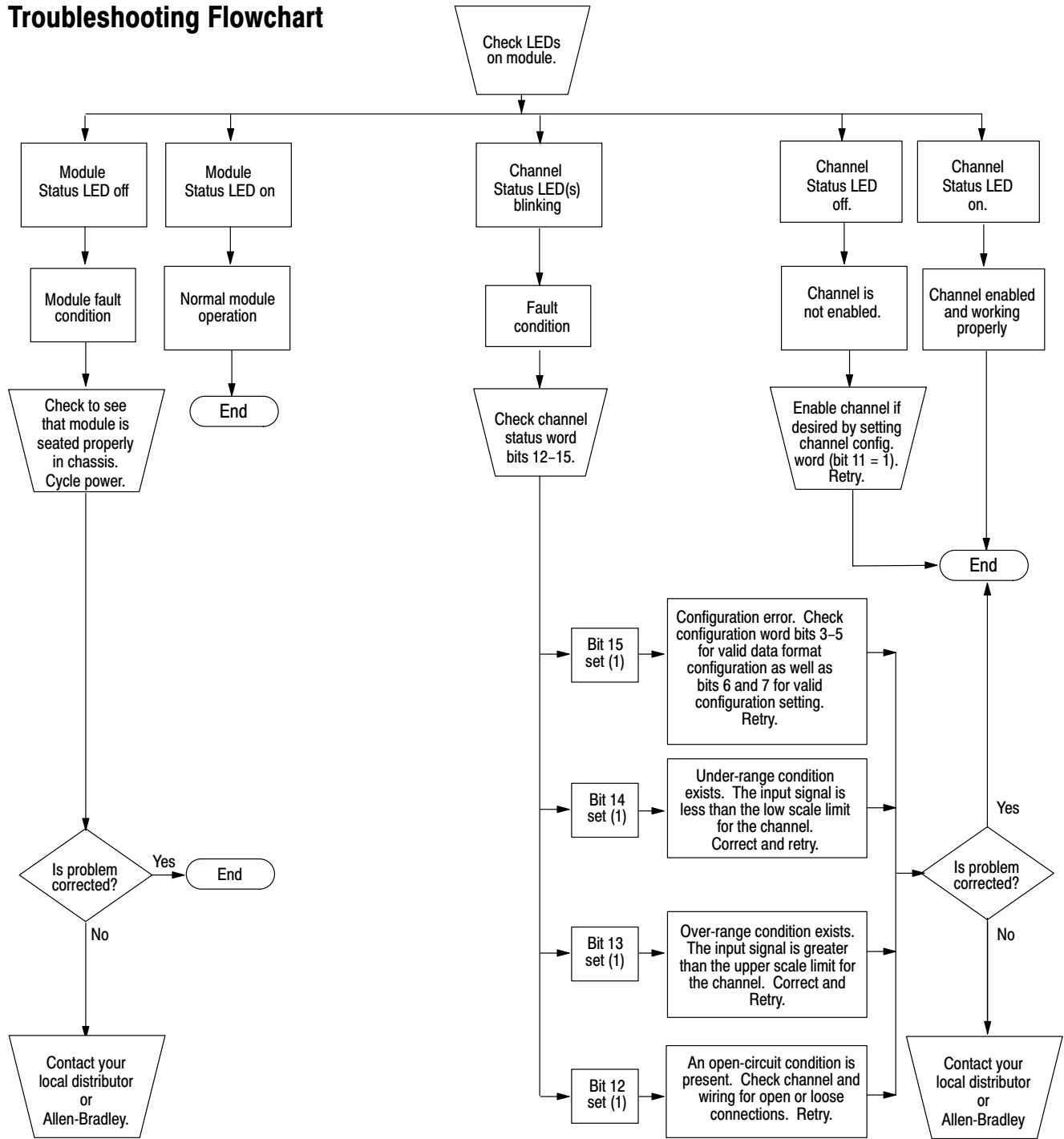


**Module Status LED (Green)**

The module status LED is used to indicate module-related diagnostic or operating errors. These *non-recoverable errors* may be detected at power-up or during module operation. Once in a module error state, the 1746-NI8 module no longer communicates with the SLC processor. Channel states are disabled, and data words are cleared.

Failure of any diagnostic test results in a non-recoverable error and requires the assistance of your local distributor or Allen-Bradley.

### Troubleshooting Flowchart



## Replacement Parts

The 1746-NI8 module has the following replaceable parts:

Part	Part Number
Replacement Terminal Block	1746-RT25G
Replacement Terminal Cover	1746-R13
1746-NI8 User Manual	1746-6.8

## Contacting Allen-Bradley

If you need to contact Allen-Bradley for assistance, please have the following information available when you call:

- a clear statement of the problem including a description of what the system is actually doing. Note and record the LED states; also, note input and output image words for the module.
- a list of things you have already tried to remedy the problem
- processor type and firmware (FRN) number. See label on left side of processor.
- hardware types in the system including I/O modules and chassis
- fault code if the SLC processor is faulted

## Application Examples

This chapter provides two application examples to help you use the analog input module. They are defined as a:

- basic example
- supplementary example

The **basic example** builds on the configuration word programming provided in chapter 6 to set up one channel for operation. This setup is then used in a typical application to display a current (amperage) value.

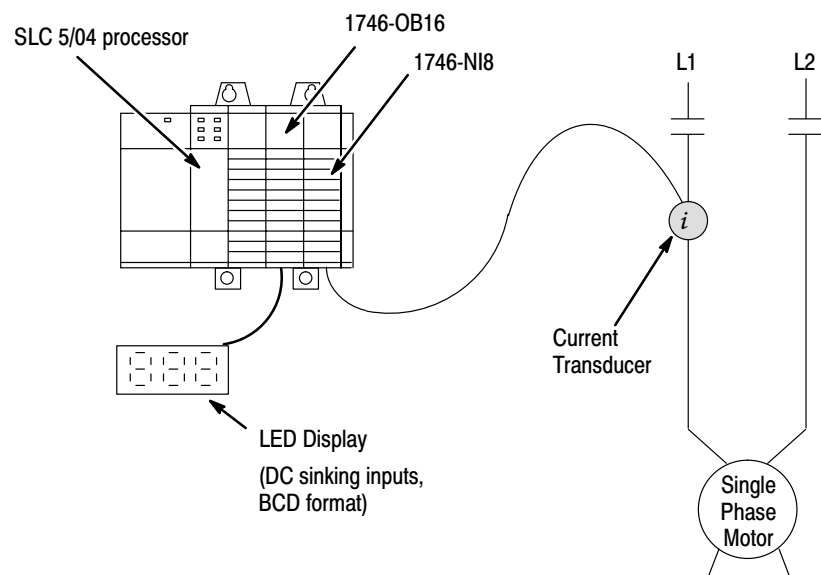
The **supplementary example** demonstrates how to perform a dynamic configuration of five of the eight available channels. The example sets up an application that allows you to manually select whether the current transducer data is displayed for L1, L2, or L3. The example also includes configuration and programming to display pressure and liquid level.

### Basic Example

#### Application Setup – Display a Current (amperage) Value

In this example, the current draw of a single-phase motor is shown on an LED display. The display requires BCD data, so the program must convert the current reading from the analog input module to BCD before sending it to the display.

#### Device Configuration



### Channel Configuration

Configure channel 0 of the 1746-NI8 module with the following setup:

- 4–20 mA input type
- engineering units data format
- zero data word in the event of an open circuit
- 10 Hz input filter to reject high frequency noise and provide rejection of 60 Hz line noise

### Channel Configuration Worksheet (With Settings Established for Channel 0)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Bit Number
0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	Channel 0 – N10:0
0	0	0	0													Channel 1
0	0	0	0													Channel 2
0	0	0	0													Channel 3
0	0	0	0													Channel 4
0	0	0	0													Channel 5
0	0	0	0													Channel 6
0	0	0	0													Channel 7

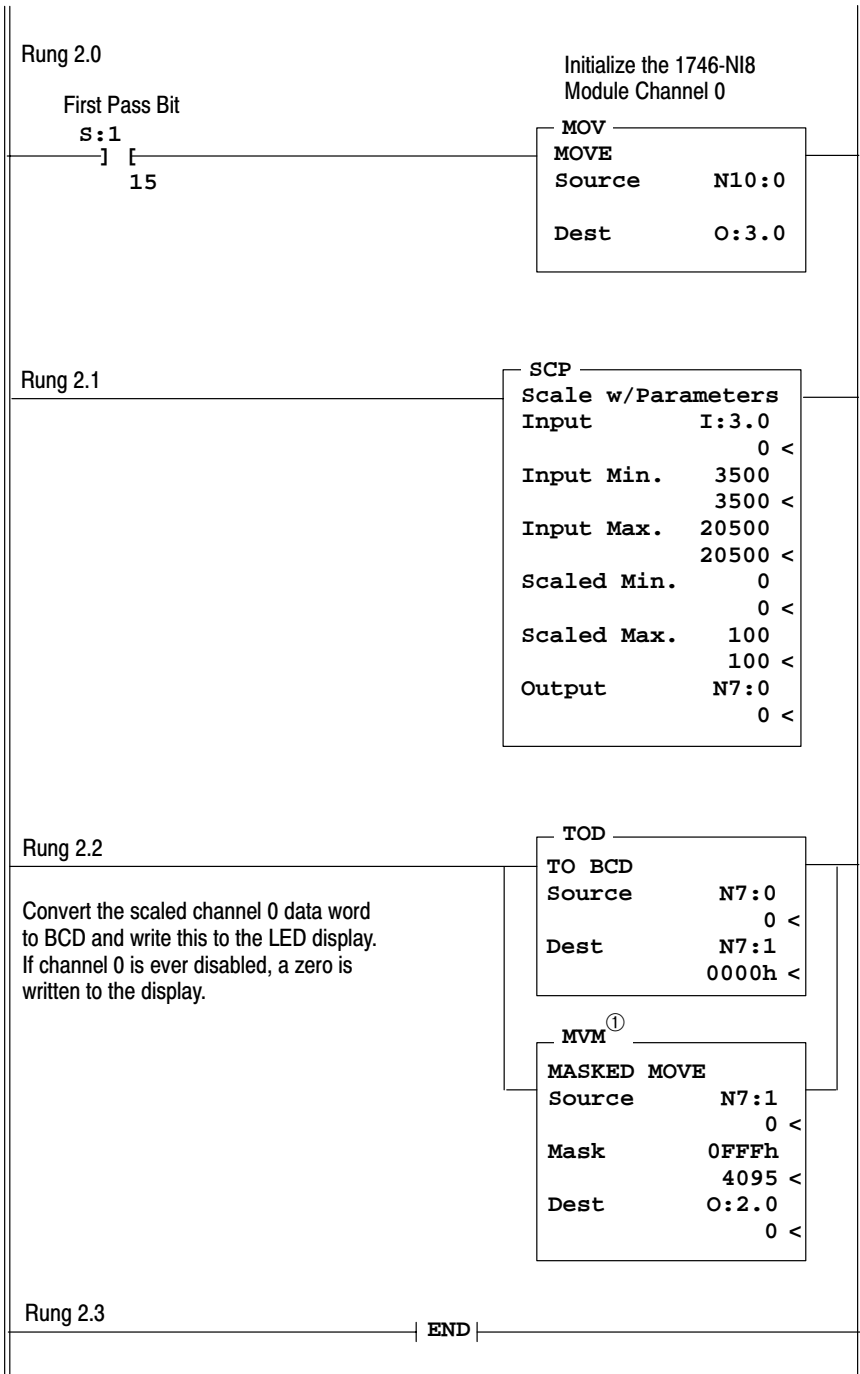
  

- Input Type
- Data Format
- Open Circuit
- Filter Frequency
- Channel Enable
- Not Used

**Bit Definitions:**

<b>Bits 0-2</b>	Input Type	000 = ±10V dc 001 = 1-5V dc	010 = 0-5V dc 011 = 0-10V dc	100 = 0-20 mA 101 = 4-20 mA	110 = ±20 mA 111 = 0-1 mA
<b>Bits 3-5</b>	Data Format	000 = engineering units 001 = scaled-for-PID	010 = proportional counts 011 = 1746-NI4 data format	100 = user defined scaling 101 = user defined scaling	110 = illegal 111 = illegal
<b>Bits 6 and 7</b>	Open Circuit	00 = zero	01 = upscale	10 = downscale	11 = illegal
<b>Bits 8-10</b>	Filter Frequency	000 = no filter 001 = 75 Hz	010 = 50 Hz 011 = 20 Hz	100 = 10 Hz 101 = 5 Hz	110 = 2 Hz 111 = 1 Hz
<b>Bit 11</b>	Channel Enable	0 = channel disabled		1 = channel enabled	
<b>Bits 12-15</b>	Not Used	0000 = always make this setting			

### Program Listing



① The use of the masked move instruction with the 0FFF mask allows you to use outputs 12, 13, 14, and 15 for other output devices in your system. The 7-segment display uses outputs 0-11.

### Data File

#### DATA FILE N10

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1

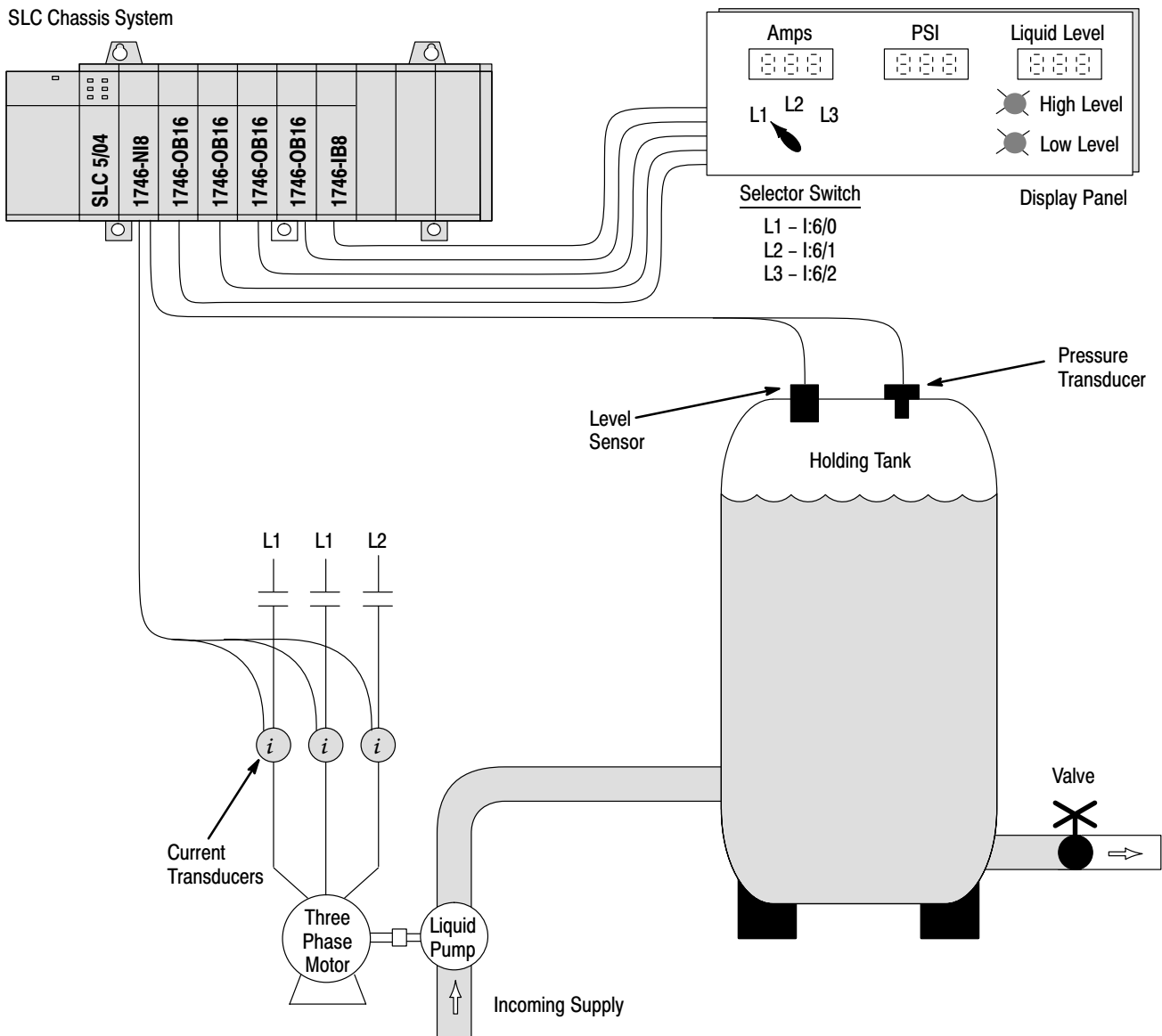
## Supplementary Example

### Application Setup – Display Amps, PSI, and Liquid Level

This example shows how to display current, pressure, and liquid level at one annunciator panel. The motor current draw is displayed in amps. The tank pressure is displayed in psi. The liquid level in the holding tank is displayed in inches.

A three-position selector switch allows the operator to choose between displaying the current draw for L1, L2, or L3 of the three-phase motor. Two warning pilot lights indicate a low or high liquid level condition in the holding tank. Each display is a 3-digit, 7-segment display. The displays have DC-sinking inputs and use BCD data format.

### Device Configuration



## Channel Configuration

Configuration setup for **current transducers**:

- channels 0, 1, and 2
- 4–20 mA input type
- engineering units data format
- zero data word in the event of an open circuit
- 10 Hz input filter to reject high frequency noise and provide 60 Hz line noise rejection

Configuration setup for **pressure transducer**:

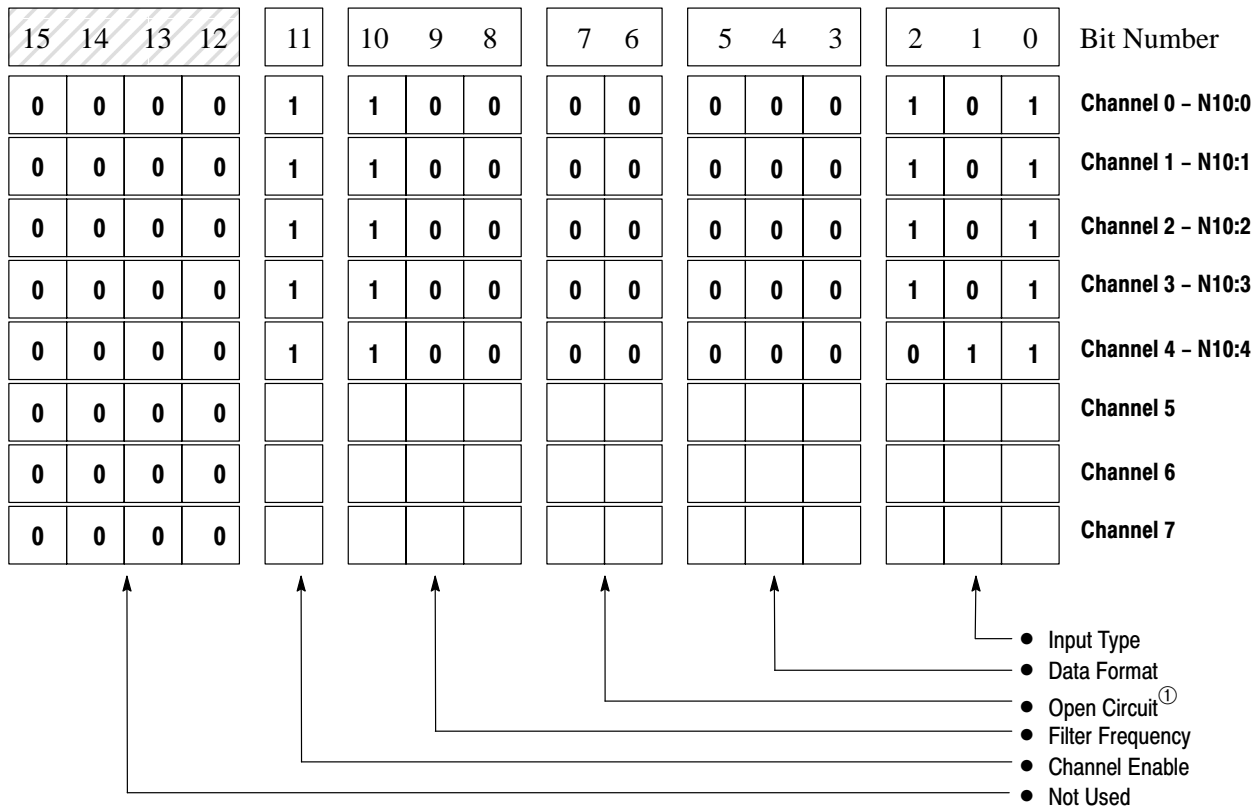
- channel 3
- 4–20 mA input type
- engineering units data format
- zero data word in the event of an open circuit
- 10 Hz input filter to reject high frequency noise and provide 60 Hz line noise rejection

Configuration setup for **level sensor**:

- channel 4
- 0–10V dc input type
- engineering units data format
- zero data word in the event of an open circuit
- 10 Hz input filter to reject high frequency noise and provide 60 Hz line noise rejection



### Channel Configuration Worksheet (With Settings Established for Channels 0-4)



**Bit Definitions:**

Bits 0-2	Input Type	000 = ±10V dc 001 = 1-5V dc	010 = 0-5V dc 011 = 0-10V dc	100 = 0-20 mA 101 = 4-20 mA	110 = ±20 mA 111 = 0-1 mA
Bits 3-5	Data Format	000 = engineering units 001 = scaled-for-PID	010 = proportional counts 011 = 1746-NI4 data format	100 = user defined scaling 101 = user defined scaling	110 = illegal 111 = illegal
Bits 6 and 7	Open Circuit <sup>①</sup>	00 = zero	01 = upscale	10 = downscale	11 = illegal
Bits 8-10	Filter Frequency	000 = no filter 001 = 75 Hz	010 = 50 Hz 011 = 20 Hz	100 = 10 Hz 101 = 5 Hz	110 = 2 Hz 111 = 1 Hz
Bit 11	Channel Enable	0 = channel disabled			1 = channel enabled
Bits 12-15	Not Used	0000 = always make this setting			

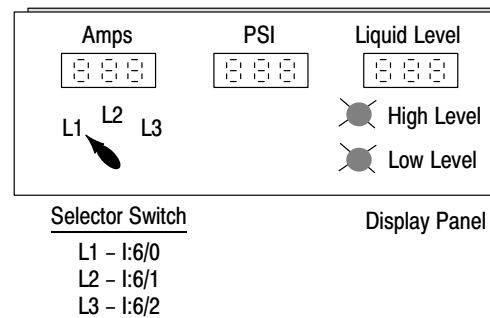
<sup>①</sup> The open circuit option is only valid for the 4-20 mA data format.

## Program Set Up and Operation Summary

1. Set up one configuration word in memory for each channel. The table below shows the configuration word allocation summary.

Channel	Configuration Word	Value
0	N10:0	L1 (amps)
1	N10:1	L2 (amps)
2	N10:2	L3 (amps)
3	N10:3	pressure (psi)
4	N10:4	liquid level (inches)

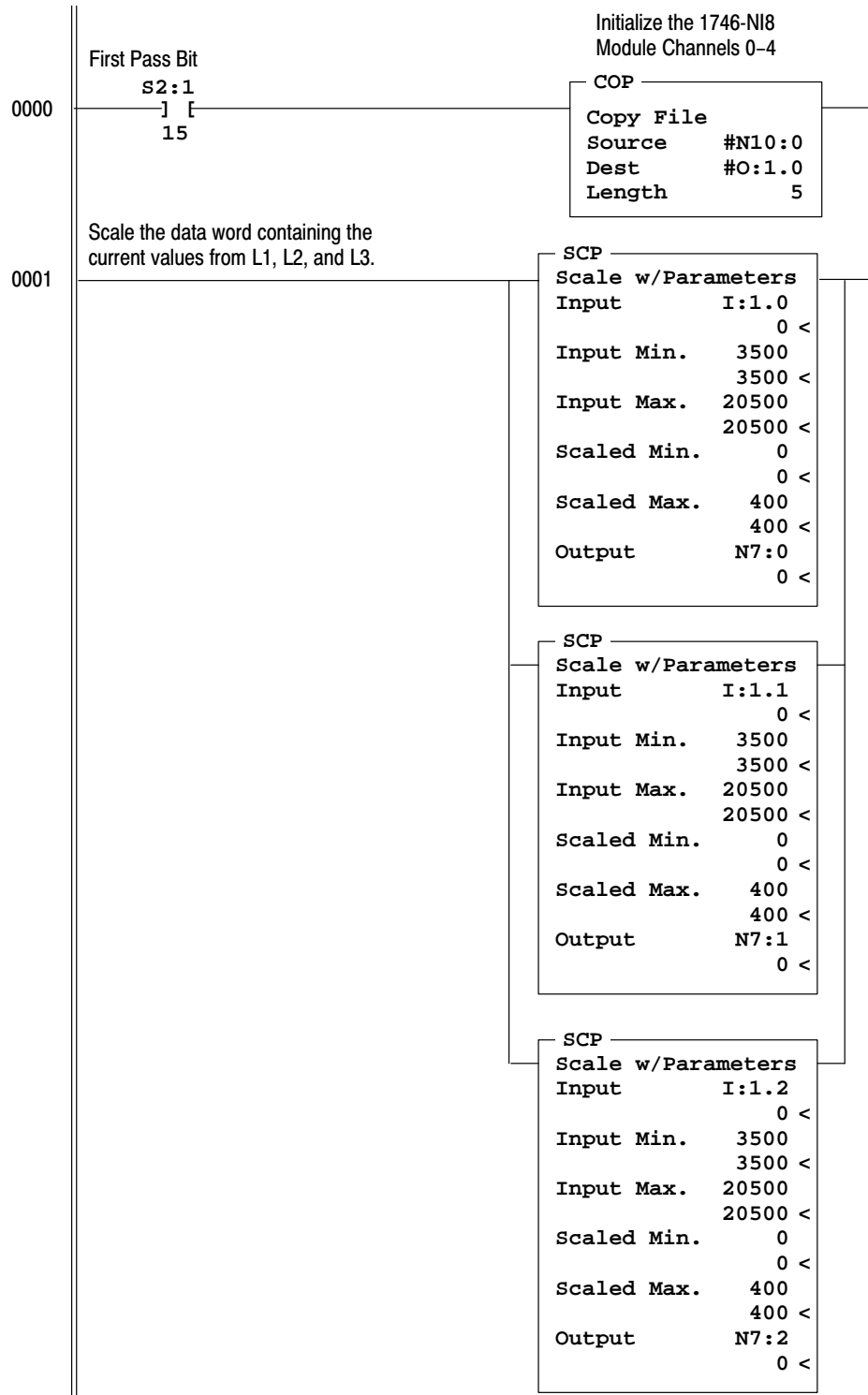
2. When the position of the three-position selector changes, convert the appropriate scaled data word to BCD and send the data to the LED display.



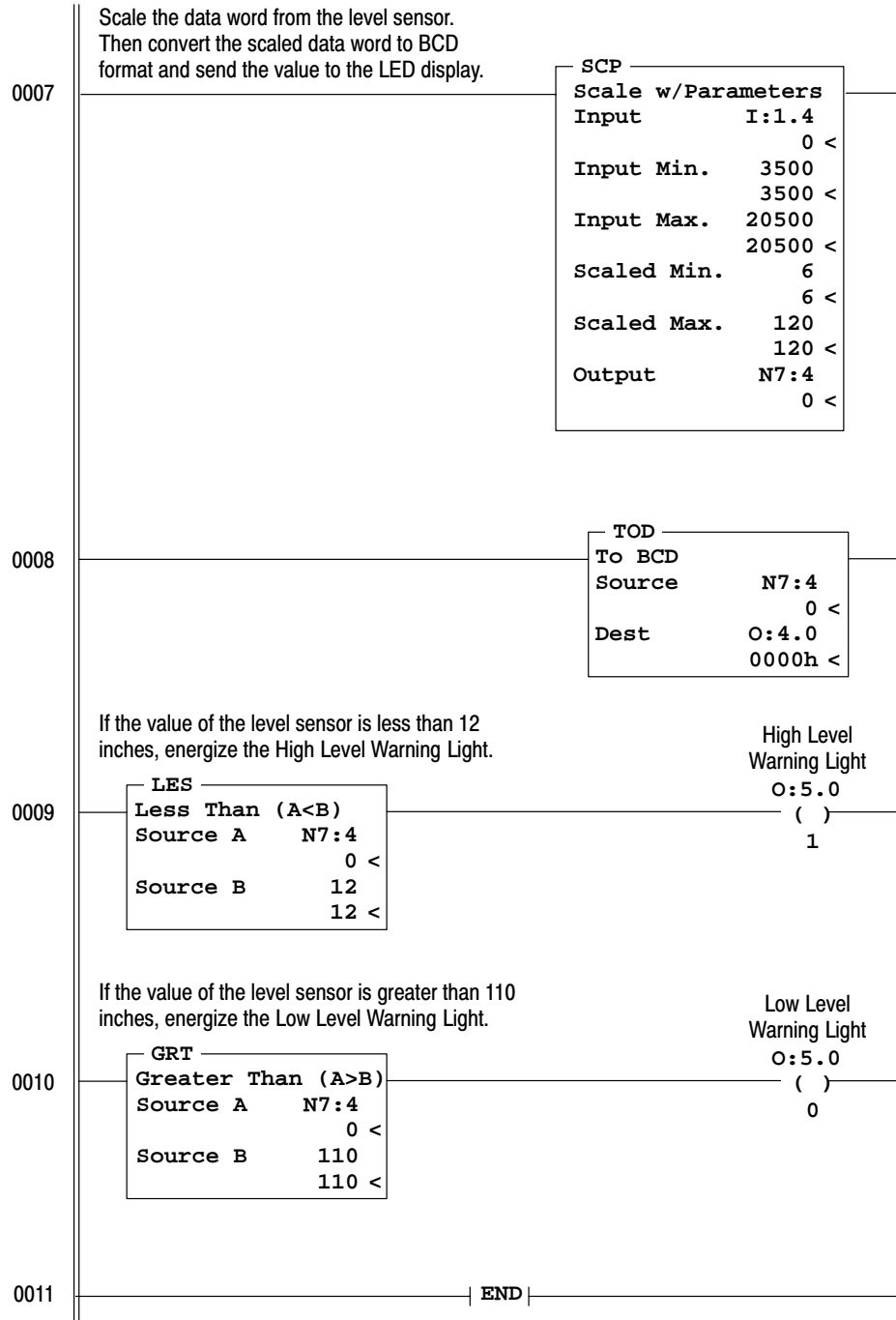
3. If the liquid level goes below the low level set point, turn on the low level warning light, and if the liquid level goes above the high level set point, turn on the high level warning light.
4. Convert the individual analog scaled data words to BCD and send the data to the respective LED displays.

### Program Listing

The first rung of this program sends the channel setup information to the 1746-NI8 module. The next four rungs send the scaled data to the LED display based on the position of the selector switch.







**Data File**

**DATA FILE N10**

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
N10:0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1
N10:1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1
N10:2	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1
N10:3	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1
N10:4	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1

## Specifications

This appendix lists the specifications for the 1746-NI8 Analog Input Module.

### Electrical Specifications

Description	Specification
Backplane Current Consumption	200 mA at 5V dc 100 mA at 24V dc
Backplane Power Consumption	3.4W maximum (1.0W @ 5V dc, 2.4W @ 24V dc)
Number of Channels	8 (backplane isolated)
I/O Chassis Location	Any I/O module slot except slot 0
A/D Conversion Method	Successive approximation, switched capacitor
Input Filtering	Low pass digital filter with programmable filter frequencies
Normal Mode Rejection (between [+] input and [-] input)	Provided by low-pass filter
Common Mode Rejection (between inputs and chassis ground)	Greater than or equal to 75 dB at DC Greater than or equal to 100 dB at 50/60 Hz
Input Filter Frequencies	1 Hz 2 Hz 5 Hz 10 Hz 20 Hz 50 Hz 75 Hz
Calibration	The module performs continuous autocalibration.
Isolation	50V dc continuous between the analog inputs and the backplane 530V ac and 750V dc pulse withstand for 1 second
Common-Mode Voltage Range	±10.5V (21V maximum between any two terminals)

### Physical Specifications

Description	Specification
LED Indicators	9 green status indicators one for each of 8 channels and one for module status
Module ID Code	Class 1 Interface: 3526 Class 3 Interface: 12726
Recommended Cable	Belden #8761 or equivalent
Maximum Wire Size	Two 14 AWG wires per terminal
Maximum Cable Impedance	Voltage Source (with less than 10Ω impedance): 40Ω maximum loop impedance, for <1LSB error Current Source (transmitter properly wired to its power supply): 250Ω maximum loop impedance, to meet common-mode voltage requirements
Terminal Block	Removable, Allen-Bradley spare part Catalog Number 1746-RT25G

## Environmental Specifications

Description	Specification
Operating Temperature	0°C to 55°C (32°F to 131°F) in any slot except slot 0 0°C to 60°C (32°F to 140°F) in right most slot of chassis
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Certification	UL listed CSA approved CE compliant for all applicable directives
Hazardous Environment Classification	Class I Division 2 Hazardous Environment

## Input Specifications

Description	Specification
Type of Input (Selectable)	± 10V dc 1-5V dc 0-5V dc 0-10V dc 0-20 mA 4-20 mA ± 20 mA 0-1 mA
Type of Data (Selectable)	Engineering Units Scaled-for-PID Proportional Counts (-32,768 to +32,767 range) Proportional Counts (User Defined Range, Class 3 only) 1746-NI4 Data Format
Input Impedance	1 MΩ
Voltage Input (maximum)	±30V between any two signal terminals
Current Input (maximum)	±30 mA
Time to Detect Open Circuit	1 module scan
Input Step Response	See Chapter 4, Channel Filter Frequency Selection, page 4-7
Input Resolution	1 mV or 1 μA
Display Resolution	1 mV or 1 μA
Overall Module Accuracy (0°C to 60°C, 32°F to 140°F)	Voltage input types (± 10V dc, 1-5V dc, 0-5V dc, 0-10V dc): ±0.1% Current input types (0-20 mA, 4-20 mA, ± 20 mA): ±0.05% Current input type (0-1 mA): ±0.5%
Overall Module Drift	Voltage input type: ±6 ppm/°C Current input type: ±12 ppm/°C
Module Update Time	See Chapter 4, Update Time, page 4-5
Channel Turn-On Time	See Chapter 4, Turn-On Time, page 4-6
Channel Turn-Off Time	See Chapter 4, Turn-Off Time, page 4-6
Channel Reconfiguration Time	See Chapter 4, Reconfiguration Time, page 4-6

## Configuration Worksheet

The following worksheet is provided to help you configure each of the channels on your module. See Chapter 5 for detailed configuration information.

15 14 13 12				11	10 9 8			7 6		5 4 3			2 1 0			Bit Number
0	0	0	0													<b>Channel 0</b>
0	0	0	0													<b>Channel 1</b>
0	0	0	0													<b>Channel 2</b>
0	0	0	0													<b>Channel 3</b>
0	0	0	0													<b>Channel 4</b>
0	0	0	0													<b>Channel 5</b>
0	0	0	0													<b>Channel 6</b>
0	0	0	0													<b>Channel 7</b>

- Input Type
- Data Format
- Open Circuit
- Filter Frequency
- Channel Enable
- Not Used

**Bit Definitions:**

Bits	Function	000	010	100	110
<b>Bits 0-2</b>	Input Type	000 = ±10V dc	010 = 0-5V dc	100 = 0-20 mA	110 = ±20 mA
		001 = 1-5V dc	011 = 0-10V dc	101 = 4-20 mA	111 = 0-1 mA
<b>Bits 3-5</b>	Data Format	000 = engineering units	010 = proportional counts	100 = user defined scaling	110 = illegal
		001 = scaled-for-PID	011 = 1746-NI4 data format	101 = user defined scaling	111 = illegal
<b>Bits 6 and 7</b>	Open Circuit	00 = zero	01 = upscale	10 = downscale	11 = illegal
<b>Bits 8-10</b>	Filter Frequency	000 = no filter	010 = 50 Hz	100 = 10 Hz	110 = 2 Hz
		001 = 75 Hz	011 = 20 Hz	101 = 5 Hz	111 = 1 Hz
<b>Bit 11</b>	Channel Enable	0 = channel disabled		1 = channel enabled	
<b>Bits 12-15</b>	Not Used	0000 = always make this setting			



## Converting from 1746-NI4 to 1746-NI8

This information is provided for those who are replacing two 1746-NI4 modules with one 1746-NI8 module.

### Module ID Code

The module identification code is a unique number encoded for each 1746 I/O module. The code defines for the processor the type of I/O or specialty module residing in a specific slot in the 1746 chassis.

Using your programming device, configure the slot with the appropriate ID code. In this example, the 1746-NI8 is in slot 3.

Catalog Number	ID Code
1746-NI8	3526 – Class 1 interface 12726 – Class 3 interface

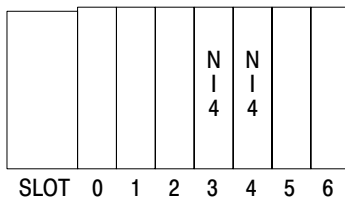
**Important:** All programming software does not support configuration for Class 3 operation.

- Advanced Programming Software (APS) supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- SLC 500 A.I. Series™ Programming Software supports Class 3 configuration. After entering the ID code (12726), enter 16 input words and 12 output words.
- RSLogix 500™, version 1.30 or later, supports Class 3 configuration. After entering the ID code (12726), select Class 3 operation.
- Earlier versions of RSLogix 500 will only support configuration for Class 1 operation. Contact Rockwell Software for information on upgrading your software.

See chapter 4 for more information on Class 1 and Class 3 interfaces.

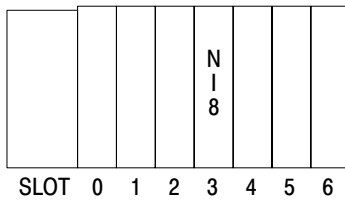
## Addressing

Addressing is changed from two modules with 4 channels to one module with 8 channels. The input addressing is shown below.



### 1746-NI4 Input Addressing

- I:3.0 – Slot 3, Channel 0 Data Word
- I:3.1 – Slot 3, Channel 1 Data Word
- I:3.2 – Slot 3, Channel 2 Data Word
- I:3.3 – Slot 3, Channel 3 Data Word
- I:4.0 – Slot 4, Channel 0 Data Word
- I:4.1 – Slot 4, Channel 1 Data Word
- I:4.2 – Slot 4, Channel 2 Data Word
- I:4.3 – Slot 4, Channel 3 Data Word



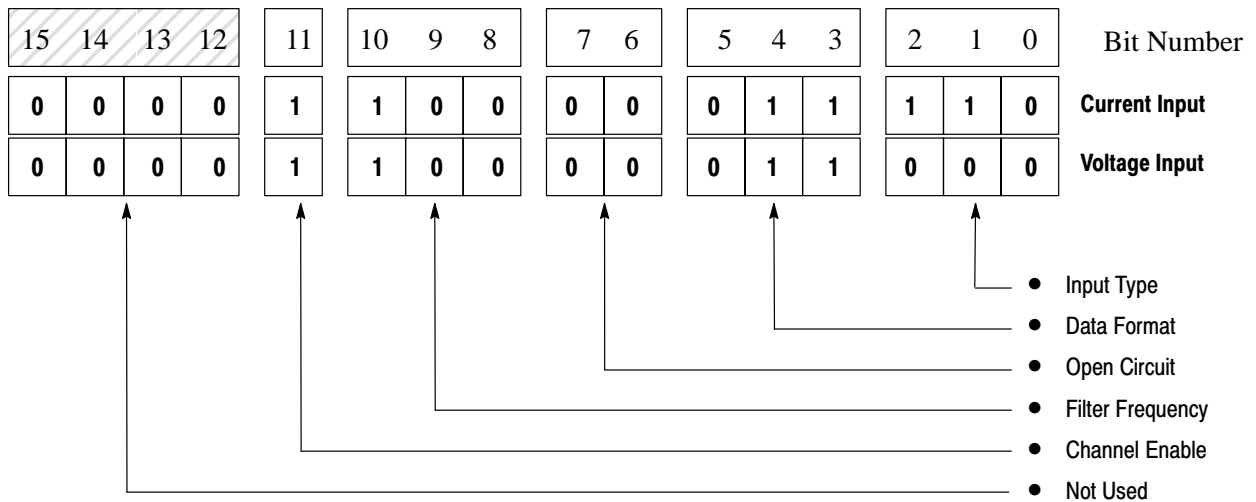
### 1746-NI8 Input Addressing

- I:3.0 – Slot 3, Channel 0 Data Word
- I:3.1 – Slot 3, Channel 1 Data Word
- I:3.2 – Slot 3, Channel 2 Data Word
- I:3.3 – Slot 3, Channel 3 Data Word
- I:3.4 – Slot 3, Channel 4 Data Word
- I:3.5 – Slot 3, Channel 5 Data Word
- I:3.6 – Slot 3, Channel 6 Data Word
- I:3.7 – Slot 3, Channel 7 Data Word

## Channel Configuration

For the 1746-NI4, input selection (voltage or current) is made via a switch. For the 1746-NI8, input selection (voltage or current) is made via a switch and a configuration word is used to define the other operating parameters for the module. The 1746-NI4 does not employ a configuration word.

To configure the 1746-NI8 for the same input type as the 1746-NI4, use the following configuration word. For voltage input you must select  $\pm 10\text{V}$  dc, and for current input you must select  $\pm 20$  mA. Define a configuration word for channels 0–7 on the 1746-NI8 module.



### Bit Definitions for Converting from 1746-NI4 to 1746-NI8:

Bits	Definition	000 = $\pm 10\text{V}$ dc	110 = $\pm 20$ mA
Bits 0–2	Input Type		
Bits 3–5	Data Format	011 = 1746-NI4 data format	
Bits 6 and 7	Open Circuit	00 = zero (the open circuit option is not available for the $\pm 20$ mA data type)	
Bits 8–10	Filter Frequency	100 = 10 Hz	
Bit 11	Channel Enable	0 = channel disabled    1 = channel enabled	
Bits 12–15	Not Used	0000 = always make this setting	

See chapter 5 for more detailed information on channel configuration.

## Ladder Program

To convert your ladder program from the 1746-NI4s to a 1746-NI8, you only need to change the module addressing. Change the addresses in the program (slot and word sub element number) to reflect the location of the new module.

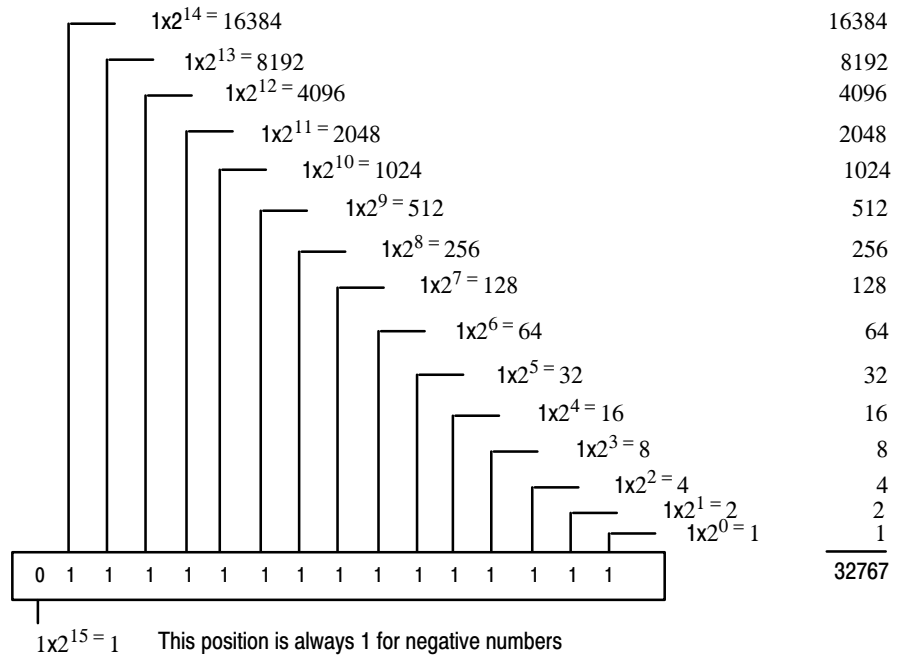
See chapter 6 for more information on ladder programming.



### Negative Decimal Values

In two's complement notation, the far left position is always 1 for negative values. The equivalent decimal value of the binary number is obtained by subtracting the value of the far left position, 32768, from the sum of the values of the other positions. In the figure below (all positions are 1), the value is  $32767 - 32768 = -1$ . For example:

$$\begin{aligned}
 &1111\ 1000\ 0010\ 0011 = \\
 &(2^{14}+2^{13}+2^{12}+2^{11}+2^5+2^1+2^0) - 2^{15} = \\
 &(16384+8192+4096+2048+32+2+1) - 32768 = \\
 &30755 - 32768 = -2013.
 \end{aligned}$$



---

# Glossary

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here refer to *Allen-Bradley's Industrial Automation Glossary*, Publication AG-7.1.

**A/D** - Refers to the analog to digital converter inherent to the module. The converter produces a digital value whose magnitude is proportional to the instantaneous magnitude of an analog input signal.

**analog input module** - An I/O module that contains circuits that convert analog dc input signals to digital values that can be manipulated by the processor.

**attenuation** - The reduction in the magnitude of a signal as it passes through a system.

**backplane** - A printed circuit board, at the back of the chassis, that provides electrical interconnection between the modules inserted into the chassis.

**channel** - Refers to one of eight, small-signal analog input interfaces available on the module's terminal block. Each channel is configured for connection to a voltage or current source input device, and has its own data and diagnostic status words.

**channel update time** - The time required for the module to sample and convert the input signals of one enabled input channel and update the channel data word.

**chassis** - A hardware assembly that houses devices such as I/O modules, adapter modules, processor modules, and power supplies.

**common mode rejection ratio** - The ratio of a device's differential voltage gain to common mode voltage gain. Expressed in dB, CMRR is a comparative measure of a device's ability to reject interference caused by a voltage common to its input terminals relative to ground.  $CMRR = 20 \text{ Log}_{10} (V_1/V_2)$

**common mode voltage** - A voltage that appears in common at both input terminals of a differential analog input with respect to ground.

**configuration word** - Contains the channel configuration information needed by the module to configure and operate each channel. Information is written to the configuration word through the logic supplied in your ladder program.

**dB** - (decibel) A logarithmic measure of the ratio of two signal levels.

**data word** - A 16-bit integer that represents the value of the analog input channel. The channel data word is valid only when the channel is enabled and there are no channel errors. When the channel is disabled the channel data word is cleared (0).

**digital filter** - A filter implemented in firmware, using discrete, sampled data of the input signal.

**filter** - A device that passes a signal or range of signals and eliminates all others.

**filter frequency** - (-3 dB frequency) The user-selectable frequency.

**full scale error** - (gain error) The difference in slope between the actual and ideal analog transfer functions.

**full scale range** - (FSR) The difference between the maximum and minimum specified analog input values.

**gain drift** - The change in full scale transition voltage measured over the operating temperature range of the module.

**input data scaling** - The data formats that you select to define the logical increments of the channel data word. These may be scaled-for-PID, or Engineering Units, which are automatically scaled. They may also be proportional counts, which you must calculate to fit the resolution of the quantity being measured in your application.

**input image** - The input from the 1746-NI8 module to the SLC processor. The input image contains the module data words and status words.

**local configuration** - A control system where all the chassis are located within several feet of the processor, and chassis-to-chassis communication is via a 1746-C7 or 1746-C9 ribbon cable.

**LSB** - (Least Significant Bit) The bit that represents the smallest value within a string of bits.

**module scan time** - same as *module update time*

**module update time** - The time required for the module to sample and convert the input signals of all enabled input channels and make the resulting data values available to the SLC™ processor.

**multiplexer** - An switching system that allows several input signals to share a common A/D converter.

**normal mode rejection** - (differential mode rejection) A logarithmic measure, in dB, of a device's ability to reject noise signals between or among circuit signal conductors.

**output image** - The output from the SLC processor to the 1746-NI8 module. The output image contains the module configuration information. Each output word configures a single channel.

**remote configuration** - A control system where the chassis can be located several thousand feet from the processor chassis. Chassis communication is via the 1747-SN Scanner and 1747-ASB Remote I/O Adapter.

**resolution** - The smallest detectable change in a measurement, typically expressed in engineering units (e.g. 1 mV) or as a number of bits. For example a 12-bit system has 4,096 possible output states. It can therefore measure 1 part in 4096.

**scaling** - The process of changing a quantity from one notation to another.

**status word** - Contains status information about the channel's current configuration and operational state. You can use this information in your ladder program to determine whether the channel data word is valid.

**step response time** - This is the time required for the channel data word signal to reach a specified percentage of its expected final value, given a large step change in the input signal.

**transducer** - A device that converts one energy form to another (e.g., mechanical to electrical). When a transducer is actuated by signals from one system or medium, it can supply a related signal to the other system or medium.



## Symbols

-3 dB frequency. *See* filter frequency

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# Class I, Division 2 PLC-RELAYS

SPDT Electromechanical Relays  
& Opto-couplers

Data Sheet 1477D

January 2005

## Features

- UL 1604 Listed for Class I, Division 2
- Only 6.2 mm (.244 in.) wide
- DIN-rail mountable
- Polarity protected (DC versions)
- Inductive kickback protection
- LED status indication
- Time saving plug-in jumper system
- Flexible, modular design

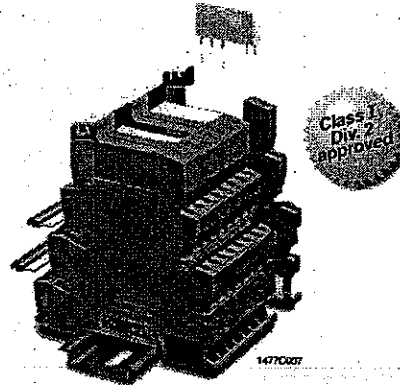


Figure 1. PLC-RSC Class I, Division 2  
Electromechanical Relays and Opto-couplers

## Description

The Class I, Division 2 PLC-Relays are space saving, pluggable, compact interface relays designed for use in Class I, Division 2 applications. The numerous voltage and application options allow convenient and economical adaptability to your control system.

These devices are UL/cUL Listed as process control equipment for use in Class I, Zone 2 and Class I, Division 2 Hazardous Locations.

This family of PLC-Relays can help eliminate the need for expensive explosion proof/purged enclosures and further expands Phoenix Contact's role in the hazardous location control industry.

### Note:

All electromechanical relays mentioned above are SPDT. For specifications on the Class I, Division 2, 24 V dc, DPDT PLC Relay, please see data sheet 2051A for P/N 2980461.

## Ordering Information

### Description

Electromechanical (Screw Terminals)

Electromechanical (Spring Terminals)

Opto-couplers (Screw Terminals)

Power distribution block

Partition plate

2 position snap-in jumper (Red)

2 position snap-in jumper (Blue)

2 position snap-in jumper (Grey)

19" snap-in jumper (Red)

19" snap-in jumper (Blue)

19" snap-in jumper (Grey)

19" snap-in jumper (Brown)

Marker strip, 10-section, un-printed

### Type

PLC-RSC-24DC/21 C1D2

PLC-RSC-120UC/21 C1D2

PLC-RSP-24DC/21 AEX

PLC-RSP-120UC/21 AEX

PLC-OSC-24DC/24DC/2 C1D2

PLC-OSC-24DC/48DC/100C1D2

PLC-OSC-120UC/24DC/2 C1D2

PLC-OSC-120UC/48DC/100 C1D2

PLC-ESK GY

PLC-ATP BK

FBST 6-PLC RD

FBST 6-PLC BU

FBST 6-PLC GY

FBST-500-PLC RD

FBST-500-PLC BU

FBST-500-PLC GY

FBST-500-PLC BN

ZB:10 UNPRINTED

### Part Number

56 03 15 4

56 03 15 7

56 03 68 4

56 03 68 3

56 03 26 0

56 03 26 1

56 03 26 2

56 03 26 3

29 66 50 8

29 66 84 1

29 66 23 6

29 66 81 2

29 66 82 5

29 66 78 6

29 66 69 2

29 66 83 8

29 67 97 6

10 53 00 1

# Class I, Division 2 PLC-RELAYS

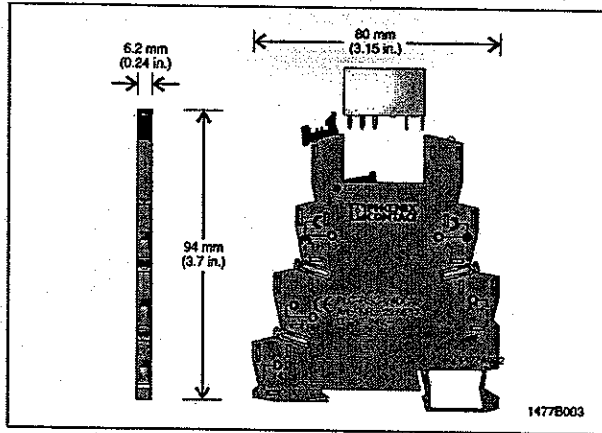


Figure 2. PLC-RELAYS Dimensions

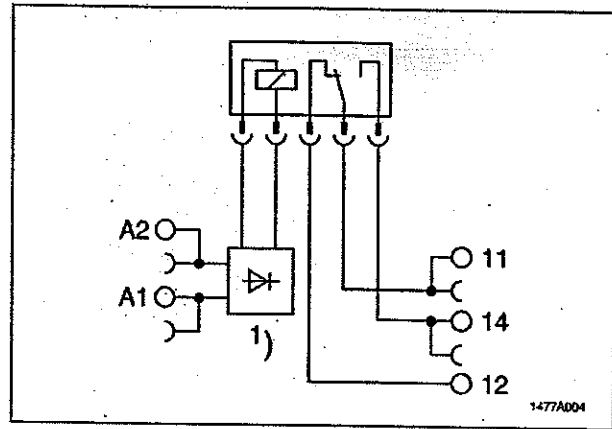


Figure 3. Mechanical Relay SPDT Terminal Assignments

Table 1. PLC-RELAYS General Specifications

<b>Technical Data</b>	
<b>Input Data</b>	
Input coil voltages .....	24 V dc, 120 V ac
<b>Output Data</b>	
Limiting continuous current .....	6 A, 100 mA, 2 A
<b>General Data</b>	
Maximum wire size .....	26-14 AWG
Ambient temperature range .....	-20°C up to +60°C
Mechanical life .....	10 <sup>7</sup> cycles
<b>Dimensions</b>	
Height .....	3.7 in. (94 mm)
Width .....	0.24 in. (6.2 mm)
Depth .....	3.15 in. (80 mm)

1477B002

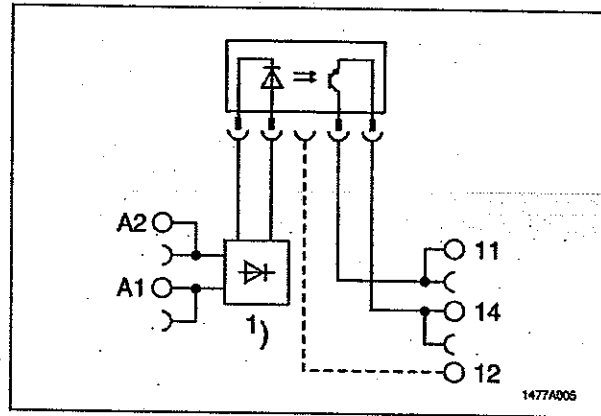


Figure 4. Solid State Relay Terminal Assignments

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# **PanelMate® Power Pro Configuration Editor Software User's Guide**

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# Preface

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# Installing the Configuration Software

## 1

*In this chapter, you will learn:*

- *How to install the Configuration Software*
- *About the Product Features*

## Installing the Configuration Software

The Software Kit contains a CD-ROM for fast, easy software installation. Select **Install Software**, and then select the software files you wish to install:

- Configuration Software files
- Configuration Database files
- Transfer Utility files
- Executive Firmware files
- PanelMate PC Runtime files

**Note:** Before installing the configuration software, make sure that you close all open applications.

**Note:** If installing the PanelMate Runtime Software only, deselect the other selections and only check the box for the PanelMate PC Runtime selection.

**Note:** If you are upgrading your configuration software, you do not need to install the Configuration Database files. However, if you do not deselect this box, your existing database will be renamed and a new database will be installed. On-screen prompts detail available options.

**Note:** PanelMate PC default fonts are not automatically installed in the Windows Font directory. Follow the installation prompts to install the PanelMate fonts and reboot the PC prior to running PanelMate PC.

After selecting the directory and subcomponent files to install, press the **Install** button. When the installation is finished, press the **YES** button in the **Question** dialog box to review the **readme.txt** file. The readme.txt file lists all the issues addressed from the previous version of software, lists the enhancements to the current version of software, and lists the new issues with the current version of software. After reviewing the readme.txt file, press the **OK** button in the **Installation Complete** dialog box. You may then install the drivers you need, or exit the installation utility.



## Product Features

The following product features can be purchased from Cutler-Hammer. If you have purchased the feature, the feature must be selected in the **New Configuration** dialog box or the **Configuration Properties** dialog box in the configuration software.

Note that some features are standard and cannot be disabled.

### Color Display

The Color Display Feature allows you to select a color configuration. If this box is not checked, the configuration will be grayscale.

### High Capacity Unit

The High Capacity Unit feature allows you to create a larger number of pages and messages than permitted in the Standard Capacity environment. Refer to the table below for feature limits. Note that all PanelMate Power Series models with Catalog Item numbers that end in X (e.g. 52PKHX), all PanelMate Power Pro models and PanelMate Pro LT models come with the High Capacity feature already installed. If necessary, users can expand their PanelMate Power Series units to High Capacity by ordering option PMUPGRADE.

Product Type		Maximum Number of Pages
PanelMate Power Series 1500	50	2500
All other PanelMate Power Series models	100	5000
PanelMate PC	200	10000

Note that the complexity of the configuration may reduce the number of pages and messages in the PanelMate unit.

### Advanced Trending Template

The Advanced Trending Template feature allows you to configure Advanced Trending Templates which display a history of a reference's value over a period of time. Advanced trending features 6 pens that can be triggered by time or event.

For information on configuring an Advanced Trending Template, refer to the **Line Trend Template** topic.

Note that ALL PanelMate Power Series units with Catalog Item numbers that end in X (e.g. 52PKHX), PanelMate Power Pro units and PanelMate Pro LT come with the Advanced Trending Template feature already installed. The Advanced Trending Template option is included in the Catalog Item PMUPGRADE or the required software can be downloaded from the Cutler-Hammer website for free.

### Allen-Bradley DH-485

The Allen-Bradley DH-485 feature allows you to communicate to the Allen-Bradley DH-485 Highway.

### Modicon Modbus

The Modicon Modbus feature allows you to communicate to Modicon PLCs via the Modicon Modbus or Modicon Modbus Plus.

Note that ALL PanelMate Power Series units with Catalog Item numbers that end in X (e.g. 52PKHX), PanelMate Power Pro units and PanelMate Pro LT come with the Modicon Modbus feature already installed. The Modicon Modbus option is included in the Catalog Item PMUPGRADE or the required software can be downloaded from the Cutler-Hammer website for free.

### **Dynamic Graphics**

The Dynamic Graphics feature allows symbols to change colors and shapes dynamically on PanelMate Power Series 1500 models.

Note that ALL PanelMate Power Series 1500 units with Catalog Item numbers that end in X (e.g. 1555THX) come with the Dynamic Graphics feature already installed. The Dynamic Graphics feature option is included in the Catalog Item PMUPGRADE or the required software can be downloaded from the Cutler-Hammer website for free.

### **256 Greyscale/Color (Model 1555/1575)**

The 256 Greyscale/Color (Model 1555/1575) feature enhances the PanelMate Power Series 1500.

If you have a PanelMate Power Series 1500 (Model 1555) and you select the 256 Greyscale/Color feature, you will have 256 shades of gray (instead of the standard 4 solid/4 blinking shades), PowerAnimation, and PowerBlink.

If you have a PanelMate Power Series 1500 (Model 1575) and you select the 256 Greyscale/Color feature, you will have a 256 color palette (instead of the standard 8 solid/8 blinking colors), PowerAnimation, and PowerBlink.

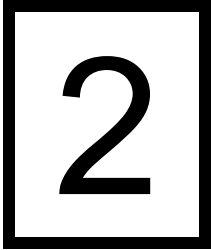
PowerAnimation allows you to create animation by defining a series of graphic objects which blink in sequence and PowerBlink allows you to create graphic objects which blink at different rates.

### **I/O Count Expansion (Model 1155/1175)**

The I/O Count Expansion feature increases the number of I/O references allowed by the PanelMate Pro LT 1100. By default, the PanelMate Pro LT 1100 allows up to 64 I/O references in a configuration. Additional I/O references can be purchased, in groups of 64 I/O references, up to a maximum of 512 I/O references. Refer to **Chapter 12: Using Tags** for more information on how a PanelMate Pro LT 1100 counts I/O references

**CAUTION:** Once a tag upgrade is loaded onto a PanelMate Pro LT 1100, it is there permanently. It cannot be removed or relocated to another unit or back to the tag key. Careful planning in determining the number of actual tag references that are to be used should be exercised before loading a tag upgrade.

# Main Screen

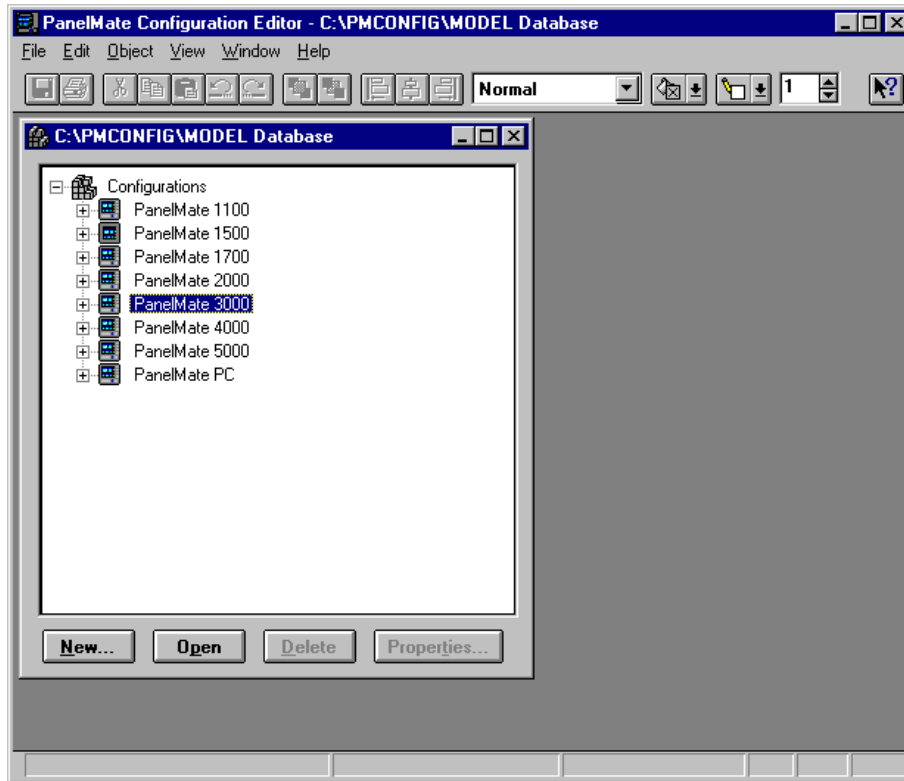


*In this chapter, you will learn:*

- *About the Main Screen*
- *About the File Menu selections*
- *About the Edit Menu selections*
- *About the Object Menu selections*
- *About the View Menu selections*
- *About the Window Menu selections*
- *About the Help Menu selections*
- *About the Toolbar selections*
- *About the Color Selection Palette*
- *About the Status Bar*
- *About Tool Palette selections*

## Main Screen

The Main Screen appears when you run the PanelMate Configuration Editor.



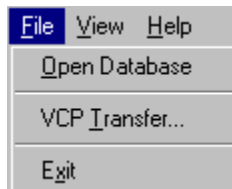
The Database TreeView Window will appear on the Main Screen. For more information about the Database TreeView Window, refer to the **Database Treeview Window** topic.

## File Menu

The File menu varies depending upon whether the database is open.

Tip: **When the database is open, the Database Treeview Window will appear.**

If the database is not open, the following File Menu will appear.



If the database is open, the following File Menu will appear.



The selections in the File Menu are described below. Note that some of the selections are available from the **toolbar**. Refer to the **toolbar** topic for more information.

**Open Database:** Opens the **Open Database** dialog box and allows you to select a database.

**Backup Database:** Opens the **Backup Database** dialog box and allows you to backup your database.

**Close:** Closes the database.

**Save:** Saves the highlighted configuration to the database.

**Save As:** Opens the **Save As** dialog box. This selection is used if you wish to save a configuration to the database under a new name.

**Convert:** Opens the **Conversion** dialog box. This selection is used if you wish to convert a configuration from one model to another (e.g., PanelMate Power Series 2000 to PanelMate Power Series 3000).

**Verify:** Opens the **Verify Application** dialog box. This selection checks all PLC references and expressions.

**References =>Tags:** Performs a reference-to-tag replacement operation. Refer to **Chapter 12: Using Tags** for more information on this operation.

**Import:** Opens the **Import** dialog box. This selection allows you to import the selected configuration file into the database.

**Export:** Opens the **Export** dialog box. This selection allows you to export the selected configuration file from the database to a current version configuration file.

**Export As:** Opens the **Export As** dialog box. This selection will export the selected configuration file from the database to an earlier version configuration file (e.g., V2.1X).

**VCP Transfer:** Executes the PanelMate Transfer software. This selection allows you to transfer configuration files, execute firmware, and drivers to and from the PanelMate unit.

Tip: **Before a configuration file can be transferred to a PanelMate unit, the configuration file must be exported.**

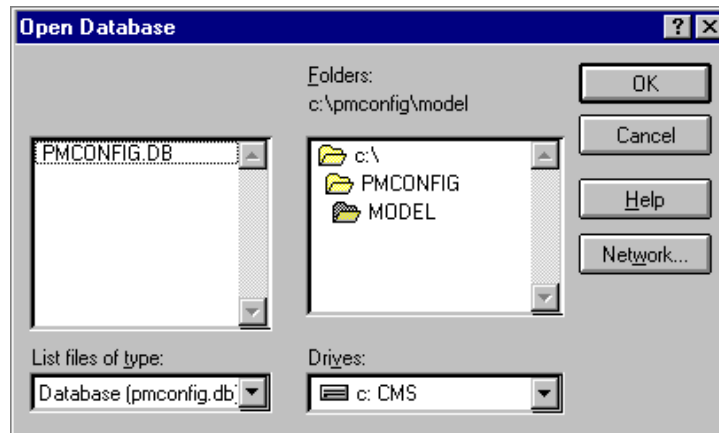
**Print:** Opens the **Configuration Editor Reports** dialog box. This selection allows you to print a hard copy of the current configuration.

For information on printing an image of a configuration page, refer to the **Printing a Configuration Page** topic.

**Exit:** Ends the PanelMate Configuration Editor session.

## Open Database

When you choose the **Open Database** dialog box from the File Menu, the **Open Database** dialog box will appear.



The **Open Database** dialog box allows you to select a PanelMate database. The default database (named model) is created during the installation process. The model database is actually a group of files located in the model subdirectory under the PanelMate Configuration Editor directory (c:\pmconfig by default). Many files (over 100) make up a PanelMate database.

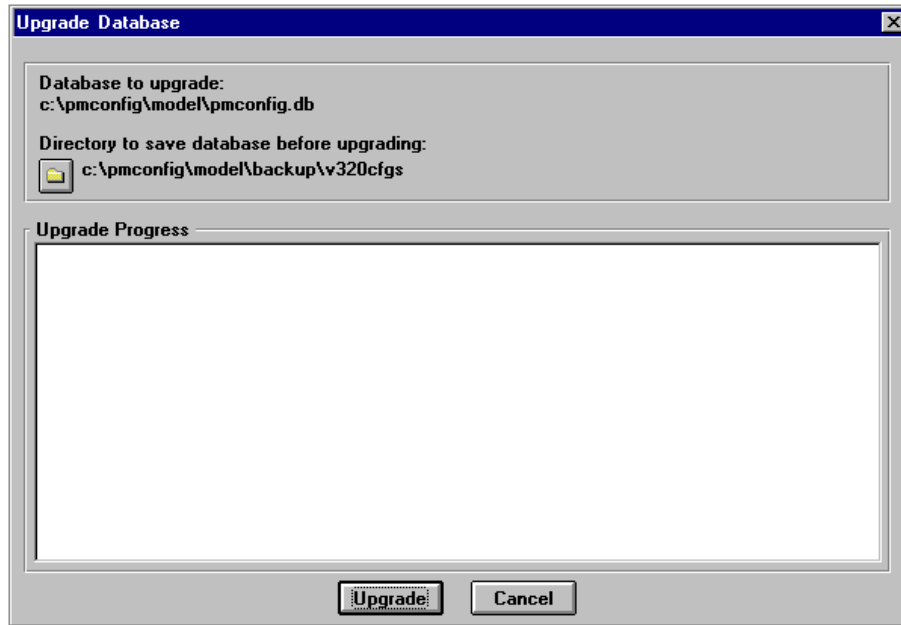
Other PanelMate databases can be accessed from the **Open Database** dialog box by selecting the drive and folder in which a valid PanelMate database resides. A single file from the database (pmconfig.db) indicates that the folder contains a viable database. Once a folder is selected which has a valid database and the **OK** button is clicked, the Configuration Editor will open the database, display the Database Treeview Window, and allow you to create or edit a configuration.

If you install new configuration software that has an upgraded database and attempt to open an earlier version of the database, the **Upgrade Database** dialog box will appear. (Note that not every new configuration software version will have an upgraded database.) The **Upgrade Database** dialog box allows you to upgrade any earlier version of the database to be compatible with the new configuration software. For more information on upgrading the database, refer to the **Upgrade Database** topic.

See the **Configuration Editor Problems** topic if problems are encountered when attempting to open a database.

## Upgrade Database

If you install new configuration software that has an upgraded database and attempt to open an older version of the database, the **Upgrade Database** dialog box will appear. (Note that not every new configuration software version will have an upgraded database.)



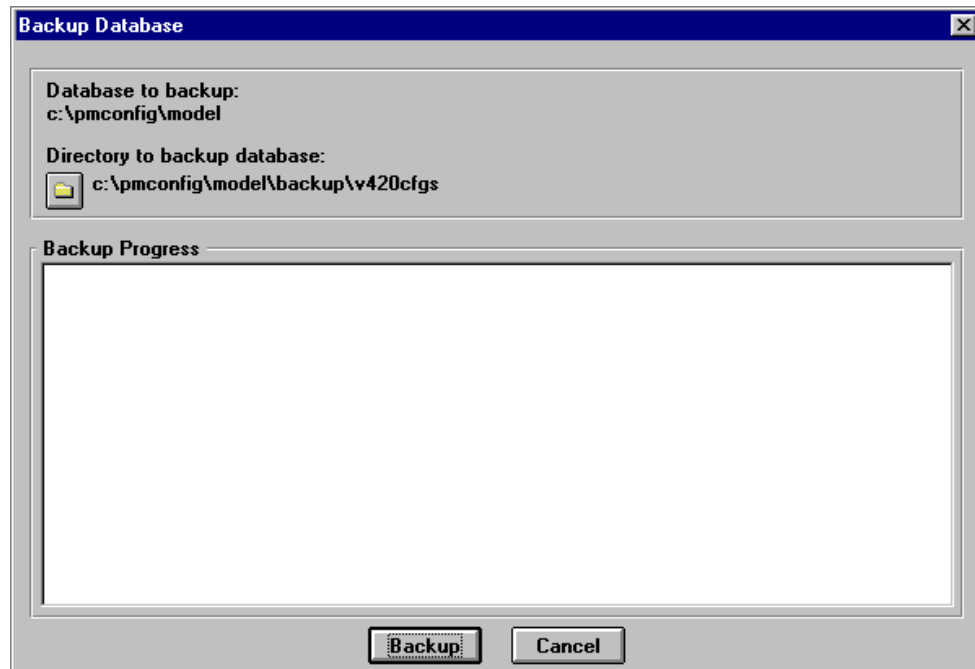
The **Upgrade Database** dialog box allows you to upgrade any earlier version of the database to be compatible with new configuration software. The default upgrade directory is created by adding the subdirectory `\backup\v320cfgs` to your current database directory. Make sure you store the original database to a directory other than the standard backup directory used in the **Backup Database** dialog box. To change the upgrade directory, click on **Directory to upgrade database** button and enter the directory pathname.

Press the **Upgrade** button to upgrade your database. When completed, a **Print** button will appear to allow you to print the upgrade progress.



## Backup Database

When you choose the **Backup Database** dialog box from the File Menu, the **Backup Database** dialog box will appear.

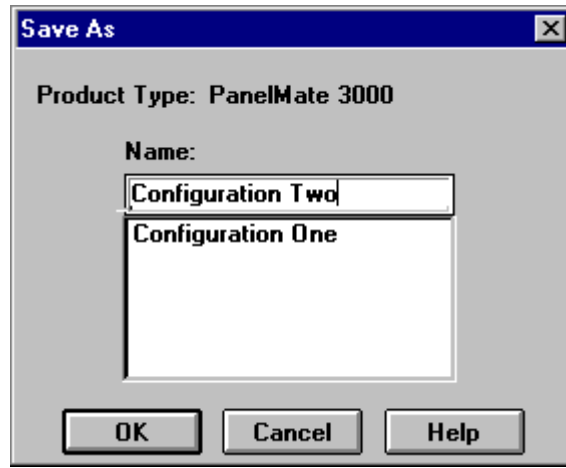


The **Backup Database** dialog box allows you to backup your database. The default backup directory is created by adding the subdirectory \backup\v420cfs to your current database directory. To change the backup directory, click on **Directory to backup database** button and enter the directory pathname.

Press the **Backup** button to backup your database. When completed, a **Print** button will appear to allow you to print the backup progress.

## Save As

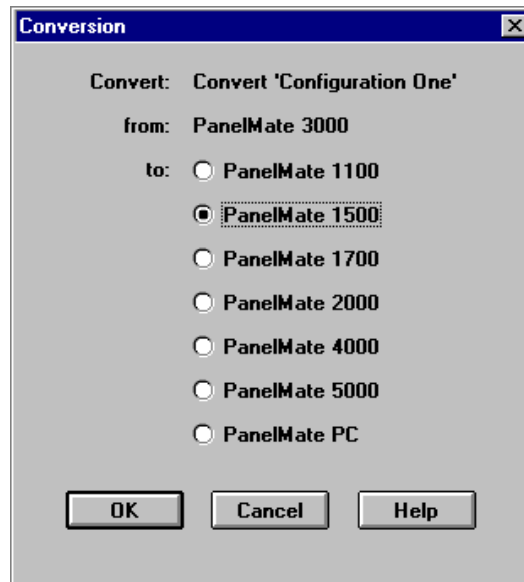
When you select a configuration filename in the Database Treeview Window and choose the Save As selection from the File Menu or click on the **Save** button in the toolbar, the **Save As** dialog box will appear.



The **Save As** dialog box allows you to save a configuration file. This selection is used if you are saving a new configuration or if you wish to save a configuration under another name.

## Conversion

When you select a configuration filename in the Database Treeview Window and choose the Convert selection from the File Menu, the **Conversion** dialog box will appear.



This **Conversion** dialog box allows you to convert a configuration file from one PanelMate hardware model to another (e.g., PanelMate Power Series 2000 to PanelMate Power Series 3000). If there are any conversion issues between PanelMate models, a dialog box will appear which will state the issues and ask if you wish to continue with the conversion. If you press the **Yes** button to continue, be aware of the issues noted in the dialog box.

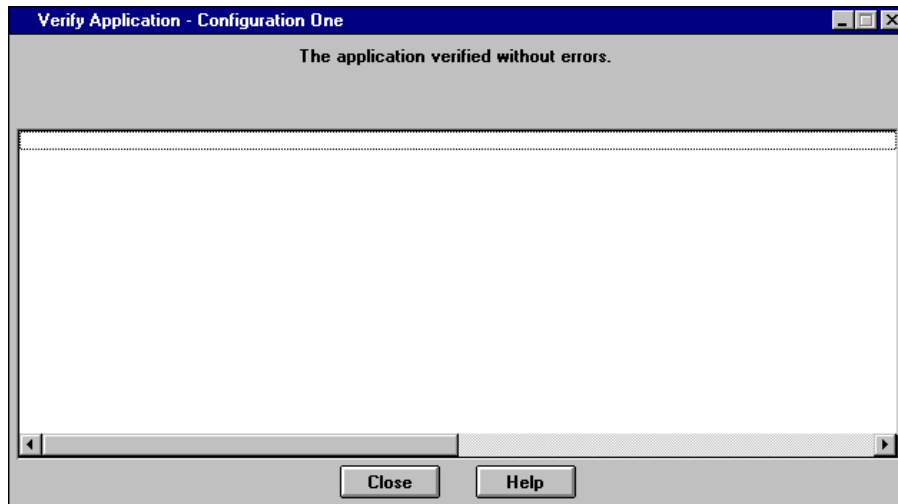
When converting to a PanelMate Power Series 1500 configuration, note the following items.

- If your configuration has PowerGraphics, the graphics cannot be converted unless the PanelMate Power Series 1500 has the PowerGraphics option installed.
- If your configuration exceeds the capacity of the standard PanelMate Power Series 1500, but does not exceed the capacity of the expanded PanelMate Power Series 1500, the Capacity Expansion Kit option will be selected in the New Configuration dialog box for the converted configuration.
- If your configuration exceeds the capacity of the expanded PanelMate Power Series, an error message will be displayed and the configuration will not be converted.

Refer to the **Product Features** topic for more information about the Capacity Expansion Kit.

## Verify Application

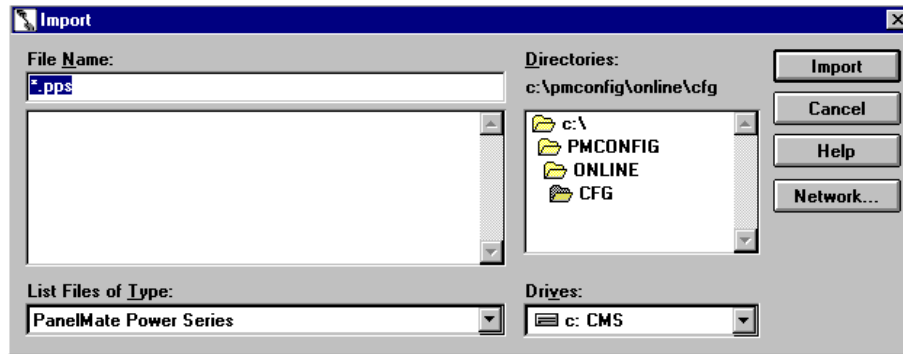
When you select a configuration filename in the Database Treeview Window and choose the Verify selection from the File Menu, the **Verify Application** dialog box will appear.



The Verify selection checks all PLC references and expressions in all configured dialog boxes and lists all invalid or illegal PLC references and expressions which would prevent a valid export.

## Import

When you choose the Import selection from the File Menu, the **Import** dialog box will appear.



The **Import** dialog box allows you to import a configuration file into the database. Note that earlier PanelMate Power Series configuration files and PanelMate Series V2.1X configuration files may also be imported.

PanelMate Series V2.1X configuration files will have one of the following extensions:

PanelMate Series 2000 Grayscale	.PC1 or .PC2
PanelMate Series 2000 Color	.PC5 or .PC6
PanelMate Series 3000 Grayscale	.PC1 or .PC2
PanelMate Series 3000 Color	.PC5 or .PC6
PanelMate Series 4000	.PC3 or .PC4

**Tip:** Once the configuration file is imported, it can be exported to a current configuration file, to an earlier PanelMate Power Series configuration file, or to a PanelMate Series V2.1X configuration file. Refer to the Export and Export As topics for more information on exporting configurations.

The Import selection and Export selection in the File Menu may be used to copy configurations from one personal computer to another. After export, a configuration (.PPS file) can be copied to another computer and imported into another PanelMate database. When using this method to copy configurations, please note the following issues:

- Test message numbers in Display Templates and Variable-Sized Display Templates are not exported. Therefore, all test message numbers in an imported configuration are set to zero (0).
- Group attributes are not exported. If a configuration had groups prior to export, the imported configuration would show all objects ungrouped.
- The displayed states for Indicator, Variable-Sized Indicator, and Variable-Sized Graphic Templates are not exported. On import, the selected state of Variable-Sized Indicators is set to state one (1), and Indicator Templates and Variable-Sized Graphic Templates are set to state five (5).

An alternate method for copying configurations from one system to another is by copying all database files to a new database directory on the target system. Shareware, zip, and unzip utilities are available to easily do this via floppy disk. This method will retain all Configuration Editor information including test messages, groups, and indicator selections.

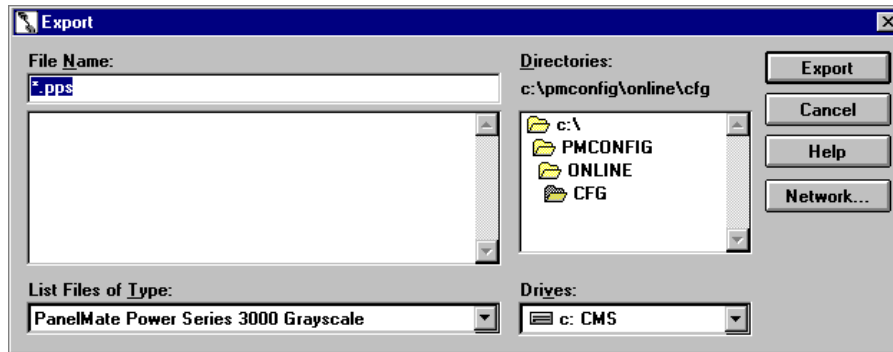
**CAUTION:** Before proceeding with the alternate method described above, ensure that the database window is closed in the PanelMate configuration software. Failure to close the database before copying the files may cause the database to become locked.

## Export

Tip: **If you wish to export to an earlier PanelMate Power Series configuration file or to a PanelMate Series V2.1X configuration file, refer to the Export As topic for more information.**

Note that configuration files must be exported before being transferred to the PanelMate unit.

When you select a configuration filename in the Database Treeview Window and choose the Export selection from the File Menu, the **Export** dialog box will appear.



The **Export** dialog box allows you to export a configuration file for the current Configuration Editor software version.

The Export selection and Import selection in the File Menu may be used to copy configurations from one personal computer to another. After export, a configuration (.PPS file) can be copied to another computer and imported into another PanelMate database. When using this method to copy configurations, please note the following issues:

- Test message numbers in Display Templates and Variable-Sized Display Templates are not exported. Therefore, all test message numbers in an imported configuration are set to zero (0).
- Group attributes are not exported. If a configuration had groups prior to export, the imported configuration would show all objects ungrouped.
- The displayed states for Indicator, Variable-Sized Indicator, and Variable-Sized Graphic Templates are not exported. On import, the selected state of Variable-Sized Indicators is set to state one (1), and Indicator Templates and Variable-Sized Graphic Templates are set to state five (5).

An alternate method for copying configurations from one system to another is by copying all database files to a new database directory on the target system. Shareware, zip, and unzip utilities are available to easily do this via floppy disk. This method will retain all Configuration Editor information including test messages, groups, and indicator selections.

## Export As

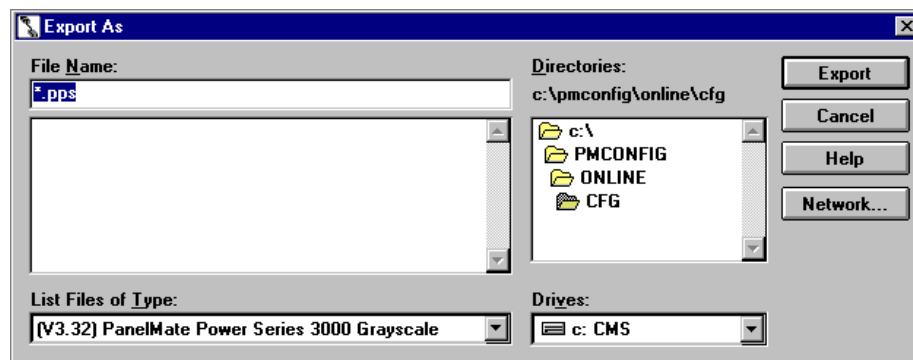
The **Export As** dialog box allows you to export to an earlier PanelMate Power Series configuration file or to a PanelMate Series V2.1X configuration file for earlier Configuration Editor software versions.

Tip: **If you wish to export to a current PanelMate Power Series configuration file, refer to the Export topic for more information.**

Tip: **For guidelines to consider before exporting to a V2.1X configuration, refer to the V2.1X Export Guidelines topic.**

Note that configuration files must be exported before being transferred to the PanelMate unit.

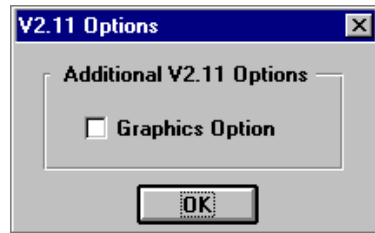
When you select a configuration filename in the Database Treeview Window and choose the Export As selection from the File Menu, the **Export As** dialog box will appear.



Before the configuration file is exported, the configuration file will be verified. The verification process checks for the following:

- Number of messages
- Number of pages
- Presence of PowerGraphics
- Compatibility issues

If you select to export to a PanelMate Series V2.1X configuration file, a **V2.11 Options** dialog box will appear.



You can check the Graphics Option box to set the graphics option in the V2.1X configuration file. If the Graphics Option box is not checked, the variable-sized graphics and symbols will not be exported.

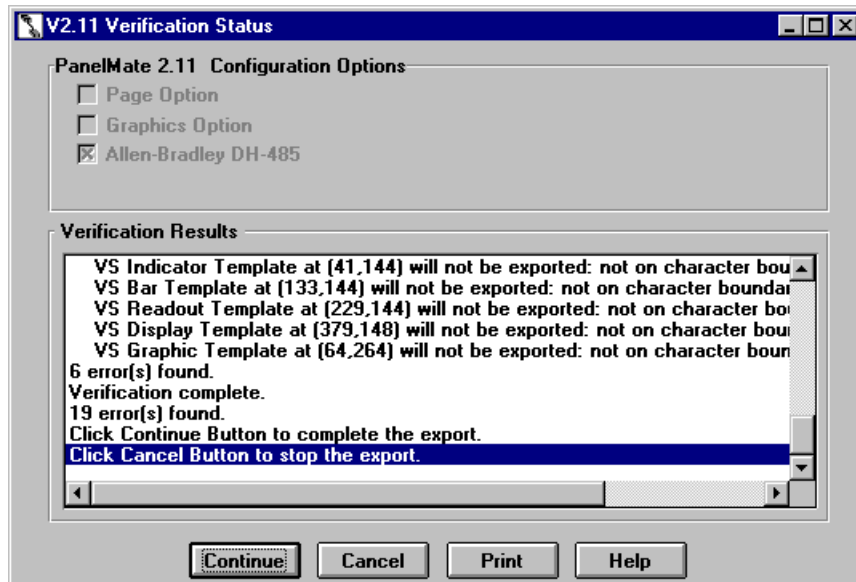
After the **V2.11 Options** dialog box appears, the configuration file will be verified and the results of the verification will be displayed in the **Verification Status** dialog box. Refer to the **Verification Status** topic for more information.

For more information about the verification process for exporting, see the **V2.1X Export Guidelines** topic or the **V2.1X Export Errors** topic.



## Verification Status

If you choose to export to a V2.1X configuration file in the **Export As** dialog box, the configuration file will be verified and then the **Verification Status** dialog box will appear.



The **Verification Status** dialog box displays the configuration options of the file, the items that will not be exported, and the reason for not exporting the items.

Note that if you correct any errors, you must export the configuration file again. If you leave the **Verification Status** dialog box open while making changes to your configuration, the changes will not be exported. The configuration is always exported exactly as it appears in the **Verification Status** dialog box. For more information about the verification process for exporting, see the **V2.1X Export Errors** topic or the **V2.1X Export Guidelines** topic.

The selections on the **Verification Status** dialog box are described below.

**Continue:** Exports the configuration according to the results listed in the Verification Results list.

**Cancel:** Closes the dialog box without exporting the configuration.

**Print:** Prints a hard copy of the verification list on the default printer.

## **V2.1X Export Guidelines**

When exporting to a V2.1X configuration, the following guidelines should be considered.

### **Text strings are decomposed into individual character elements.**

V2.1X does not support text strings.

All text elements on a page are used to create a single V2.1X Static Page Symbol that is made up of individual character elements. You can place and edit the Character Elements individually.

### **The Auto-Centering attribute is lost during export.**

V2.1X does not support auto centering. Everything is exported as left justified.

### **The Direct Select (Touchscreen Only) field is lost during export.**

The Direct Select (Touchscreen Only) in the System Parameters field is not supported by V2.1X.

### **Colors are converted to their closest match.**

V2.1X configurations contain up to eight colors. Some PanelMate Power Series configurations contain up to 256 colors.

### **Blinking foreground colors are lost during export.**

Blinking foreground colors are not supported by V2.1X.

### **The default label Reset PLC Comm is changed to Enable Fault Relay.**

PanelMate Power Series 1500 is exported as PanelMate Series 2000/PanelMate Series 3000 when going to V2.1X. The default label Reset PLC Comm does not exist.

### **Maintenance Template options Allow on Page, Enable Writes, and Protection are lost during export.**

Maintenance Templates are not supported by V2.1X.

### **Some System Parameter fields are converted during export.**

Scan Delays (Screen, Alarm, Message, and Trend) are exported as part of the PLC Name and Port Table.

The Screen Blanking Inactivity Period is rounded to the nearest 20 minute interval.

The Control Bit Reset Delay is rounded to the nearest 250 mSec interval.

The Password Protection Time Out is rounded to the nearest five minute interval.

### **The Maintenance Template Soft Key Prompts, Contrast Adjustment Soft Key Prompts, Touchscreen Button Templates, Touchscreen Keypad Entry Labels, Touchscreen Control Keys, and the Switch To Two Column Keypad and Switch to Three Column Keypad labels from the Setup Page are lost during export.**

These Online Labels are not supported by V2.1X.

### **The Refresh Background Graphics Online feature on the Variable-Sized Graphics Template - VS Graphics Attributes Tab dialog box is not exported.**

This option is not supported by V2.1X.

### V2.1X Export Errors

Before the configuration file is exported, the configuration file is checked for features not supported by V2.1X configuration software. If there are features that cannot be exported, you will see one or more of the following error messages:

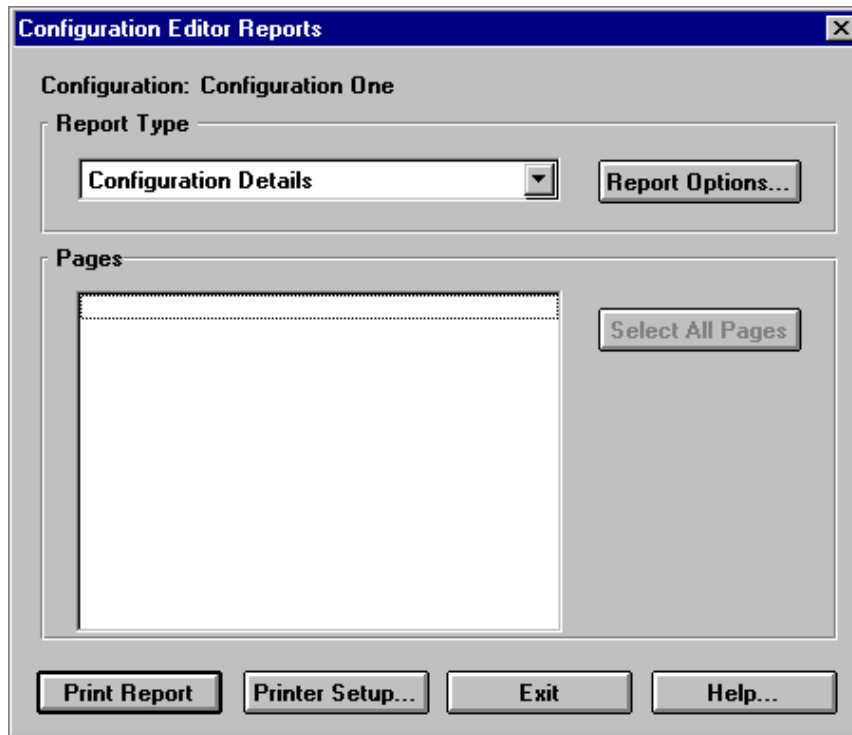
Error Message	Reason for Error
Any element is not on a character boundary (X, Y).	X must be a multiple of 8. Y must be a multiple of 16.
Symbol offset is not on a character boundary (X, Y).	X must be a multiple of 8. Y must be a multiple of 16.
Any element overlaps another element.	Overlapping elements are not allowed in V2.1X.
The Graphics Option is not set.	Set this option on the <b>V2.1X Options</b> dialog box if graphics are used.
PowerGraphics are included.	Symbols and static graphics containing PowerGraphics are not supported by V2.1X.  PowerGraphics include lines, rectangles, polygons, ellipses, and arcs.
PanelMate Power Series templates are included.	PanelMate Power Series templates such as Line Trend and Variable-Sized Control Button are not supported by V2.1X.
Any element is positioned on the top or bottom row, or the right hand column.	PanelMate Power Series units have an additional row at the top and bottom of the display, and an additional column at the left side.
Any element is not an even character height.	The pixel height of all V2.1X elements must be a multiple of 16 (16, 32, 48, etc.).
Any element is not an even character width.	The pixel width of all V2.1X elements must be a multiple of 8 (8, 16, 24, etc.).

Tip: **To make sure that all objects are on a character boundary prior to export, go to each page and select all objects using the Edit - Select All pull-down menu, then turn on the character cell grid with the Edit - Snap To Grid pull-down menu.**

Error Message	Reason for Error
<p>If the page number or message number in a PanelMate Power Series configuration exceeds the maximum page number or maximum message number allowed in the V2.1X configuration software, the page or message will not be exported.</p> <p>For example, if a PanelMate Power Series configuration has pages numbered 90 through 95 and you export the configuration to a PanelMate Series 2000 un-expanded unit which can contain 10 pages (numbered 0-9), no pages will be exported because all page numbers are greater than 9.</p>	<p>The PanelMate Series 2000 and PanelMate Series 3000 can have a maximum limit of 10 pages (numbered 0-9) and 100 messages (numbered 1-100).</p> <p>The PanelMate Series 2000 Expanded and the PanelMate Series 3000 Expanded can have a maximum limit of 30 pages (numbered 0-29) and 500 messages (numbered 1-500).</p> <p>The PanelMate Series 4000 can have a maximum limit of 10 pages (numbered 0-9) and 250 messages (numbered 1-250).</p> <p>The PanelMate Series 4000 Expanded can have a maximum limit of 30 pages (numbered 0-29) and 500 messages (numbered 1-500).</p>
More than 10 PLCs are configured.	V2.1X supports up to 10 PLCs.
A PLC configured on port 1, port 2, or I/O is not supported by V2.1X.	PanelMate Power Series supports a number of PLCs which V2.1X does not.
A device driver associated with the default device name (in the PLC Name And Port Table) is not supported by V2.1X.	<p>In the PLC Name And Port Table, if no device name is given to a PLC, the PLC assumes the default device name.</p> <p>If the driver associated with the default name is not supported by V2.1X, the default device name will not be exported.</p>
A Symbol name is too long.	V2.1X Symbol names can be no longer than six characters.

## Configuration Editor Reports

When you select a configuration filename in the Database Treeview Window and choose the Print selection from the File Menu or click on the **Print** button from the toolbar, the **Configuration Editor Reports** dialog box will appear.



The fields in the **Configuration Editor Reports** dialog box are described below.

**Report Type:** Allows you to select the type of report you wish to print. There are three types of reports that can be printed, as listed below.

**Configuration Details:** Allows you to print reports on various details of the total configuration, as selected using the **Report Options** button.

**<Report Options ...>:** Opens the **Configuration Editor Report Options** dialog box. This selection allows you to select the report options.

**PLC Cross Reference:** Allows you to print a detailed cross reference of the tags used in the Configuration. See **Chapter 12: Using Tags** for more information.

**Symbol Library:** Allows you to print a list of the symbols available in the symbol library.

**Pages:** Allows you to select the pages you wish to print, or click the **<Select All Pages>** button.

**<Select All Pages>:** Allows you to select all pages listed in the Pages box for printing.

**<Print Reports>:** Allows you to print the Configuration Report you have configured.

**<Printer Setup>:** Allows you to view the standard Microsoft Windows **Print Setup** dialog box. The options you see may vary depending upon the type of printer installed in your system.

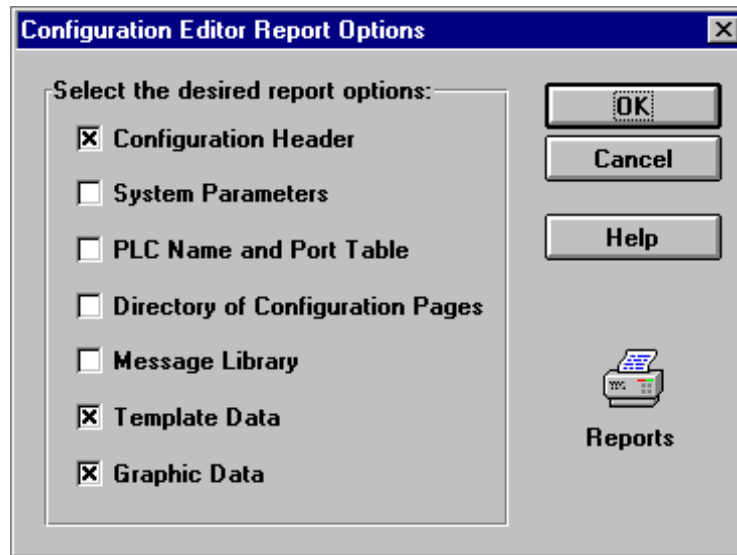
**<Exit>:** Closes the dialog box without printing.

**<Help>:** Calls for online help.

### Configuration Editor Reports Options

Note that the Print function does not support printing the System Online Labels and Fonts.

When you press the **Report Options** button on the **Configuration Editor Reports** dialog box, the **Configuration Editor Report Options** dialog box will appear.



The **Configuration Editor Report Options** dialog box allows you to select which options will appear on your printed report.

The fields in the **Configuration Editor Reports Options** dialog box are described below.

**Configuration Header:** Prints information contained in the **Configuration Properties** dialog box.

**System Parameters:** Prints information from the **System Parameters** dialog boxes for the selected configuration.

**PLC Name and Port Table:** Prints information from the **PLC Name and Port Table** dialog boxes for the selected configuration.

**Directory of Configuration Pages:** Prints a list of all pages and page properties.

**Message Library:** Prints the contents of the Message Library.

**Template Data:** Prints all template property information (in text format) for all templates (both fixed and variable-sized) found on the selected pages.

**Graphic Data:** Prints all object property information (in text format) for all static graphics found on the selected pages.

Note that the Print function does not support graphic printing of PanelMate pages. In order to print pixel image copies of PanelMate pages, use the built-in Windows clipboard feature to copy a bitmap image of the page to the clipboard (**Print Screen** key or **Alt** and **Print Screen** keys). Then use a standard bitmap editor, such as Windows Paintbrush, to edit and/or print an image of the page to a printer. Refer to the **Printing a Configuration Page** topic for more information

Check the desired report options then click the **OK** button to return to the **Configuration Editor Reports** dialog box.

### Printing a Configuration Page

For information on printing a configuration page from the PanelMate software, refer to the steps below.

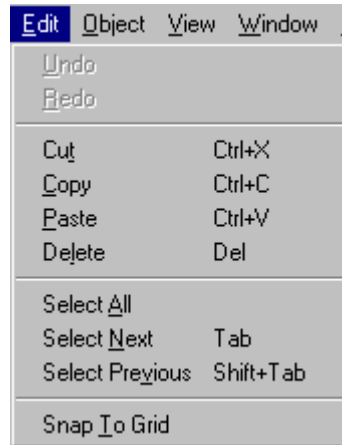
1. Open the configuration page you wish to print and maximize the page.
2. Create a rectangle the size of the entire page. The rectangle should have a white fill and white pen. Move the rectangle to the back. (This step is optional and is intended to provide a white background for templates and graphics if your printer does not print solid black well.)
3. Hold the Alt key and press the Print Screen button on your keyboard to place an image of the configuration software screen in the Windows clipboard. (Note that any graphics software package can be used to edit and print the image by choosing the Paste selection within the graphics software package. The following steps use the Paintbrush software as an example.)
4. Minimize the PanelMate software to an icon.
5. Open the Paintbrush software and maximize the screen.
6. Under the View Menu in Paintbrush, deselect the Tools and Linesize and Palette selections. (This step allows the entire configuration page to be displayed.)
7. Under the Edit Menu, choose the Paste selection and the configuration page image will be pasted from the Windows clipboard.
8. You may edit the configuration page image or print the page as it appears.

For information on editing the configuration page image in the Paintbrush software, refer to the steps below.

9. Select the Cutout tool and outline the desired part of the page you wish to print.
10. Under the Edit Menu, choose the Cut selection to cut the desired part of the page.
11. Under the File Menu, choose the New selection to start a new session.
12. Under the Edit Menu, choose the Paste selection to paste the contents of the clipboard on the new screen.
13. Print the page.

## Edit Menu

The Edit Menu is shown below.



Objects can be edited using keys on the keyboard. For information on editing objects using the keyboard, refer to the **Editing Graphics** topic

The selections in the Edit Menu are described below. Note that some of the selections are available from the toolbar. Refer to the **toolbar** topic for more information.

**Undo:** Reverses the last operation you performed. For example, if you cut an object, Undo makes it re-appear. There are several levels of Undo (the exact number depends upon your memory resources).

**Redo:** Reverses the effect of the last Undo command. There are several levels of Redo (the exact number depends upon your memory resources).

**Cut:** Erases a selected object(s) from the screen and places the object(s) on the Windows clipboard.

**Copy:** Copies a selected object(s) to the Windows clipboard, but does not erase the object(s) from the screen.

**Paste:** Copies object(s) from the Windows clipboard into the current configuration page.

It is not recommended to copy and paste bitmaps to and from the clipboard. To insert a bitmap, use the bitmap tool on the tool palette.

Tip: **Graphics can be pasted from other software packages onto a configuration page. Refer to the Using Graphics from Other Software topic for more information.**

Tip: **Complex objects pasted into a configuration should be re-sized using the software package in which the drawing was created. Copying objects to the clipboard from other software packages tends to multiply the number of objects. Attempting to resize these objects in the Configuration Editor may cause a General Protection Fault.**



**Delete:** Erases selected object(s) from the screen and does **not** place the object(s) in the Windows clipboard.

Note that the Configuration Software cursor may remain as an “hourglass” when deleting objects even after the deletion is complete. When the mouse is moved, the original cursor will return if the deletion is complete.

**Select All:** Selects all objects in the current configuration page.

**Select Next:** Selects the next object - in the order in which objects were created.

**Select Previous:** Selects the previous object - in the order in which objects were created.

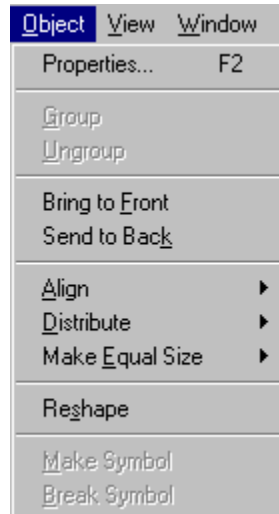
Note that the keyboard keys used to select, resize, move, select next, or select previous objects will not function on a configuration page when another window has been selected. For example, if an object is selected and the cursor is placed inside of the **color selection palette** and the **Arrow** keys are used to select different colors on the palette, the **Arrow** keys cannot be used to move the selected object unless the configuration page and the object are re-selected. This also applies when an object is selected and the cursor is placed inside of the Select Font box or the Pen Width box on the **toolbar**.

**Snap To Grid:** If this item is checked, objects are automatically aligned with an invisible on-screen grid when existing objects are moved or new objects are placed on the page. The grid is set up on 8x16 pixel boundaries for character-based alignment. The Snap To Grid is intended to facilitate development of V2.1X configurations.

Note that resize does not function on a group if the snap-to-grid feature is enabled.

## Object Menu

The Object Menu is shown below.



Objects can be edited using keys on the keyboard. For information on editing objects using the keyboard, refer to the **Editing Graphics** topic.

The selections in the Object Menu are described below. Note that some of the selections are available from the toolbar. Refer to the **toolbar** topic for more information.

**Properties...:** Opens the **Object Properties** dialog box for the selected object. Use this selection to edit specific object information. You can also use the **F2** key as a shortcut key.

**Group:** Joins selected objects together into a group object. The group object is contained within a single bounding rectangle and can be moved, resized, etc. Note that you can group objects (lines, rectangles, etc.), but you cannot group templates.

**Tip:** **When configurations containing groups are imported, the objects within those groups will appear as individual objects and not part of a group. Since groups have no function in the online configuration, the exported file does not maintain group attributes.**

**Ungroup:** Separates a group object into its individual component objects.

**Bring To Front:** Brings the selected object(s) to the front (top) of a stack of objects. If more than one object is selected, the objects maintain their relative position in the stack.

**Send To Back:** Sends the selected object(s) to the back (bottom) of a stack of objects. If more than one object is selected, the objects maintain their relative position in the stack.

**Align:** Opens a pop-up menu that allows you to select the type of alignment you prefer. All selected objects will be aligned with the **last** object selected. Note that you can align objects (lines, rectangles, etc.), but you cannot align templates.

**Lefts:** Aligns the objects along their left edges.

**Centers:** Aligns the objects along their vertical centerlines.

**Rights:** Aligns the objects along their right edges.

**Tops:** Aligns the objects along their top edges.

**Middles:** Aligns the objects along their horizontal centerlines.

**Bottoms:** Aligns the objects along their bottom edges.

**Distribute:** Distributes or evenly spaces three or more selected objects vertically and horizontally. Note that you can distribute objects (lines, rectangles, etc.), but you cannot distribute templates.

**Vertically:** Distributes the objects along their vertical centerlines.

**Horizontally:** Distributes the objects along their horizontal centerlines.

**Make Equal Size:** Makes two or more selected objects equal in size to the last object selected. Note that you can make objects (lines, rectangles, etc.) equal size but you cannot make templates equal size.

**Width:** Makes the objects equal in width.

**Height:** Makes the objects equal in height.

**Both:** Makes the objects equal in both width and height.

**Reshape:** Displays vertical box handles on the selected polygon or arc. Drag the handles to re-shape the object.

**Make Symbol:** Opens the **Make Symbol** dialog box. This selection will make a symbol from a group of selected objects (lines, rectangles, etc.).

**Break Symbol:** Breaks a symbol into the original component objects.

## Object Properties

When you choose the Properties selection under the Object Menu or double click on any object on a page, the **Object Properties** dialog box for that object will appear.

Object Properties is a set of three tabbed dialog boxes used to select the object's attributes, location, size, and visibility. The dialog boxes are listed below.

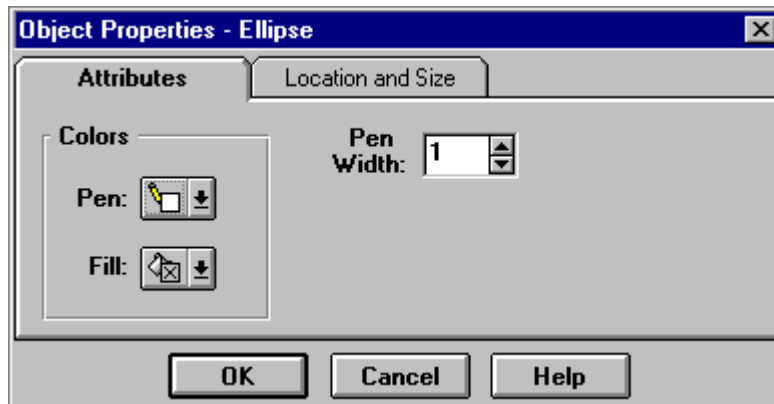
- Object Properties - Attributes Tab
- Object Properties - Location And Size Tab
- Object Properties - Visibility Tab

Tip: **The Object Properties - Visibility Tab dialog box only appears when you double click on a Text object.**

Note that it is not possible to resize a fixed template with the size handles. To resize a fixed template, you must use the **Object Properties** dialog box.

### Object Properties - Attributes Tab

The **Object Properties - Attributes Tab** dialog box is shown below.



The **Object Properties - Attributes Tab** dialog box allows you to change the color and pen width of a selected object.

The fields in the **Object Properties - Attributes Tab** dialog box are described below.

#### Colors

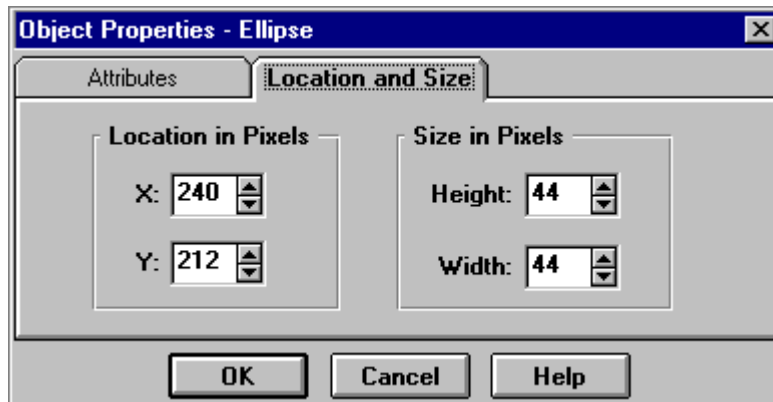
**Pen:** Allows you to select the foreground color or intensity for the object. The **Pen** button will display the standard Color Selection Palette.

**Fill:** Allows you to select the background color or intensity for the object. The **Fill** button will display the standard Color Selection Palette.

**Pen Width:** Allows you to enter a pen width for the selected object.

## Object Properties – Location and Size Tab

The **Object Properties - Location and Size Tab** dialog box is shown below.



The **Object Properties - Location and Size Tab** dialog box allows you to change the pixel location and size of a selected object.

The fields in the **Object Properties - Location and Size Tab** dialog box are described below.

### Location in Pixels

**X:** Allows you to move the object to the left or right on the configuration page. The value entered in the X field determines the distance in pixels from the left edge of the page.

**Y:** Allows you to move the object up and down on the configuration page. The value entered in the Y field determines the distance in pixels from the top of the page.

### Size In Pixels

**Height:** Allows you to enter the height in pixels of the selected object. Note that you can re-size and re-shape an object by dragging one of the selection handles with the selection tool.

**Width:** Allows you to enter the width in pixels of the selected object. Note that you can re-size and re-shape an object by dragging one of the selection handles with the selection tool.

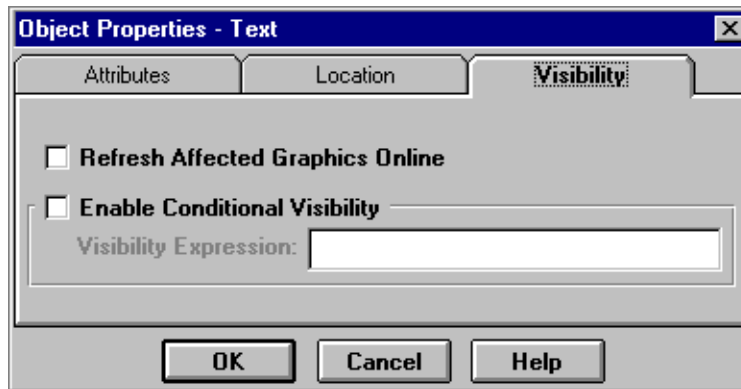
Tip: **Objects can be resized using keys on the keyboard. For information on editing objects using the keyboard, refer to the Editing Graphics topic.**

## Object Properties - Visibility Tab

Tip: **The Object Properties - Visibility Tab dialog box only appears when you double click on a Text object.**

Note that a Text object that has the Refresh Affected Graphics Online field or the Enable Conditional Visibility field checked cannot be made into a symbol.

The **Object Properties - Visibility Tab** dialog box is shown below.



The **Object Properties - Visibility Tab** dialog box allows you to configure the refresh graphics and visibility features.

The fields in the **Object Properties - Visibility Tab** dialog box are described below.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the Text object to be refreshed to properly reflect the layering of objects on the page whenever the symbol is updated.

**Enable Conditional Visibility:** Allows you to determine if the Text object will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the Text object will always appear on the page.

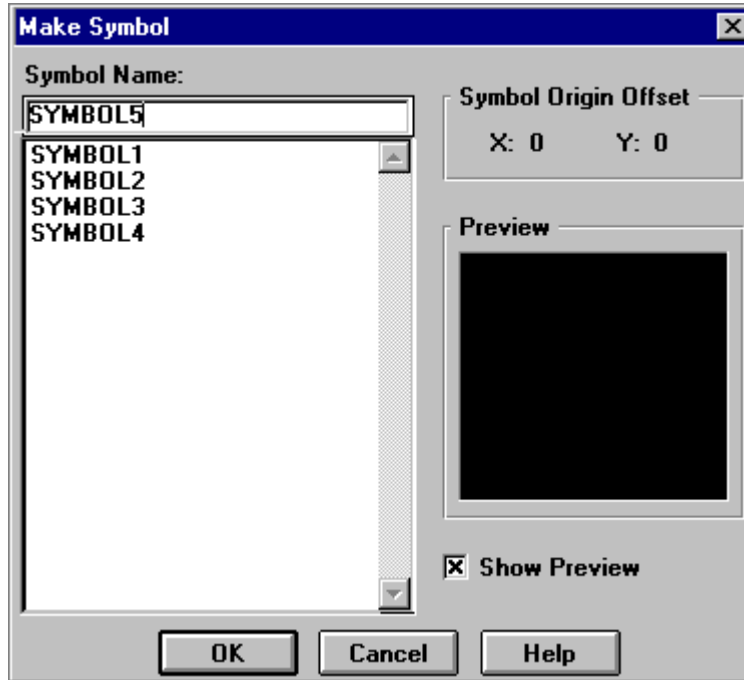
It is important to note that a text object that is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the text object is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the Text object will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the Text object will appear and all template updating will be activated when in Run Mode.

## Make Symbol

A symbol is a collection of graphic objects grouped together and given a name. The allowable objects for a symbol are lines, rectangles, ellipses, arcs, polygons, text, and bitmaps. If there are any fixed templates, variable-sized templates, variable-sized control buttons, or symbols in the collection of objects you wish to make into a symbol, the Make Symbol selection in the Object Menu will be disabled. Also note that if you have a Text object selected and the Refresh Affected Graphics Online field or the Enable Conditional Visibility field is checked in the **Object Properties - Visibility Tab** dialog box, the Make Symbol selection will be disabled.

When a group of allowable objects are selected on a configuration page and you choose the Make Symbol selection from the Object Menu, the **Make Symbol** dialog box will appear.



The **Make Symbol** dialog box allows you to create symbols.



The fields in the **Make Symbol** dialog box are described below.

**Symbol Name:** Allows you to enter the name of the symbol you wish to create. Note that when a symbol has been created, the symbol name will appear in the Database Treeview Window under the Symbol Library selection. For more information on the Symbol Library, refer to the **Symbol Library** topic.

**Symbol Origin Offset:** Displays the symbol's origin offset (in pixels). The default Symbol Origin Offset for X and Y is 0 and 0 (no offset).

**X:** Displays the X origin offset in pixels.

**Y:** Displays the Y origin offset in pixels.

**Preview:** Displays the selected symbol in the Preview box if the Show Preview box is selected.

**Show Preview:** Allows the selected symbol to be shown in the Preview box.

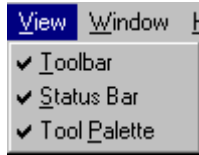
Once a symbol has been created, you may double click on the symbol to view the **Symbol Properties** dialog box. Refer to the **Symbol Properties** topic for more information.

Note the following items:

- The objects that make up a symbol cannot be edited. If you wish to change an object within a symbol, you must select the symbol on the configuration page and choose the Break Symbol selection under the Object Menu to break the symbol into the original separate objects. The objects may be edited and then you may choose the Make Symbol selection from the Object Menu again.
- If you create a symbol that contains a circle, the circle may be displayed slightly out of position (1 pixel in X or Y dimension) in Run Mode compared to what is displayed in the Configuration Software.

## View Menu

The View Menu is shown below.



The selections in the View Menu are described below.

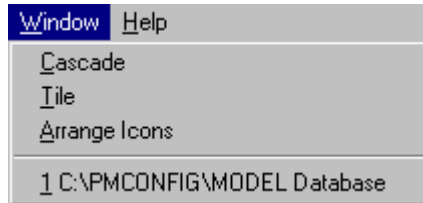
**Toolbar:** Shows or hides the toolbar at the top of the screen. When the toolbar is visible, a check mark appears beside this menu item.

**Status Bar:** Shows or hides the status bar at the bottom of the screen. When the status bar is visible, a check mark appears beside this menu item.

**Tool Palette:** Shows or hides the tool palette. When the tool palette is visible, a check mark appears beside this menu item.

## Window Menu


The Window Menu is shown below.



The selections in the Window Menu are described below.

**Cascade:** Arranges all open windows so they overlap. The title bar of all windows remains visible so you can easily select a window.

**Tile:** Arranges all open windows side-by-side so there is no overlap.

**Arrange Icons:** Arranges all icons in orderly rows. To reduce a configuration window to an icon, click its  button.

**Configurations:** Lists all open windows, including those that have been reduced to icons. To make a window active, select its name from the list.

Note that when a Configuration Page Window is opened, the Window Menu will not display the Configuration Page Window as an open window.

## Help Menu

The Help Menu is shown below.



The selections in the Help Menu are described below.

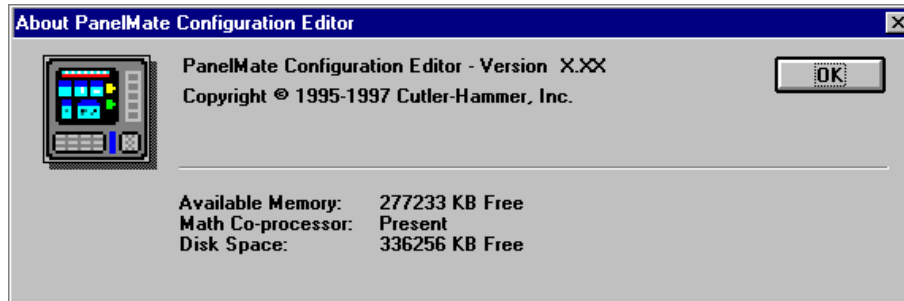
**C**ontents: Goes to the first topic of the Configuration Editor help file.

**U**sing Help: Provides general information about using help. This is the standard Windows help file.

**A**bout PM Config: Displays the **About PanelMate Configuration Editor** dialog box and lists system information.

## About PanelMate Configuration Editor

When you choose the About PM Config selection in the Help Menu, the **About PanelMate Configuration Editor** dialog box will appear.



The information in the **About PanelMate Configuration Editor** dialog box is listed below:

- Name of the Configuration Editor, version number, and copyright information.
- Amount of free memory
- Presence of math co-processor
- Amount of free disk space

## Toolbar

When the Toolbar selection is checked under the View Menu, the Toolbar will appear on the Main Screen.



You can use the Toolbar buttons to perform many of Configuration Editor's standard operations. The Toolbar buttons are described below.



**Save:** Saves the current configuration to disk.



**Print:** Prints a hard copy of the current configuration.



**Cut:** Removes the selected object from the configuration, and places it on the Windows clipboard.



**Copy:** Places a copy of the selected object on the Windows clipboard, but does not remove it from the configuration.



**Paste:** Pastes the contents of the Windows clipboard into the current configuration.



**Undo:** Un-does the previous operation.



**Redo:** Re-does the operation previously un-done.



**Bring To Front:** Brings a selected object to the front (top) of a stack of objects.



**Send To Rear:** Sends a selected object to the rear (bottom) of a stack of objects.



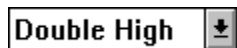
**Align Left:** Aligns all selected objects along the left edge of the last object selected.



**Align Center:** Aligns all selected objects along the vertical centerline of the last object selected.



**Align Right:** Aligns all selected objects along the right edge of the last object selected.



**Select Font:** Select a font for the selected text object.



**Fill Colors:** This button consists of two parts. Click the paint can icon to fill the selected object with the color shown in the box. Click the arrow icon to display the Color Selection Palette.



**Pen Colors:** This button consists of two parts. Click the pencil icon to set the pen color of the selected object to the color shown in the box. Click the arrow icon to display the Color Selection Palette.



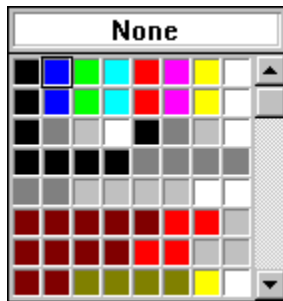
**Pen Width:** Choose a pen width for the selected object. Note that the Pen Width value in the Toolbar is not fully visible when using a large font video driver.



**Help:** Makes context-sensitive help available. When you click this button, the cursor displays a question mark. Then, click most on-screen features for context-sensitive help.

## Color Selection Palette

When you click the down arrow buttons on the Pen Color button or Fill Color button in the toolbar, the Color Selection Palette will appear.



The Color Selection palette allows you to select pen color (or shade) and fill color (or shade). You can choose:

- Colors (on color units only)
- Blinking colors (on color systems only)
- Shades of gray
- Blinking shades of gray

Note the following Color Palette items:

- You can move the Color Selection Palette by clicking the left mouse button and dragging the palette to the desired position on the screen. The Color Selection Palette will then have a small title and icon that will indicate whether it is the Pen Color or Fill Color palette.
- If the 256 Greyscale/Color option is installed on the PanelMate Power Series 1500, additional colors or shades of gray will be available.
- In order for the color palette to accurately represent the color and blink characteristics of the PanelMate online unit, the video driver selected from the Windows Control Panel must be a 256 color driver. If the video driver is not a 256 color driver (either 16 color or more than 256 color), the color palette shown in the Configuration Editor will not match that of the online unit.
- The black color displayed in row 1, column 1 and row 3, column 1 are colors selected to be compatible with PanelMate versions prior to the PanelMate Power Series. If these colors are selected, then the number of characters displayed in a 1-cell template will be reduced from 12 to 10.

## Status Bar

When the Status Bar selection is checked under the View Menu, the Status Bar will appear on the Main Screen.



The Configuration Editor uses the Status Bar at the bottom of the window to display messages and information about the current status of the application.


























## Tool Palette

When the Tool Palette is selected in the View Menu, the Tool Palette will display when you open a page.



The Tool Palette buttons are listed below.

 Selection	 Reshape	 Line
 Rectangle	 Ellipse	 Arc
 Polygon	 Text	 Symbol
 Bitmap	 Indicator Template	 Readout Template
 Bar Template	 Table Template	 Bar Trend Template
 Line Trend Template	 Display Template	 VS Indicator Template
 VS Bar Template	 VS Readout Template	 VS Display Template
 VS Graphic Template	 VS Control Button	

## Selection Tool

The Selection tool allows you to select objects on the current page. A selected object is enclosed in a bounding box having handles (small squares) at the corners of the bounding box, and at the center of every side. Use the Selection tool to drag the handles to re-size or re-shape the object.

To select more than one object, press the **Shift** key while you click the desired objects. You can also use the Selection tool to draw a dotted selection box (marquee) around multiple objects to select them.

## Reshape Tool

The Reshape tool allows you to re-shape selected arcs and polygons.

To reshape an arc or polygon ...

14. Select the Reshape tool.
15. Click the object you wish to reshape. An arc displays two handles (squares) and a polygon displays a handle at the ends, and at each vertex (corner).
16. Place the cursor over a handle and it changes to a cross.
17. Drag the handle to reshape the object.

**Tip:** If the reshape tool is used on an arc and the cursor is inside the arc, the arc is converted to a pie shape or a chord.

To add a node (vertex) to a polygon ...

18. Press the **Ctrl** key.
19. Place the cursor on the line where you wish to add a node. A plus sign (+) appears.
20. Click and drag the cursor away, then release the **Ctrl** key.

To delete a node on a polygon ...

1. Place the cursor on the node you wish to delete. A plus sign (+) appears.
2. Press the **Ctrl** key and click once to delete the node.

## Line Tool

The Line tool allows you to place a line object on the page. Place the cursor on the configuration page, press the mouse button, and drag to create a line. While using this tool, press the **Shift** key to constrain the line to a 45° angle.

## Rectangle Tool

The Rectangle tool allows you to place a rectangle object on the page. Place the cursor on the configuration page, press the mouse button, and drag to create a rectangle. While using this tool, press the **Shift** key to constrain the rectangle to a square.

## Ellipse Tool

The Ellipse tool allows you to place an ellipse object on the page. Place the cursor on the configuration page, press the mouse button, and drag to create an ellipse. While using this tool, press the **Shift** key to constrain the ellipse to a circle.

## Arc Tool

The Arc tool allows you to draw an arc, chord, or pie-shaped object on the page. Place the cursor on the configuration page, press the mouse button, and drag to create an arc. While using this tool, press the **Shift** key to constrain the arc to a circular shape.

To draw a chord or pie shape ...

1. Draw an arc.
2. Reshape it using the Reshape tool. For information on the Reshape tool, refer to the **Reshape Tool** topic.

The maximum arc size that can be displayed in Run Mode is 358°. To check the arc size, double-click on the arc to open the **Object Properties** dialog box.

## Polygon Tool

The Polygon tool allows you to place a polyline (a jagged line) or a closed polygon (multi-sided figure) on the configuration page.

To create a polyline ...

1. Select the polygon tool.
2. Click to place the first point, then release the mouse button. As you move the mouse, a rubber band line follows the cursor.
3. Click to place the next point.
4. Continue until the polyline is complete.

To create a polygon ...

1. Perform steps 1-3 (under Creating A Polyline) to draw the polygon shape.
2. Place the last point very near the first one. It is not necessary to place it exactly on top. The polygon is automatically completed.

Note that you may use the Reshape tool to reshape a polyline or a polygon. For more information on the Reshape tool, refer to the **Reshape Tool** topic.

## Text Tool

The Text tool allows you to place a text object on the page.

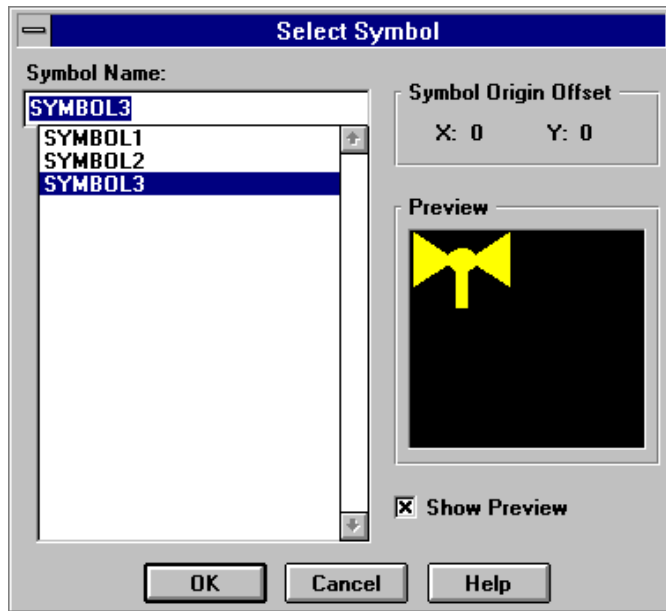
## Symbol Tool

The Symbol tool allows you to place a symbol object on the page. When the Symbol tool is selected from the tool palette and you click on the configuration page, the **Select Symbol** dialog box will appear. For more information on the **Select Symbol** dialog box, refer to the **Select Symbol** topic.

Note that graphics can be pasted from other software packages onto a configuration page and made into a symbol. Refer to the **Using Graphics from Other Software** topic for more information.

## Select Symbol

When you select the Symbol tool or the Variable-Sized Graphic Template tool from the tool palette and click on a configuration page, the **Select Symbol** dialog box will appear.



The **Select Symbol** dialog box is used to select an existing symbol to place on a configuration page.

The fields in the **Select Symbol** dialog box are described below.

**Symbol Name:** Displays the lists of symbol names. Note that you may scroll through the symbol name list and preview each symbol if the Show Preview box is selected.

**Symbol Origin Offset:** Displays the symbol's origin offset (in pixels).

**X:** Displays the X origin offset in pixels.

**Y:** Displays the Y origin offset in pixels.

**Preview:** Displays the selected symbol in the Preview box if the Show Preview box is selected.

**Show Preview:** Allows the selected symbol to be shown in the Preview box.

## Bitmap Tool

The Bitmap tool allows you to place a bitmap object (picture) on the page. When this tool is selected and you click a configuration page, a standard **Open Bitmap File** dialog box will appear.

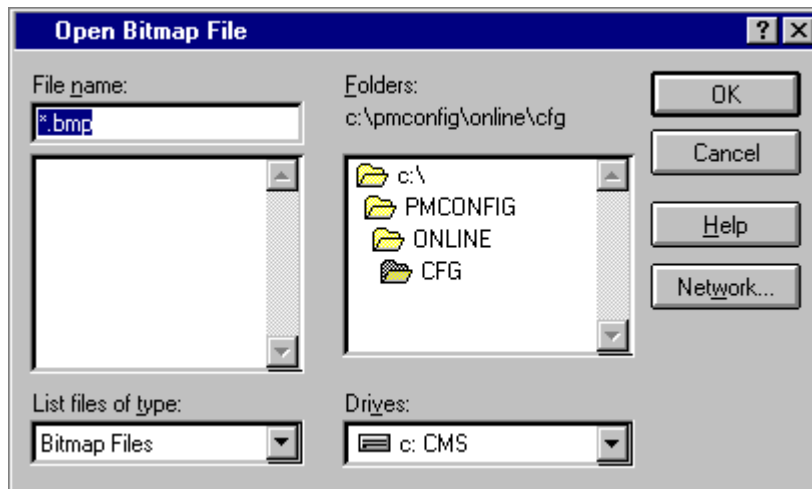
Bitmaps are used for backgrounds or other objects it is not easy or convenient to draw. Bitmaps reside in disk files having a .BMP extension.

Graphics can be pasted from other software packages onto a configuration page. Refer to the **Using Graphics from Other Software** topic for more information.

Tip: **Bitmaps use a lot of memory. The larger the bitmap, the more memory is consumed.**

### Open Bitmap File

When you select the Bitmap tool from the tool palette and click on a configuration page, the **Open Bitmap File** dialog box will appear.



The **Open Bitmap File** dialog box will allow you to select the bitmap you wish to use.

## Indicator Template Tool

The Indicator Template tool allows you to place an Indicator Template on the page. Indicator Templates are the lights and buttons of a control panel. They indicate and control the status of devices by turning them on or off. Refer to the **Indicator Template** topic for more information.

## Readout Template Tool

The Readout Template tool allows you to place a Readout Template on the page. Readout Templates are designed to replace numeric and digital readout devices found on a conventional control panel, and to supply the functionality often provided by CRT-based devices. Refer to the **Readout Template** topic for more information.

## Bar Template Tool

The Bar Template tool allows you to place a Bar Template on the page. Bar Templates are the analog meters and face plates of a control panel. They indicate a value in analog fashion using a bar graph that shows these values in graphical form:

- Current value
- Steeping
- High and low alarm levels

Refer to the **Bar Template** topic for more information.

## Bar Trend Template Tool

The Bar Trend tool allows you to place a Bar Trend Template on the page. Bar Trend Templates collect, store, and display data to provide a historical perspective on how:

- A single data point has changed
- A data point may behave in the future

Refer to the **Bar Trend Template** topic for more information.

## Table Template Tool

The Table Template tool allows you to place a Table Template on the page. Table Templates display a table of values and accept numeric entry for all the items in the table. Refer to the **Table Template** topic for more information.

## Line Trend Template Tool

The Advanced Trending Template box must be selected in the **New Configuration** dialog box or in the **Configuration Properties** dialog box before a Line Trend Template can be created

The Line Trend Template tool allows you to place a Line Trend Template on the page. Line Trend Templates collect, store, and display data to provide a historical perspective on how:

- A single data point has changed
- A data point may behave in the future

Refer to the **Line Trend Template** topic for more information.

## Display Template Tool

The Display Template tool allows you to place a Display Template on the page. Display Templates are used like standard LED or LCD message units or displays. Refer to the **Display Template** topic for more information.

## Variable-Sized Indicator Template Tool

The Variable-Sized Indicator Template tool allows you to place a Variable-Sized Indicator Template on the page. Variable-Sized Indicator Templates let you use small indicators to create high-density status displays on your page. Refer to the **Variable-Sized Indicator Template** topic for more information.

## Variable-Sized Bar Template Tool

The Variable-Sized Bar Template tool allows to place a Variable-Sized Bar Template on the page. Variable-Sized Bar Templates are the analog meters and face plates of a control panel. They indicate a value in analog fashion using a bar graph that shows these values in graphical form:

- Current value
- Setpoint
- High and low alarm levels

Refer to the **Variable-Sized Bar Template** topic for more information.

## Variable-Sized Readout Template Tool

The Variable-Sized Readout Template tool allows you to place a Variable-Sized Readout Template on the page. Variable-Sized Readout Templates are designed to replace numeric and digital readout devices found on a conventional control panel, and to supply the functionality often provided by CRT-based devices. Refer to the **Variable-Sized Readout Template** topic for more information.

## Variable-Sized Display Template Tool

The Variable-Sized Display Template tool allows you to place a Variable-Sized Display Template on the page. Variable-Sized Display Templates are designed to replace LED or LCD message units or display readouts. Refer to the **Variable-Sized Display Template** topic for more information.

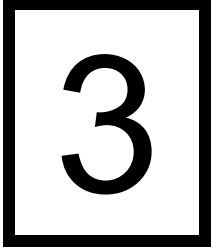
## Variable-Sized Graphic Template Tool

The Variable-Sized Graphic tool allows you to place a Variable-Sized Graphic Template on the page. Variable-Sized Graphic Templates consists of one or more symbols and are used to indicate the status of a device and to control the device (e.g., by turning it ON or OFF). Refer to the **Variable-Sized Graphic Template** topic for more information.

## Variable-Sized Control Button Tool

The Variable-Sized Control Button tool allows you to place a Variable-Sized Control Button Template on the page. Variable Sized Control Button Templates are used to provide momentary control to the PLC or to issue a local page change command. Refer to the **Variable-Sized Control Button Template** topic for more information.

# Database Treeview Window



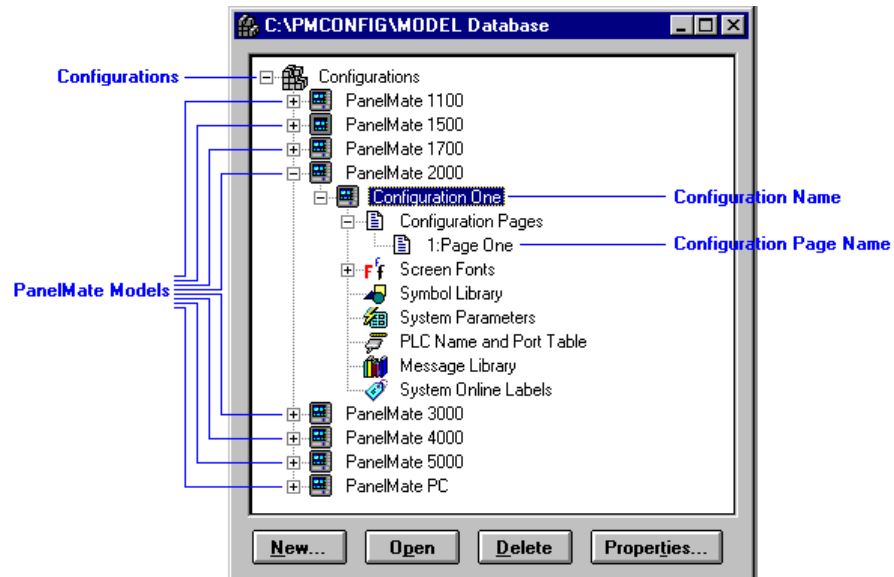
*In this chapter, you will learn:*

- *About the Database Treeview Window*
- *How to open a New Configuration*
- *How to open a New Configuration Page*
- *How to set the Configuration Properties*
- *How to set the Page Properties*



## Database Treeview Window

The Database Treeview Window appears on the Main Screen.



The Database Treeview Window allows you to create and edit configuration pages and is the main interface used to access the Configuration Software. This window displays the database in a tree-like structure similar to the Microsoft Windows File Manager.

To expand and contract the database tree, you may double-click on the icons or click once on the + or - symbol next to the icons. Note that if an icon does not have a + or - symbol, there are no additional levels.

The buttons on the Database Treeview Window are described below.

**New:** Opens the **New Configuration** dialog box or the **New Configuration Page** dialog box depending on which icon is selected.

If you have the Configurations icon, a PanelMate model icon, or a configuration name icon selected and click the **New** button, the **New Configuration** dialog box will appear.

If you have the Configurations Pages icon selected and click the **New** button, the **New Configuration Page** dialog box will appear.

**Open:** Opens or expands the currently selected icon in the database tree. For example, if you select a configuration page name and click the **Open** button, the configuration page will open. If you select the Symbol Library icon and click the **Open** button, the symbol names (if configured) will appear. (You must select the symbol name and click the **Open** button to view the **Symbol Library** dialog box.)

**Delete:** Allows you to delete a selected configuration or a selected configuration page.

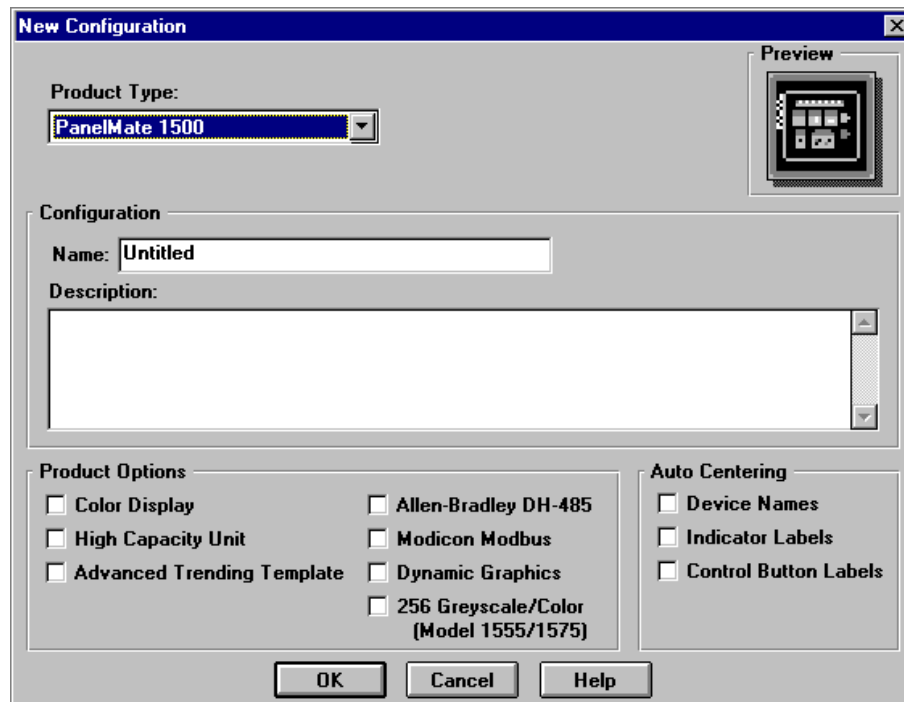
**Properties:** Opens the **Configuration Properties** dialog box or the **Page Properties** dialog box depending on which icon is selected.

If you have a configuration name selected and press the **Properties** button, the **Configuration Properties** dialog box will appear.

If a configuration page is selected and press the **Properties** button, the **Page Properties** dialog box will appear.

## New Configuration

When the Configurations icon, a PanelMate model icon, or a configuration name icon is selected and the **New** button is clicked in the Database Treeview Window, the **New Configuration** dialog box appear.



The **New Configuration** dialog box allows you to create a new configuration.

The fields in the **New Configuration** dialog box are described below.

**Product Type:** Allows you to select the product for which the configuration is being created.

**Preview:** Displays a generalized view of the selected product type.

### Configuration

**Name:** Allows you to enter the name of the configuration.

**Description:** Allows you to enter a brief description of the configuration.

## Product Features

The following Product Features can also be selected in the **Configuration Properties** dialog box.

**Color Display:** Allows you to select a color configuration. If this box is not checked, the configuration will be grayscale.

**High Capacity Unit:** Allows you to create a larger number of pages and messages than permitted in the Standard Capacity environment. Refer to the table below for feature limits.

Product Type	Maximum Number of Pages	Maximum Number of Messages
PanelMate Power Series 1500	50	2500
All other PanelMate Power Series models	100	5000
PanelMate PC	200	10000

Note that the complexity of the configuration may reduce the number of pages and messages in the PanelMate unit.

**Advanced Trending Template:** Allows you to configure Advanced Trending Templates which display a history of a reference's value over a period of time. Advanced trending features 6 pens that can be triggered by time or event.

For information on configuring an Advanced Trending Template, refer to the **Line Trend Template** topic.

**Allen-Bradley DH-485:** Allows you to communicate to the Allen-Bradley Data Highway.

**Modicon Modbus:** Allows you to communicate to Modicon PLCs via the Modicon Modbus or Modicon Modbus Plus.

**Dynamic Graphics:** Allows symbols to change colors and shapes dynamically on PanelMate Power Series 1500 models.

**256 Greyscale/Color (Model 1555/1575):** Enhances the PanelMate Power Series 1500.

If you have a PanelMate Power Series 1500 (Model 1555) and you select the 256 Greyscale/Color feature, you will have 16 shades of gray (instead of the standard 8 shades), PowerAnimation, and PowerBlink.

If you have a PanelMate Power Series 1500 (Model 1575) and you select the 256 Greyscale/Color feature, you will have a 256 color palette (instead of the standard 16 colors), PowerAnimation, and PowerBlink.

PowerAnimation allows you to create animation by defining a series of graphic objects which blink in sequence and PowerBlink allows you to create graphic objects which blink at different rates.

## Auto Centering

**Device Names:** Allows you to automatically center all Device Names within templates which have Device Names on all pages of this configuration.

**Indicator Labels:** Allows you to automatically center all Indicator Labels within the Indicator Template label area on all pages of this configuration.

**Control Button Labels:** Allows you to automatically center all Control Button Labels for all templates which have control buttons defined on all pages of this configuration.

## New Configuration Page

When the Configurations Pages icon is selected and the **New** button is clicked in the Database Treeview Window, the **New Configuration Page** dialog box will appear.

The screenshot shows the 'New Configuration Page' dialog box. It has a title bar with the text 'New Configuration Page' and a close button. The dialog is divided into three sections: 'Page', 'Maintenance Templates', and 'Flexible Page Layout'. In the 'Page' section, there is a 'Number' spinner set to 0, a 'Title' text box containing 'Untitled', and a 'Protection' dropdown menu set to 'None'. In the 'Maintenance Templates' section, there are two checkboxes: 'Allow on Page' (unchecked) and 'Enable Writes' (unchecked), and a 'Protection' dropdown menu set to 'None'. In the 'Flexible Page Layout' section, there are four checkboxes: 'Page Status Banner' (checked), 'Cancel Key' (checked), 'Alarm Table' (checked), and 'Default Buttons' (checked). At the bottom of the dialog are three buttons: 'OK', 'Cancel', and 'Help'.

The **New Configuration Page** dialog box is used to determine features for individual configuration pages and to determine features for the Maintenance Template. For more information about the Maintenance Template, refer to the **Maintenance Template** topic. For more information about the **Maintenance Template** topic, refer to the **Maintenance Template** topic in the Online Operation User's Guide.

The fields in the **New Configuration Page** dialog box are described below.

### Page

**Number:** Allows you to enter the page number for the new configuration page.

**Title:** Allows you to enter a title for the new configuration page.

**Protection:** Allows you to control access to a page by selecting a type of protection for the new configuration page. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

**Tip:** If a page is password protected, but is selected as the startup page in the Startup Page field in the System Parameters - General Tab dialog box, password protection will be ignored on initial bootup.

The page will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option which may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

### Maintenance Templates

Maintenance Templates are designed to replace TCAM (timer/counter access module) and RAP (register access panel) devices that are typically used during the setup and troubleshooting of PLCs.

**Allow On Page:** Allows you to determine if the Maintenance Template will display on the current page.

**Enable Writes:** Allows you to determine if the operator can change the data or just monitor it. If this box is checked, the data is read/write, otherwise the data is read-only.



**CAUTION:**

Make your selection based on the expertise of operators and maintenance personnel.

**Protection:** Allows you to select a type of protection for displaying Maintenance Templates on the current page. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

The Maintenance Template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option which may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

For additional information about Maintenance Templates, see the **Maintenance Template** topic. For more information about the **Maintenance Template** topic, refer to the **Maintenance Template** topic in the Online Operation User's Guide.

### Flexible Page Layout

The Flexible Page Layout feature is intended for use on touchscreen units only.

If a flexible item appears on top of a template or graphic on your configuration page, the underlying template or graphic will be deleted when the configuration is exported.

**Page Status Banner:** Allows you to determine if the Page Status Banner will appear on the screen of your touchscreen unit. Note that if you do not want the Page Status Banner to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Page Status Banner box.

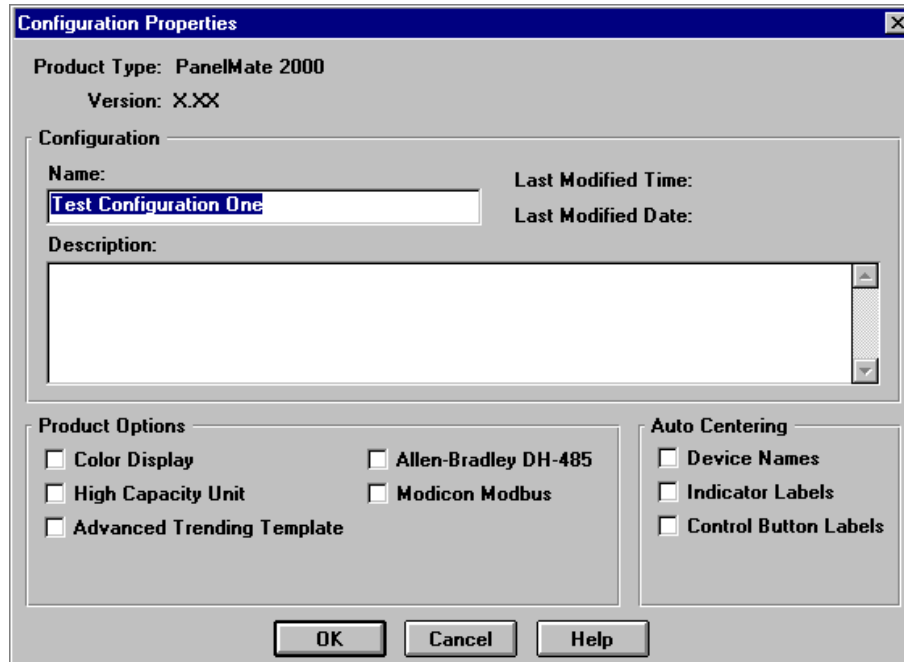
**Default Buttons:** Allows you to determine if the default buttons will appear on the screen of your touchscreen unit. Note that if you do not want the Default Buttons to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Default Buttons box.

**Alarm Table:** Allows you to determine if alarms will appear on the screen of your touchscreen unit. Note that if you do not want alarms to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Alarms Table box.

**Cancel Key:** Allows you to determine if the **CANCEL** key will appear on the screen of your touchscreen unit. Note that if you do not want the **CANCEL** key to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Cancel Key box.

## Configuration Properties

When a configuration name is selected in the Database Treeview Window and the **Properties** button is clicked, the **Configuration Properties** dialog box will appear.



The **Configuration Properties** dialog box displays configuration, product features, and auto-centering information.

The fields in the **Configuration Properties** dialog box are described below.

**Product Type:** Displays the product type.

**Version:** Displays the configuration software version number.

### Configuration

**Name:** Displays the name assigned when the configuration was created in the **New Configuration** dialog box. You may change this name to save the configuration under a new name.

**Last Modified Time:** Displays the time of the last modification to the configuration.

**Last Modified Date:** Displays the date of the last modification to the configuration.

**Description:** Displays the description entered when the configuration was created in the **New Configuration** dialog box. You can edit the description as required.

## Product Features

The following Product Features can also be selected in the **New Configuration** dialog box.

**Color Display:** Allows you to select a color configuration. If this box is not checked, the configuration will be grayscale.

**High Capacity Unit:** Allows you to create a larger number of pages and messages than permitted in the Standard Capacity environment. Refer to the table below for feature limits.

Product Type	Maximum Number of Pages	Maximum Number of Messages
PanelMate Power Series 1500	50	2500
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PanelMate PC	100	10000

Note that the complexity of the configuration may reduce the number of pages and messages in the PanelMate unit.

**Advanced Trending Template:** Allows you to configure Advanced Trending Templates which display a history of a reference's value over a period of time. Advanced trending features 6 pens that can be triggered by time or event.

For information on configuring an Advanced Trending Template, refer to the **Line Trend Template** topic.

**Allen-Bradley DH-485:** Allows you to communicate to the Allen-Bradley Data Highway.

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**Dynamic Graphics:** Allows symbols to change colors and shapes dynamically on PanelMate Power Series 1500 models.

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If you have a PanelMate Power Series 1500 (Model 1575) and you select the 256 Greyscale/Color feature, you will have a 256 color palette (instead of the standard 16 colors), PowerAnimation, and PowerBlink.

PowerAnimation allows you to create animation by defining a series of graphic objects which blink in sequence and PowerBlink allows you to create graphic objects which blink at different rates.

### Auto Centering

**Device Names:** Allows you to automatically center all Device Names within templates which have Device Names on all pages of this configuration.

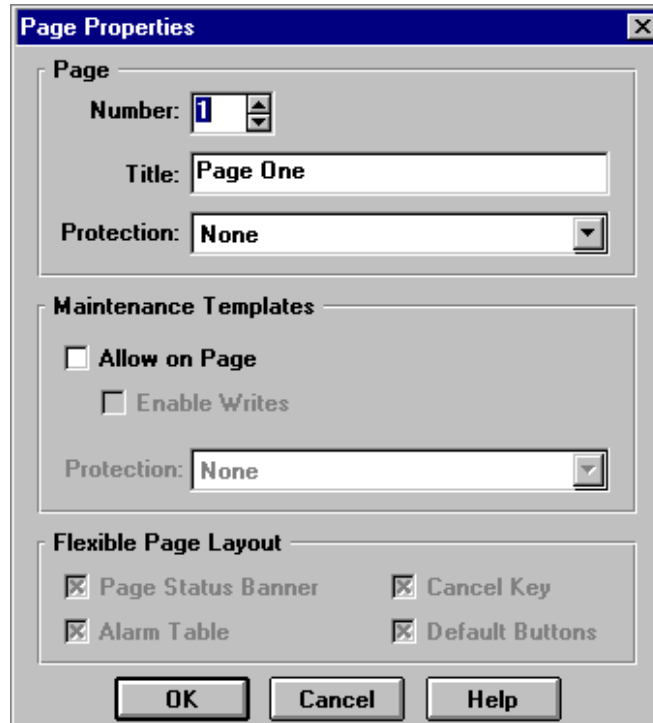
**Indicator Labels:** Allows you to automatically center all Indicator Labels within the Indicator Template label area on all pages of this configuration.

**Control Button Labels:** Allows you to automatically center all Control Button Labels for all templates which have control buttons defined on all pages of this configuration.



## Page Properties

When a configuration page is selected in the Database Treeview Window and the **Properties** button is clicked, the **Page Properties** dialog box will appear.



The **Page Properties** dialog box is used to determine features for individual configuration pages and to determine features for the Maintenance Template. For more information about the Maintenance Template, refer to the **Maintenance Template** topic. For more information about the **Maintenance Template** topic, refer to the **Maintenance Template** topic in the Online Operation User's Guide.

The fields in the **Page Properties** dialog box are described below.

### Page

**Number:** Allows you to enter a page number for the configuration page.

**Title:** Allows you to enter a title for the page.

**Protection:** Allows you to control access to individual pages. If the operator does not enter the correct password or if operator cannot unlock the security keyswitch wired to the PanelMate unit, the page will not be displayed. The selections available are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B Only

**Tip:** **If a page is password protected, but is selected as the startup page in the Startup Page field in the System Parameters - General Tab dialog box, password protection will be ignored on initial bootup.**

The page will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.


The security keyswitch is an option which may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

### Maintenance Templates

Maintenance Templates are designed to replace TCAM (timer/counter access module) and RAP (register access panel) devices that are typically used during the setup and troubleshooting of PLCs.

**Allow On Page:** Determines if the operator can display the pop-up Maintenance Template over the current page.

**Enable Writes:** Determines if the operator can change the data or just monitor data in the Maintenance Template. If the Enable Writes box is selected, the data is read/write. If the Enable Writes box is not selected, the data is read-only.

 **CAUTION:** Make your selection based on the expertise of operators and maintenance personnel.

**Protection:** Allows you to select a type of protection for displaying Maintenance Templates on the current page. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

The Maintenance Template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option which may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

For additional information about Maintenance Templates, see the **Maintenance Template** topic. For more information about the **Maintenance Template** topic, refer to the **Maintenance Template** topic in the Online Operation User's Guide.

### Flexible Page Layout

The Flexible Page Layout feature is intended for use on touchscreen units only.

If a flexible item appears on top of a template or graphic on your configuration page, the underlying template or graphic will be deleted when the configuration is exported.

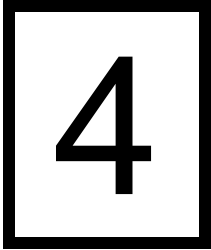
**Page Status Banner:** Allows you to determine if the Page Status Banner will appear on the screen of your touchscreen unit. Note that if you do not want the Page Status Banner to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Page Status Banner box.

**Default Buttons:** Allows you to determine if the default buttons will appear on the screen of your touchscreen unit. Note that if you do not want the Default Buttons to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Default Buttons box.

**Alarm Table:** Allows you to determine if alarms will appear on the screen of your touchscreen unit. Note that if you do not want alarms to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Alarms Table box.

**Cancel Key:** Allows you to determine if the **CANCEL** key will appear on the screen of your touchscreen unit. Note that if you do not want the **CANCEL** key to appear, you must select the Flexible Page Layout field in the **System Parameters - General Tab** dialog box and de-select the Cancel Key box.

# Font Editor

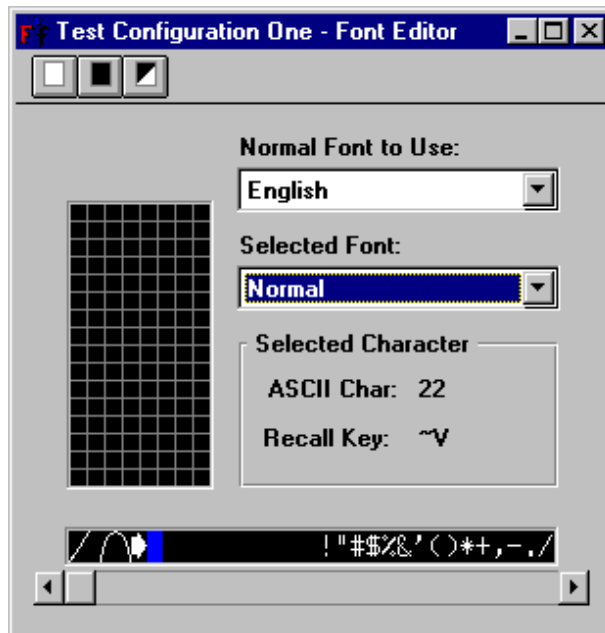


*In this chapter, you will learn:*

- *About the Font Editor*
- *About character sets*

## Font Editor

When you double click on the Normal, Graphic, Double High, or Quad selection under Screen Fonts in the Database Treeview Window, the **Font Editor** dialog box will appear.



The **Font Editor** dialog box allows you to edit existing characters or create new characters while still viewing the page layout.

The three buttons at the top of the **Font Editor** dialog box are described below.



This button will set all pixels to white in the 8x16 pixel box.



This button will set all pixels to black in the 8x16 pixel box.



This button will invert all pixels to the opposite color (i.e., black pixels to white pixels and white pixels to black pixels) in the 8x16 pixel box.

The 8x16 pixel box gives you the ability to create custom characters by redefining or creating a new character in the 8 x 16 pixel bitmap box for each character. The character set may be selected in the Normal Font to Use field and the font may be selected in the Selected Font field.

The fields in the **Font Editor** dialog box are described below.

**Normal Font to Use:** Allows you to select a character set. The character sets are listed below.

- English
- Danish1
- French1
- French2
- German1
- Spanish1
- Swedish1

**Selected Font:** Allows you to select the font to edit. The selections available are Normal, Graphics, Double High, and Quad. To view the Normal characters, refer to the **English Font** topic. To view Graphic characters, refer to the **Graphics Font** topic.

Note that the Double High and Quad fonts are only available if you selected the Redefine Quad Font or Redefine Double High Font fields in the **System Parameters - General Tab** dialog box.

The table below lists the fonts and the number of characters that can be edited.

Fonts	Number of Standard Font Characters	Number of Extended Font Characters
Normal	<sup>10</sup> ASCII characters 22-31	138 ASCII characters 22-31 and 128-255
Graphic	26 ASCII characters 101-126	154 ASCII characters 101-126 and 128-255
Double High	126 ASCII characters 1-126	254 ASCII characters 1-126 and 128-255
Quad	126 ASCII characters 1-126	254 ASCII characters 1-126 and 128-255

If you have strings using extended font characters and you disable the Enable Extended Fonts field in the **System Parameters - General Tab** dialog box, the strings will be truncated after and including the first character from the extended area (characters 128-255) of the font when the configuration is exported.

To access the extended fonts, the Enable Extended Fonts field must be selected in the **System Parameters - General Tab** dialog box.

Note that when redefining a character or editing a character that already exists in a font, the font will be changed on all pages where it is used.

### Selected Character

**ASCII Char:** Displays the ASCII character number for the character selected in the character selection window.

**Recall Key:** Displays the recall key or combination of keys you must enter to get the character to display.

**Character Selection Window:** Displays characters from the character set you selected in the Selected Font field. When a character has been selected, the character will be displayed in the 8x16 pixel box. You may use the scroll bar to scroll through the character set.

## English Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character /, press the recall keys ~Q.

To enter the character C, press the recall key C.

To enter the character ®, press the recall keys ALT+0174.

↑	~A	~B	~C	~D	~E	~F	~G
↓	~I	~J	~K	~L	~M	~N	~O
~H	~Q	~R	~S	~T	~U	~V	~W
>	~X	~Y	~Z	~[	~\	~^	~_
~P	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
<b>□</b> ALT+0128	<b>□</b> ALT+0129	<b>,</b> ALT+0130	<b>f</b> ALT+0131	<b>„</b> ALT+0132	<b>…</b> ALT+0133	<b>†</b> ALT+0134	<b>‡</b> ALT+0135
<b>^</b> ALT+0136	<b>%</b> ALT+0137	<b>§</b> ALT+0138	<b>&lt;</b> ALT+0139	<b>€</b> ALT+0140	<b>□</b> ALT+0141	<b>□</b> ALT+0142	<b>□</b> ALT+0143
<b>□</b> ALT+0144	<b>‘</b> ALT+0145	<b>’</b> ALT+0146	<b>“</b> ALT+0147	<b>”</b> ALT+0148	<b>•</b> ALT+0149	<b>-</b> ALT+0150	<b>-</b> ALT+0151
<b>~</b> ALT+0152	<b>™</b> ALT+0153	<b>§</b> ALT+0154	<b>&gt;</b> ALT+0155	<b>€</b> ALT+0156	<b>□</b> ALT+0157	<b>□</b> ALT+0158	<b>Ÿ</b> ALT+0159
<b>□</b> ALT+0160	<b>ı</b> ALT+0161	<b>ı</b> ALT+0162	<b>£</b> ALT+0163	<b>¤</b> ALT+0164	<b>¥</b> ALT+0165	<b>ı</b> ALT+0166	<b>§</b> ALT+0167
<b>“</b> ALT+0168	<b>©</b> ALT+0169	<b>ı</b> ALT+0170	<b>«</b> ALT+0171	<b>¬</b> ALT+0172	<b>-</b> ALT+0173	<b>®</b> ALT+0174	<b>-</b> ALT+0175
<b>°</b> ALT+0176	<b>±</b> ALT+0177	<b>²</b> ALT+0178	<b>³</b> ALT+0179	<b>´</b> ALT+0180	<b>µ</b> ALT+0181	<b>¶</b> ALT+0182	<b>·</b> ALT+0183
<b>,</b> ALT+0184	<b>ı</b> ALT+0185	<b>°</b> ALT+0186	<b>»</b> ALT+0187	<b>¼</b> ALT+0188	<b>½</b> ALT+0189	<b>¾</b> ALT+0190	<b>¿</b> ALT+0191
<b>À</b> ALT+0192	<b>Á</b> ALT+0193	<b>Â</b> ALT+0194	<b>Ã</b> ALT+0195	<b>Ä</b> ALT+0196	<b>Å</b> ALT+0197	<b>Æ</b> ALT+0198	<b>Ç</b> ALT+0199
<b>È</b> ALT+0200	<b>É</b> ALT+0201	<b>Ê</b> ALT+0202	<b>Ë</b> ALT+0203	<b>Ì</b> ALT+0204	<b>Í</b> ALT+0205	<b>Î</b> ALT+0206	<b>Ï</b> ALT+0207
<b>Ð</b> ALT+0208	<b>Ñ</b> ALT+0209	<b>Ò</b> ALT+0210	<b>Ó</b> ALT+0211	<b>Ô</b> ALT+0212	<b>Õ</b> ALT+0213	<b>Ö</b> ALT+0214	<b>×</b> ALT+0215
<b>Ø</b> ALT+0216	<b>Ù</b> ALT+0217	<b>Ú</b> ALT+0218	<b>Û</b> ALT+0219	<b>Ü</b> ALT+0220	<b>Ý</b> ALT+0221	<b>Þ</b> ALT+0222	<b>ß</b> ALT+0223
<b>à</b> ALT+0224	<b>á</b> ALT+0225	<b>â</b> ALT+0226	<b>ã</b> ALT+0227	<b>ä</b> ALT+0228	<b>å</b> ALT+0229	<b>æ</b> ALT+0230	<b>ç</b> ALT+0231
<b>è</b> ALT+0232	<b>é</b> ALT+0233	<b>ê</b> ALT+0234	<b>ë</b> ALT+0235	<b>ì</b> ALT+0236	<b>í</b> ALT+0237	<b>î</b> ALT+0238	<b>ï</b> ALT+0239
<b>ð</b> ALT+0240	<b>ñ</b> ALT+0241	<b>ò</b> ALT+0242	<b>ó</b> ALT+0243	<b>ô</b> ALT+0244	<b>õ</b> ALT+0245	<b>ö</b> ALT+0246	<b>÷</b> ALT+0247
<b>ø</b> ALT+0248	<b>ù</b> ALT+0249	<b>ú</b> ALT+0250	<b>û</b> ALT+0251	<b>ü</b> ALT+0252	<b>ý</b> ALT+0253	<b>þ</b> ALT+0254	<b>ÿ</b> ALT+0255



## Danish1 Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character Æ, press the recall keys ~W.

To enter the character C, press the recall key C.

To enter the character ®, press the recall keys ALT+0174.

•	~A	~B	~C	~D	~E	~F	~G
~H	~I	~J	~K	~L	~M	~N	~O
~P	~Q	~R	~S	~T	~U	~V	~W
~X	~Y	~Z	~[	~\	~]	~^	~_
	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b>[</b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
<b>□</b> ALT+0128	<b>□</b> ALT+0129	<b>,</b> ALT+0130	<b>f</b> ALT+0131	<b>"</b> ALT+0132	<b>ALT+0133</b>	<b>‡</b> ALT+0134	<b>‡</b> ALT+0135
<b>ALT+0136</b>	<b>&amp;</b> ALT+0137	<b>§</b> ALT+0138	<b>€</b> ALT+0139	<b>€</b> ALT+0140	<b>□</b> ALT+0141	<b>□</b> ALT+0142	<b>□</b> ALT+0143
<b>□</b> ALT+0144	<b>'</b> ALT+0145	<b>'</b> ALT+0146	<b>"</b> ALT+0147	<b>"</b> ALT+0148	<b>*</b> ALT+0149	<b>-</b> ALT+0150	<b>-</b> ALT+0151
<b>~</b> ALT+0152	<b>"</b> ALT+0153	<b>š</b> ALT+0154	<b>›</b> ALT+0155	<b>«</b> ALT+0156	<b>□</b> ALT+0157	<b>□</b> ALT+0158	<b>Ÿ</b> ALT+0159
<b>ALT+0160</b>	<b>ı</b> ALT+0161	<b>ç</b> ALT+0162	<b>£</b> ALT+0163	<b>×</b> ALT+0164	<b>¥</b> ALT+0165	<b>:</b> ALT+0166	<b>§</b> ALT+0167
<b>"</b> ALT+0168	<b>ø</b> ALT+0169	<b>ı</b> ALT+0170	<b>«</b> ALT+0171	<b>¬</b> ALT+0172	<b>-</b> ALT+0173	<b>ø</b> ALT+0174	<b>-</b> ALT+0175
<b>*</b> ALT+0176	<b>±</b> ALT+0177	<b>²</b> ALT+0178	<b>³</b> ALT+0179	<b>´</b> ALT+0180	<b>µ</b> ALT+0181	<b>¶</b> ALT+0182	<b>·</b> ALT+0183
<b>¸</b> ALT+0184	<b>ˆ</b> ALT+0185	<b>ˆ</b> ALT+0186	<b>»</b> ALT+0187	<b>¼</b> ALT+0188	<b>½</b> ALT+0189	<b>¾</b> ALT+0190	<b>¿</b> ALT+0191
<b>À</b> ALT+0192	<b>Á</b> ALT+0193	<b>Â</b> ALT+0194	<b>Ã</b> ALT+0195	<b>Ä</b> ALT+0196	<b>Å</b> ALT+0197	<b>Æ</b> ALT+0198	<b>Ç</b> ALT+0199
<b>È</b> ALT+0200	<b>É</b> ALT+0201	<b>Ê</b> ALT+0202	<b>Ë</b> ALT+0203	<b>Ì</b> ALT+0204	<b>Í</b> ALT+0205	<b>Î</b> ALT+0206	<b>Ï</b> ALT+0207
<b>Ð</b> ALT+0208	<b>Ñ</b> ALT+0209	<b>Ò</b> ALT+0210	<b>Ó</b> ALT+0211	<b>Ô</b> ALT+0212	<b>Õ</b> ALT+0213	<b>Ö</b> ALT+0214	<b>×</b> ALT+0215
<b>Ø</b> ALT+0216	<b>Ù</b> ALT+0217	<b>Ú</b> ALT+0218	<b>Û</b> ALT+0219	<b>Ü</b> ALT+0220	<b>Ý</b> ALT+0221	<b>Þ</b> ALT+0222	<b>ß</b> ALT+0223
<b>à</b> ALT+0224	<b>á</b> ALT+0225	<b>â</b> ALT+0226	<b>ã</b> ALT+0227	<b>ä</b> ALT+0228	<b>å</b> ALT+0229	<b>æ</b> ALT+0230	<b>ç</b> ALT+0231
<b>è</b> ALT+0232	<b>é</b> ALT+0233	<b>ê</b> ALT+0234	<b>ë</b> ALT+0235	<b>ì</b> ALT+0236	<b>í</b> ALT+0237	<b>î</b> ALT+0238	<b>ï</b> ALT+0239
<b>ð</b> ALT+0240	<b>ñ</b> ALT+0241	<b>ó</b> ALT+0242	<b>ô</b> ALT+0243	<b>õ</b> ALT+0244	<b>ö</b> ALT+0245	<b>ø</b> ALT+0246	<b>-</b> ALT+0247
<b>ø</b> ALT+0248	<b>ù</b> ALT+0249	<b>ú</b> ALT+0250	<b>û</b> ALT+0251	<b>ü</b> ALT+0252	<b>ý</b> ALT+0253	<b>þ</b> ALT+0254	<b>ÿ</b> ALT+0255

## French1 Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character **É**, press the recall keys **~]**.

To enter the character **Ç**, press the recall key **C**.

To enter the character **®**, press the recall keys **ALT+0174**.

•	~A	~B	~C	~D	~E	~F	~G
~H	~I	~J	~K	~L	~M	~N	~O
~P	~Q	~R	~S	~T	~U	~V	~W
~X	~Y	~Z	~[	~\	~]	~^	~_
	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
<b>□</b> ALT+0128	<b>□</b> ALT+0129	<b>,</b> ALT+0130	<b>f</b> ALT+0131	<b>„</b> ALT+0132	<b>…</b> ALT+0133	<b>†</b> ALT+0134	<b>‡</b> ALT+0135
<b>^</b> ALT+0136	<b>%</b> ALT+0137	<b>§</b> ALT+0138	<b>&lt;</b> ALT+0139	<b>€</b> ALT+0140	<b>□</b> ALT+0141	<b>□</b> ALT+0142	<b>□</b> ALT+0143
<b>□</b> ALT+0144	<b>‘</b> ALT+0145	<b>’</b> ALT+0146	<b>“</b> ALT+0147	<b>”</b> ALT+0148	<b>•</b> ALT+0149	<b>-</b> ALT+0150	<b>-</b> ALT+0151
<b>~</b> ALT+0152	<b>™</b> ALT+0153	<b>§</b> ALT+0154	<b>&gt;</b> ALT+0155	<b>€</b> ALT+0156	<b>□</b> ALT+0157	<b>□</b> ALT+0158	<b>¥</b> ALT+0159
<b>ALT+0160</b>	<b>i</b> ALT+0161	<b>¢</b> ALT+0162	<b>£</b> ALT+0163	<b>¤</b> ALT+0164	<b>¥</b> ALT+0165	<b> </b> ALT+0166	<b>§</b> ALT+0167
<b>“</b> ALT+0168	<b>@</b> ALT+0169	<b>¡</b> ALT+0170	<b>«</b> ALT+0171	<b>¬</b> ALT+0172	<b>-</b> ALT+0173	<b>®</b> ALT+0174	<b>-</b> ALT+0175
<b>°</b> ALT+0176	<b>±</b> ALT+0177	<b>²</b> ALT+0178	<b>³</b> ALT+0179	<b>´</b> ALT+0180	<b>µ</b> ALT+0181	<b>¶</b> ALT+0182	<b>•</b> ALT+0183
<b>¸</b> ALT+0184	<b>¹</b> ALT+0185	<b>º</b> ALT+0186	<b>»</b> ALT+0187	<b>¼</b> ALT+0188	<b>½</b> ALT+0189	<b>¾</b> ALT+0190	<b>¿</b> ALT+0191
<b>À</b> ALT+0192	<b>Á</b> ALT+0193	<b>Â</b> ALT+0194	<b>Ã</b> ALT+0195	<b>Ä</b> ALT+0196	<b>Å</b> ALT+0197	<b>Æ</b> ALT+0198	<b>Ç</b> ALT+0199
<b>È</b> ALT+0200	<b>É</b> ALT+0201	<b>Ê</b> ALT+0202	<b>Ë</b> ALT+0203	<b>Ì</b> ALT+0204	<b>Í</b> ALT+0205	<b>Î</b> ALT+0206	<b>Ï</b> ALT+0207
<b>Ð</b> ALT+0208	<b>Ñ</b> ALT+0209	<b>Ò</b> ALT+0210	<b>Ó</b> ALT+0211	<b>Ô</b> ALT+0212	<b>Õ</b> ALT+0213	<b>Ö</b> ALT+0214	<b>×</b> ALT+0215
<b>Ø</b> ALT+0216	<b>Ù</b> ALT+0217	<b>Ú</b> ALT+0218	<b>Û</b> ALT+0219	<b>Ü</b> ALT+0220	<b>Ý</b> ALT+0221	<b>Þ</b> ALT+0222	<b>ß</b> ALT+0223
<b>à</b> ALT+0224	<b>á</b> ALT+0225	<b>â</b> ALT+0226	<b>ã</b> ALT+0227	<b>ä</b> ALT+0228	<b>å</b> ALT+0229	<b>æ</b> ALT+0230	<b>ç</b> ALT+0231
<b>è</b> ALT+0232	<b>é</b> ALT+0233	<b>ê</b> ALT+0234	<b>ë</b> ALT+0235	<b>ì</b> ALT+0236	<b>í</b> ALT+0237	<b>î</b> ALT+0238	<b>ï</b> ALT+0239
<b>ð</b> ALT+0240	<b>ñ</b> ALT+0241	<b>ò</b> ALT+0242	<b>ó</b> ALT+0243	<b>ô</b> ALT+0244	<b>õ</b> ALT+0245	<b>ö</b> ALT+0246	<b>+ ALT+0247</b>
<b>ø</b> ALT+0248	<b>ù</b> ALT+0249	<b>ú</b> ALT+0250	<b>û</b> ALT+0251	<b>ü</b> ALT+0252	<b>ý</b> ALT+0253	<b>þ</b> ALT+0254	<b>ÿ</b> ALT+0255

## French2 Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character  $\hat{\text{I}}$ , press the recall keys  $\sim\text{I}$ .

To enter the character  $\text{C}$ , press the recall key  $\text{C}$ .

To enter the character  $\text{\textcircled{R}}$ , press the recall keys  $\text{ALT}+\text{0174}$ .

$\text{\textcircled{R}}$	$\text{\textcircled{A}}$	$\text{\textcircled{B}}$	$\text{\textcircled{C}}$	$\text{\textcircled{D}}$	$\text{\textcircled{E}}$	$\text{\textcircled{F}}$	$\text{\textcircled{G}}$
$\text{\textcircled{H}}$	$\text{\textcircled{I}}$	$\text{\textcircled{J}}$	$\text{\textcircled{K}}$	$\text{\textcircled{L}}$	$\text{\textcircled{M}}$	$\text{\textcircled{N}}$	$\text{\textcircled{O}}$
$\text{\textcircled{P}}$	$\text{\textcircled{Q}}$	$\text{\textcircled{R}}$	$\text{\textcircled{S}}$	$\text{\textcircled{T}}$	$\text{\textcircled{U}}$	$\text{\textcircled{V}}$	$\text{\textcircled{W}}$
$\text{\textcircled{X}}$	$\text{\textcircled{Y}}$	$\text{\textcircled{Z}}$	$\text{\textcircled{[}}$	$\text{\textcircled{\textbackslash}}$	$\text{\textcircled{]}}$	$\text{\textcircled{\textasciicircum}}$	$\text{\textcircled{\textunderscore}}$
	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>Ø</b> ALT+0127
□	□	,	f	„	…	†	‡
ALT+0128	ALT+0129	ALT+0130	ALT+0131	ALT+0132	ALT+0133	ALT+0134	ALT+0135
ˆ	‰	Š	<	€	□	□	□
ALT+0136	ALT+0137	ALT+0138	ALT+0139	ALT+0140	ALT+0141	ALT+0142	ALT+0143
□	‘	’	“	”	-	-	-
ALT+0144	ALT+0145	ALT+0146	ALT+0147	ALT+0148	ALT+0149	ALT+0150	ALT+0151
˘	™	š	>	œ	□	□	Ÿ
ALT+0152	ALT+0153	ALT+0154	ALT+0155	ALT+0156	ALT+0157	ALT+0158	ALT+0159
	ı	ı	£	×	¥	ı	§
ALT+0160	ALT+0161	ALT+0162	ALT+0163	ALT+0164	ALT+0165	ALT+0166	ALT+0167
˙	©	ı	«	¬	-	®	-
ALT+0168	ALT+0169	ALT+0170	ALT+0171	ALT+0172	ALT+0173	ALT+0174	ALT+0175
°	±	²	³	´	µ	¶	·
ALT+0176	ALT+0177	ALT+0178	ALT+0179	ALT+0180	ALT+0181	ALT+0182	ALT+0183
,	ı	°	»	¼	½	¾	¿
ALT+0184	ALT+0185	ALT+0186	ALT+0187	ALT+0188	ALT+0189	ALT+0190	ALT+0191
À	Á	Â	Ã	Ä	Å	Æ	Ç
ALT+0192	ALT+0193	ALT+0194	ALT+0195	ALT+0196	ALT+0197	ALT+0198	ALT+0199
È	É	Ê	Ë	Ì	Í	Î	Ï
ALT+0200	ALT+0201	ALT+0202	ALT+0203	ALT+0204	ALT+0205	ALT+0206	ALT+0207
Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×
ALT+0208	ALT+0209	ALT+0210	ALT+0211	ALT+0212	ALT+0213	ALT+0214	ALT+0215
Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
ALT+0216	ALT+0217	ALT+0218	ALT+0219	ALT+0220	ALT+0221	ALT+0222	ALT+0223
à	á	â	ã	ä	å	æ	ç
ALT+0224	ALT+0225	ALT+0226	ALT+0227	ALT+0228	ALT+0229	ALT+0230	ALT+0231
è	é	ê	ë	ì	í	î	ï
ALT+0232	ALT+0233	ALT+0234	ALT+0235	ALT+0236	ALT+0237	ALT+0238	ALT+0239
ø	ñ	ò	ó	ô	õ	ö	÷
ALT+0240	ALT+0241	ALT+0242	ALT+0243	ALT+0244	ALT+0245	ALT+0246	ALT+0247
ø	ù	ú	û	ü	ý	þ	ÿ
ALT+0248	ALT+0249	ALT+0250	ALT+0251	ALT+0252	ALT+0253	ALT+0254	ALT+0255



	<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
	<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
<b>□</b> ALT+0128	<b>□</b> ALT+0129	<b>,</b> ALT+0130	<b>f</b> ALT+0131	<b>„</b> ALT+0132	<b>…</b> ALT+0133	<b>†</b> ALT+0134	<b>‡</b> ALT+0135	
<b>^</b> ALT+0136	<b>‰</b> ALT+0137	<b>Š</b> ALT+0138	<b>&lt;</b> ALT+0139	<b>€</b> ALT+0140	<b>□</b> ALT+0141	<b>□</b> ALT+0142	<b>□</b> ALT+0143	
<b>□</b> ALT+0144	<b>‘</b> ALT+0145	<b>’</b> ALT+0146	<b>“</b> ALT+0147	<b>”</b> ALT+0148	<b>-</b> ALT+0149	<b>-</b> ALT+0150	<b>-</b> ALT+0151	
<b>˘</b> ALT+0152	<b>™</b> ALT+0153	<b>š</b> ALT+0154	<b>&gt;</b> ALT+0155	<b>œ</b> ALT+0156	<b>□</b> ALT+0157	<b>□</b> ALT+0158	<b>Ÿ</b> ALT+0159	
	<b>ı</b> ALT+0160	<b>ı</b> ALT+0161	<b>£</b> ALT+0162	<b>×</b> ALT+0163	<b>¥</b> ALT+0164	<b>ı</b> ALT+0165	<b>§</b> ALT+0166	
<b>˙</b> ALT+0168	<b>©</b> ALT+0169	<b>ı</b> ALT+0170	<b>«</b> ALT+0171	<b>¬</b> ALT+0172	<b>-</b> ALT+0173	<b>®</b> ALT+0174	<b>-</b> ALT+0175	
<b>°</b> ALT+0176	<b>±</b> ALT+0177	<b>²</b> ALT+0178	<b>³</b> ALT+0179	<b>´</b> ALT+0180	<b>µ</b> ALT+0181	<b>¶</b> ALT+0182	<b>·</b> ALT+0183	
<b>,</b> ALT+0184	<b>ı</b> ALT+0185	<b>°</b> ALT+0186	<b>»</b> ALT+0187	<b>¼</b> ALT+0188	<b>½</b> ALT+0189	<b>¾</b> ALT+0190	<b>¿</b> ALT+0191	
<b>À</b> ALT+0192	<b>Á</b> ALT+0193	<b>Â</b> ALT+0194	<b>Ã</b> ALT+0195	<b>Ä</b> ALT+0196	<b>Å</b> ALT+0197	<b>Æ</b> ALT+0198	<b>Ç</b> ALT+0199	
<b>È</b> ALT+0200	<b>É</b> ALT+0201	<b>Ê</b> ALT+0202	<b>Ë</b> ALT+0203	<b>Ì</b> ALT+0204	<b>Í</b> ALT+0205	<b>Î</b> ALT+0206	<b>Ï</b> ALT+0207	
<b>Ð</b> ALT+0208	<b>Ñ</b> ALT+0209	<b>Ò</b> ALT+0210	<b>Ó</b> ALT+0211	<b>Ô</b> ALT+0212	<b>Õ</b> ALT+0213	<b>Ö</b> ALT+0214	<b>×</b> ALT+0215	
<b>Ø</b> ALT+0216	<b>Ù</b> ALT+0217	<b>Ú</b> ALT+0218	<b>Û</b> ALT+0219	<b>Ü</b> ALT+0220	<b>Ý</b> ALT+0221	<b>Þ</b> ALT+0222	<b>ß</b> ALT+0223	
<b>à</b> ALT+0224	<b>á</b> ALT+0225	<b>â</b> ALT+0226	<b>ã</b> ALT+0227	<b>ä</b> ALT+0228	<b>å</b> ALT+0229	<b>æ</b> ALT+0230	<b>ç</b> ALT+0231	
<b>è</b> ALT+0232	<b>é</b> ALT+0233	<b>ê</b> ALT+0234	<b>ë</b> ALT+0235	<b>ì</b> ALT+0236	<b>í</b> ALT+0237	<b>î</b> ALT+0238	<b>ï</b> ALT+0239	
<b>ð</b> ALT+0240	<b>ñ</b> ALT+0241	<b>ò</b> ALT+0242	<b>ó</b> ALT+0243	<b>ô</b> ALT+0244	<b>õ</b> ALT+0245	<b>ö</b> ALT+0246	<b>÷</b> ALT+0247	
<b>ø</b> ALT+0248	<b>ù</b> ALT+0249	<b>ú</b> ALT+0250	<b>û</b> ALT+0251	<b>ü</b> ALT+0252	<b>ý</b> ALT+0253	<b>þ</b> ALT+0254	<b>ÿ</b> ALT+0255	



## Spanish1 Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character Ñ, press the recall keys ~Y.

To enter the character Ç, press the recall key C.

To enter the character ®, press the recall keys ALT+0174.

•	ˆ	˘	˙	˚	˛	˜	˝
	~A	~B	~C	~D	~E	~F	~G
ˆ	˘	˙	˚	˛	˜	˝	˝
~H	~I	~J	~K	~L	~M	~N	~O
)	/	'	(	)	•	à	ä
~P	~Q	~R	~S	~T	~U	~V	~W
É	Ñ	ı	ı	~\	~]	~^	~_
~X	~Y	~Z	~[	~\	~]	~^	~_
	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
□	□	,	f	„		†	‡
ALT+0128	ALT+0129	ALT+0130	ALT+0131	ALT+0132	ALT+0133	ALT+0134	ALT+0135
	£	§	ı	€	□	□	□
ALT+0136	ALT+0137	ALT+0138	ALT+0139	ALT+0140	ALT+0141	ALT+0142	ALT+0143
□	ı	ı	“	”	•	-	-
ALT+0144	ALT+0145	ALT+0146	ALT+0147	ALT+0148	ALT+0149	ALT+0150	ALT+0151
~	™	š	›	«	□	□	Ÿ
ALT+0152	ALT+0153	ALT+0154	ALT+0155	ALT+0156	ALT+0157	ALT+0158	ALT+0159
	ı	ı	£	×	¥	ı	§
ALT+0160	ALT+0161	ALT+0162	ALT+0163	ALT+0164	ALT+0165	ALT+0166	ALT+0167
“	®	ı	«	¬	-	®	-
ALT+0168	ALT+0169	ALT+0170	ALT+0171	ALT+0172	ALT+0173	ALT+0174	ALT+0175
°	±	²	³	´	µ	¶	·
ALT+0176	ALT+0177	ALT+0178	ALT+0179	ALT+0180	ALT+0181	ALT+0182	ALT+0183
¸	ı	°	»	¼	½	¾	¿
ALT+0184	ALT+0185	ALT+0186	ALT+0187	ALT+0188	ALT+0189	ALT+0190	ALT+0191
À	Á	Â	Ã	Ä	Å	Æ	Ç
ALT+0192	ALT+0193	ALT+0194	ALT+0195	ALT+0196	ALT+0197	ALT+0198	ALT+0199
È	É	Ê	Ë	Ì	Í	Î	Ï
ALT+0200	ALT+0201	ALT+0202	ALT+0203	ALT+0204	ALT+0205	ALT+0206	ALT+0207
Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×
ALT+0208	ALT+0209	ALT+0210	ALT+0211	ALT+0212	ALT+0213	ALT+0214	ALT+0215
Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
ALT+0216	ALT+0217	ALT+0218	ALT+0219	ALT+0220	ALT+0221	ALT+0222	ALT+0223
à	á	â	ã	ä	å	æ	ç
ALT+0224	ALT+0225	ALT+0226	ALT+0227	ALT+0228	ALT+0229	ALT+0230	ALT+0231
è	é	ê	ë	ì	í	î	ï
ALT+0232	ALT+0233	ALT+0234	ALT+0235	ALT+0236	ALT+0237	ALT+0238	ALT+0239
ð	ñ	ó	ô	õ	ö	ø	-
ALT+0240	ALT+0241	ALT+0242	ALT+0243	ALT+0244	ALT+0245	ALT+0246	ALT+0247
ø	ù	ú	û	ü	ý	þ	ÿ
ALT+0248	ALT+0249	ALT+0250	ALT+0251	ALT+0252	ALT+0253	ALT+0254	ALT+0255

## Swedish1 Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

To enter the character Ö, press the recall keys ~X.

To enter the character Ç, press the recall key C.

To enter the character ®, press the recall keys ALT+0174.

•	~A	~B	~C	~D	~E	~F	~G
~H	~I	~J	~K	~L	~M	~N	~O
~P	~Q	~R	~S	~T	~U	~V	~W
~X	~Y	~Z	~[	~\	~]	~^	~_
	!	"	#	\$	%	&	'
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v</b>	<b>w</b>
<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~</b>	<b>□</b> ALT+0127
<b>□</b> ALT+0128	<b>□</b> ALT+0129	<b>,</b> ALT+0130	<b>f</b> ALT+0131	<b>„</b> ALT+0132	<b>ALT+0133</b>	<b>†</b> ALT+0134	<b>‡</b> ALT+0135
<b>ALT+0136</b>	<b>£</b> ALT+0137	<b>§</b> ALT+0138	<b>©</b> ALT+0139	<b>€</b> ALT+0140	<b>□</b> ALT+0141	<b>□</b> ALT+0142	<b>□</b> ALT+0143
<b>□</b> ALT+0144	<b>'</b> ALT+0145	<b>'</b> ALT+0146	<b>”</b> ALT+0147	<b>”</b> ALT+0148	<b>,</b> ALT+0149	<b>-</b> ALT+0150	<b>-</b> ALT+0151
<b>~</b> ALT+0152	<b>™</b> ALT+0153	<b>š</b> ALT+0154	<b>)</b> ALT+0155	<b>«</b> ALT+0156	<b>□</b> ALT+0157	<b>□</b> ALT+0158	<b>Ÿ</b> ALT+0159
<b>ALT+0160</b>	<b>ı</b> ALT+0161	<b>ç</b> ALT+0162	<b>£</b> ALT+0163	<b>×</b> ALT+0164	<b>¥</b> ALT+0165	<b>;</b> ALT+0166	<b>§</b> ALT+0167
<b>..</b> ALT+0168	<b>ø</b> ALT+0169	<b>ı</b> ALT+0170	<b>«</b> ALT+0171	<b>¬</b> ALT+0172	<b>-</b> ALT+0173	<b>ø</b> ALT+0174	<b>-</b> ALT+0175
<b>°</b> ALT+0176	<b>±</b> ALT+0177	<b>²</b> ALT+0178	<b>³</b> ALT+0179	<b>´</b> ALT+0180	<b>µ</b> ALT+0181	<b>¶</b> ALT+0182	<b>·</b> ALT+0183
<b>¸</b> ALT+0184	<b>ˆ</b> ALT+0185	<b>˚</b> ALT+0186	<b>»</b> ALT+0187	<b>¼</b> ALT+0188	<b>½</b> ALT+0189	<b>¾</b> ALT+0190	<b>¿</b> ALT+0191
<b>À</b> ALT+0192	<b>Á</b> ALT+0193	<b>Â</b> ALT+0194	<b>Ã</b> ALT+0195	<b>Ä</b> ALT+0196	<b>Å</b> ALT+0197	<b>Æ</b> ALT+0198	<b>Ç</b> ALT+0199
<b>È</b> ALT+0200	<b>É</b> ALT+0201	<b>Ê</b> ALT+0202	<b>Ë</b> ALT+0203	<b>Ì</b> ALT+0204	<b>Í</b> ALT+0205	<b>Î</b> ALT+0206	<b>Ï</b> ALT+0207
<b>Ð</b> ALT+0208	<b>Ñ</b> ALT+0209	<b>Ò</b> ALT+0210	<b>Ó</b> ALT+0211	<b>Ô</b> ALT+0212	<b>Õ</b> ALT+0213	<b>Ö</b> ALT+0214	<b>×</b> ALT+0215
<b>Ø</b> ALT+0216	<b>Ù</b> ALT+0217	<b>Ú</b> ALT+0218	<b>Û</b> ALT+0219	<b>Ü</b> ALT+0220	<b>Ý</b> ALT+0221	<b>Þ</b> ALT+0222	<b>ß</b> ALT+0223
<b>à</b> ALT+0224	<b>á</b> ALT+0225	<b>â</b> ALT+0226	<b>ã</b> ALT+0227	<b>ä</b> ALT+0228	<b>å</b> ALT+0229	<b>æ</b> ALT+0230	<b>ç</b> ALT+0231
<b>é</b> ALT+0232	<b>ê</b> ALT+0233	<b>ë</b> ALT+0234	<b>l</b> ALT+0235	<b>ì</b> ALT+0236	<b>í</b> ALT+0237	<b>î</b> ALT+0238	<b>ï</b> ALT+0239
<b>ò</b> ALT+0240	<b>ó</b> ALT+0241	<b>ô</b> ALT+0242	<b>ó</b> ALT+0243	<b>ô</b> ALT+0244	<b>õ</b> ALT+0245	<b>ö</b> ALT+0246	<b>-</b> ALT+0247
<b>ø</b> ALT+0248	<b>ù</b> ALT+0249	<b>ú</b> ALT+0250	<b>û</b> ALT+0251	<b>ü</b> ALT+0252	<b>ý</b> ALT+0253	<b>þ</b> ALT+0254	<b>y</b> ALT+0255

## Graphic Font

To enter the following characters, press the recall key(s). Refer to the examples below.

### Examples:

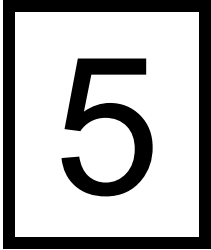
To enter the character **■**, press the recall keys ~Q.

To enter the character **▣**, press the recall key N.

	~A	~B	~C	~D	~E	~F	~G
~H	~I	~J	~K	~L	~M	~N	~O
~P	~Q	~R	~S	~T	~U	~V	~W
~X	~Y	~Z	~[	~\	~]	~^	~_
-	-	-	-	-	-	-	-
-	!	"	#	\$	%	&	'
-	-	-	-	-	-	-	-
(	)	*	+	,	-	.	/
0	1	2	3	4	5	6	7
8	9	:	:	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
,	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o

	→	+					
	<b>p</b>	<b>q</b>	<b>r</b>	<b>s</b>	<b>t</b>	<b>u</b>	<b>v w</b>
	<b>x</b>	<b>y</b>	<b>z</b>	<b>{</b>	<b> </b>	<b>}</b>	<b>~ ALT+0127</b>
<b>ALT+0128</b>	<b>ALT+0129</b>	<b>ALT+0130</b>	<b>ALT+0131</b>	<b>ALT+0132</b>	<b>ALT+0133</b>	<b>ALT+0134</b>	<b>ALT+0135</b>
<b>ALT+0136</b>	<b>ALT+0137</b>	<b>ALT+0138</b>	<b>ALT+0139</b>	<b>ALT+0140</b>	<b>ALT+0141</b>	<b>ALT+0142</b>	<b>ALT+0143</b>
<b>ALT+0144</b>	<b>ALT+0145</b>	<b>ALT+0146</b>	<b>ALT+0147</b>	<b>ALT+0148</b>	<b>ALT+0149</b>	<b>ALT+0150</b>	<b>ALT+0151</b>
<b>ALT+0152</b>	<b>ALT+0153</b>	<b>ALT+0154</b>	<b>ALT+0155</b>	<b>ALT+0156</b>	<b>ALT+0157</b>	<b>ALT+0158</b>	<b>ALT+0159</b>
<b>ALT+0160</b>	<b>ALT+0161</b>	<b>ALT+0162</b>	<b>ALT+0163</b>	<b>ALT+0164</b>	<b>ALT+0165</b>	<b>ALT+0166</b>	<b>ALT+0167</b>
<b>ALT+0168</b>	<b>ALT+0169</b>	<b>ALT+0170</b>	<b>ALT+0171</b>	<b>ALT+0172</b>	<b>ALT+0173</b>	<b>ALT+0174</b>	<b>ALT+0175</b>
<b>ALT+0176</b>	<b>ALT+0177</b>	<b>ALT+0178</b>	<b>ALT+0179</b>	<b>ALT+0180</b>	<b>ALT+0181</b>	<b>ALT+0182</b>	<b>ALT+0183</b>
<b>ALT+0184</b>	<b>ALT+0185</b>	<b>ALT+0186</b>	<b>ALT+0187</b>	<b>ALT+0188</b>	<b>ALT+0189</b>	<b>ALT+0190</b>	<b>ALT+0191</b>
<b>ALT+0192</b>	<b>ALT+0193</b>	<b>ALT+0194</b>	<b>ALT+0195</b>	<b>ALT+0196</b>	<b>ALT+0197</b>	<b>ALT+0198</b>	<b>ALT+0199</b>
<b>ALT+0200</b>	<b>ALT+0201</b>	<b>ALT+0202</b>	<b>ALT+0203</b>	<b>ALT+0204</b>	<b>ALT+0205</b>	<b>ALT+0206</b>	<b>ALT+0207</b>
<b>ALT+0208</b>	<b>ALT+0209</b>	<b>ALT+0210</b>	<b>ALT+0211</b>	<b>ALT+0212</b>	<b>ALT+0213</b>	<b>ALT+0214</b>	<b>ALT+0215</b>
<b>ALT+0216</b>	<b>ALT+0217</b>	<b>ALT+0218</b>	<b>ALT+0219</b>	<b>ALT+0220</b>	<b>ALT+0221</b>	<b>ALT+0222</b>	<b>ALT+0223</b>
<b>ALT+0224</b>	<b>ALT+0225</b>	<b>ALT+0226</b>	<b>ALT+0227</b>	<b>ALT+0228</b>	<b>ALT+0229</b>	<b>ALT+0230</b>	<b>ALT+0231</b>
<b>ALT+0232</b>	<b>ALT+0233</b>	<b>ALT+0234</b>	<b>ALT+0235</b>	<b>ALT+0236</b>	<b>ALT+0237</b>	<b>ALT+0238</b>	<b>ALT+0239</b>
<b>ALT+0240</b>	<b>ALT+0241</b>	<b>ALT+0242</b>	<b>ALT+0243</b>	<b>ALT+0244</b>	<b>ALT+0245</b>	<b>ALT+0246</b>	<b>ALT+0247</b>
<b>ALT+0248</b>	<b>ALT+0249</b>	<b>ALT+0250</b>	<b>ALT+0251</b>	<b>ALT+0252</b>	<b>ALT+0253</b>	<b>ALT+0254</b>	<b>ALT+0255</b>

# Symbol Library



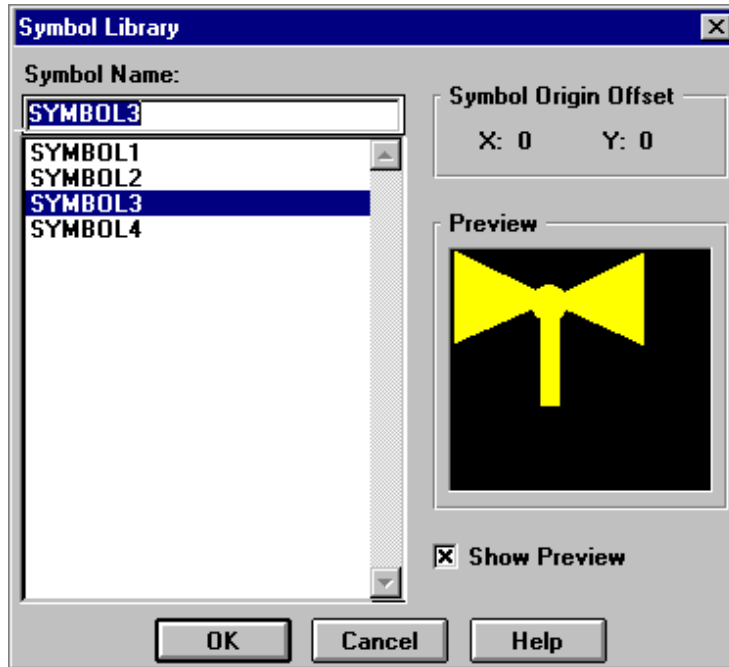
*In this chapter, you will learn:*

- *About the Symbol Library*
- *About the Symbol Properties*
- *About the Symbol Origin*

## Symbol Library

For information on creating symbols, refer to the **Make Symbol** topic.

When symbols have been created in the configuration and you click on a symbol name under the Symbol Library selection in the Database Treeview Window, the **Symbol Library** dialog box will appear.



The **Symbol Library** dialog box allows you to view all symbol names that have been created for your configuration.

The fields in the **Symbol Library** dialog box are described below.

**Symbol Name:** Displays the name of the symbol you selected. Note that you may scroll through the symbol name list and preview each symbol if the Show Preview box is selected.

**Symbol Origin Offset:** Displays the symbol's origin offset (in pixels). The default Symbol Origin Offset for X and Y is 0 and 0 (no offset).

**X:** Displays the X origin offset in pixels.

**Y:** Displays the Y origin offset in pixels.

**Preview:** Displays the selected symbol in the Preview box if the Show Preview box is selected.

**Show Preview:** Allows the selected symbol to be shown in the Preview box.

If the Symbol Library Preview Window is not displaying the selected symbol, simply open any configuration page and the functionality will be restored.

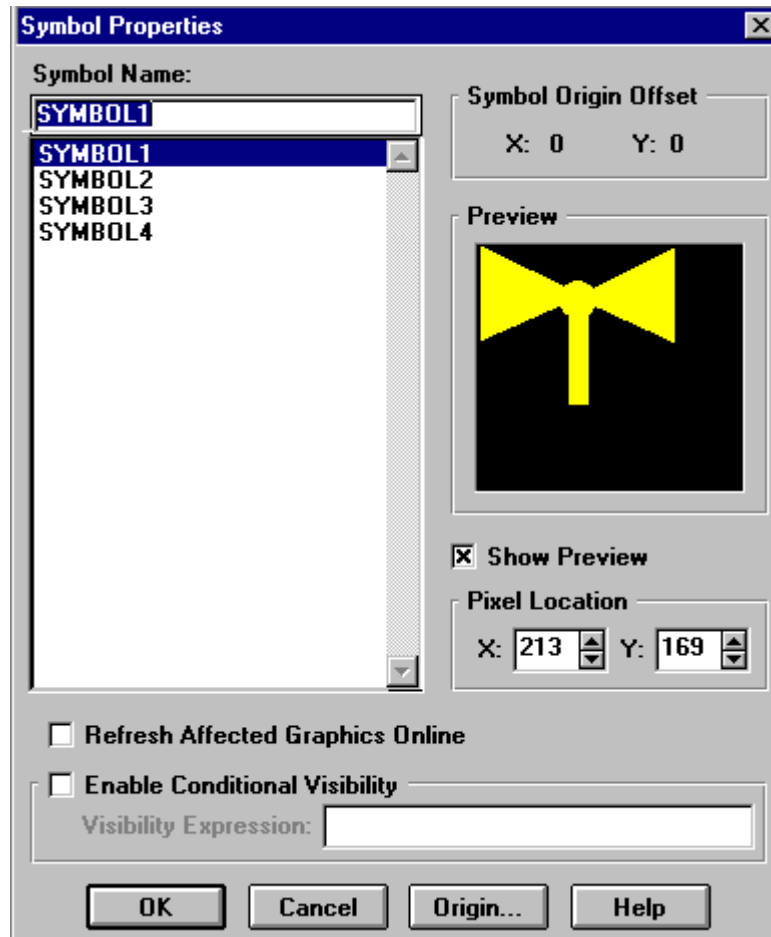
You may double click on a symbol on a configuration page to view the **Symbol Properties** dialog box. Refer to the **Symbol Properties** topic for more information.

The objects that make up a symbol cannot be edited. If you wish to change an object within a symbol, you must select the symbol on the configuration page and choose the Break Symbol selection under the Object Menu to break the symbol into the original separate objects. The objects may be edited and then you may choose the Make Symbol selection from the Object Menu again.



## Symbol Properties

When you double click on a symbol on a configuration page, the **Symbol Properties** dialog box will appear.



The **Symbol Properties** dialog box allows you to change the pixel location and the X-Y offset of the symbol and preview the selected symbol.

The fields in the **Symbol Properties** dialog box are described below.

**Symbol Name:** Displays the name of the symbol you selected. Note that you may scroll through the symbol name list and preview each symbol if the Show Preview box is selected.

**Symbol Origin Offset:** Displays the symbol's origin offset (in pixels). The default Symbol Origin Offset for X and Y is 0 and 0 (no offset). The blinking crosshair in the bounding box represents the origin location. All of the objects that make up a symbol are drawn using an offset from the origin.

**X:** Displays the X origin offset in pixels.

**Y:** Displays the Y origin offset in pixels.

**Preview:** Displays the selected symbol in the Preview box if the Show Preview box is selected.

**Show Preview:** Allows the selected symbol to be shown in the Preview box.

**Pixel Location:** Allows you to change the pixel location for the selected symbol.

**X:** Allows you to move the symbol to the left or right on the configuration page. The value entered in the X field determines the distance in pixels from the left edge of the page.

**Y:** Allows you to move the symbol up and down on the configuration page. The value entered in the Y field determines the distance in pixels from the top of the page.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the symbol to be refreshed to properly reflect the layering of objects on the page whenever the symbol is updated.

**Enable Conditional Visibility:** Allows you to determine if the symbol will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the symbol will always appear on the page.

Note that a symbol that is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the symbol is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

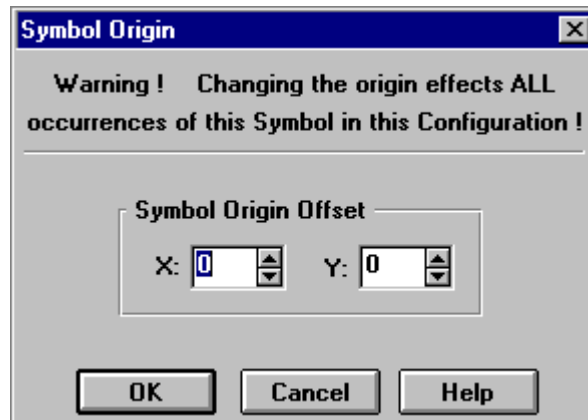
It is also important to note that if you attempt to layer more than two symbols and use the Enable Conditional Visibility feature to display different states of a symbol on a PanelMate Power Series 1500 unit, the PanelMate unit's performance may be sluggish. If this occurs, the Dynamic Graphics option should be installed and Variable-Sized Graphic objects should be used to display the different symbol states.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the symbol will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the symbol will appear and all template updating will be activated when in Run Mode.

**<Origin>:** Opens the **Symbol Origin** dialog box. This button allows you to change the selected symbol's Origin Offset.

## Symbol Origin

When you press the **Origin** button on the **Symbol Properties** dialog box, the **Symbol Origin** dialog box will appear.



The **Symbol Origin** dialog box allows you to change the offset of the selected symbol's origin.

**⚠ CAUTION:** Changing the origin affects ALL occurrences of this symbol in this configuration!

The fields in the **Symbol Origin** dialog box are described below.

**Symbol Origin Offset:** Allows you to change the offset of the symbol's origin. Note that if you modify the offset, you will be modifying the offset of the actual symbol in the Symbol Library that may be used on several pages throughout the configuration. If you increase the X and Y offsets, the objects in the symbol will move left and down respectively. If you decrease the X and Y offsets, the objects in the symbol will move right and up respectively. The blinking crosshair will remain at a constant position that is the origin location.

The values in the X and Y offsets are added to the original offset of each object from the upper-left corner of the bounding box. If an object in the symbol was originally 20 pixels in X from the blinking crosshair and you modified the X origin offset to be 10, the object would be drawn 30 pixels ( $20 + 10 = 30$ ) from the blinking crosshair. Likewise, if you modified the X origin offset to be -10, the object would be drawn 10 pixels ( $20 + (-10) = 10$ ) from the blinking crosshair.

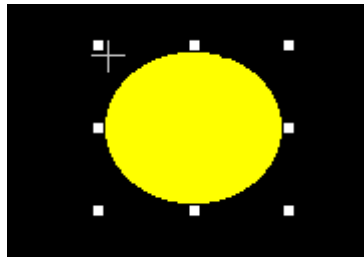
**X:** Allows you to offset the symbol to the left or right.

**Y:** Allows you to offset the symbol up or down.

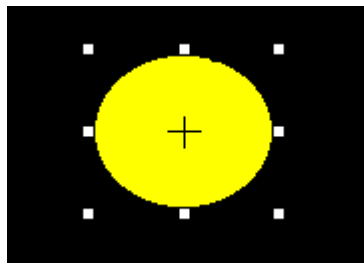
For more information on the Symbol Origin Offset, refer to the **Symbol Origin Offset Example**.

**Symbol Origin Offset Example**

A circle has been created with a height of 100 pixels and a width of 100 pixels and made into a symbol. The blinking crosshair that represents the origin appears in the upper-left corner. The X and Y origin offset is 0 and 0. Refer to the figure below.

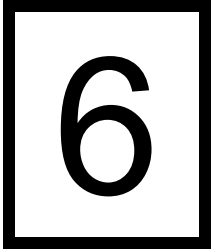


To offset the symbol so the origin appears in the center of the circle, change the X and Y origin offset to -50 and -50. Refer to the figure below.



Now when symbol is used, the location you click on the configuration page will be at the center of the circle instead of the upper-left corner.

# System Parameters



*In this chapter, you will learn:*

- *About the System Parameters - General Tab dialog box*
- *About the System Parameters - Password Tab dialog box*
- *About the System Parameters - Communications Tab dialog box*
- *About the System Parameters - Remote Tab dialog box*

## System Parameters

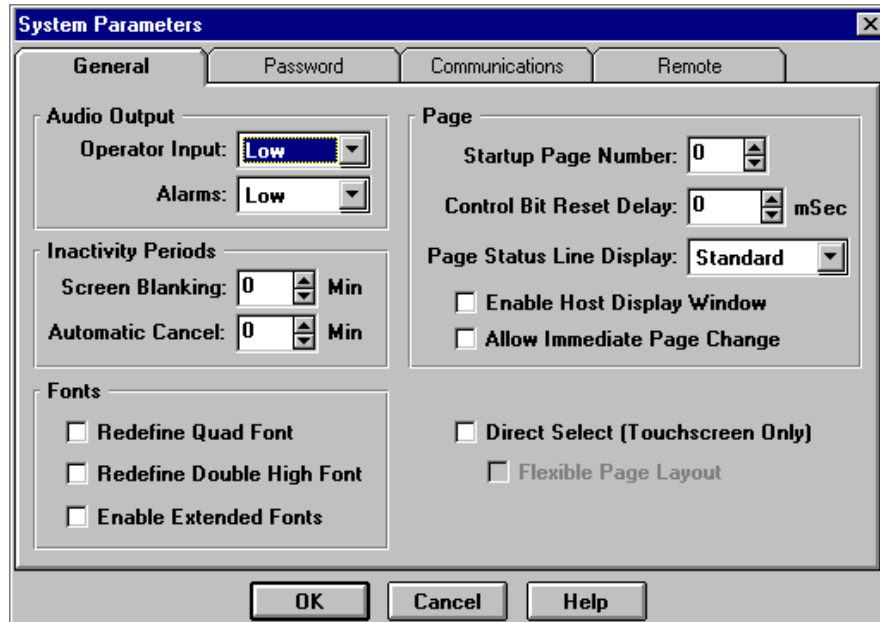
When you double click on the System Parameters selection in the Database Treeview Window, the **System Parameters** dialog box will appear.

System Parameters are a set of four tabbed dialog boxes used to edit system parameters. The System Parameters are used by the PanelMate unit while it is in Run Mode. The dialog boxes are listed below.

- System Parameters - General Tab
- System Parameters - Password Tab
- System Parameters - Communications Tab
- System Parameters - Remote Tab

## System Parameters – General Tab

The System Parameters - General Tab dialog box is shown below.



The fields in the System Parameters - General Tab dialog box are described below.

### Audio Output

**Operator Input:** Sets the volume of the audio tones used as feedback for operator inputs.

**Alarms:** Sets the volume of alarm annunciation.

### Inactivity Periods

**Screen Blanking:** Determines the time the PanelMate unit waits, without operator input, before blanking the screen. This function helps prolong the life of the monitor.

To prevent “screen burn”, the PanelMate unit waits the indicated number of minutes. If there is no operator input during this time, the PanelMate unit displays a screensaver that shows PanelMate units randomly appearing.

Any operator input resets the Screen Blanking timer and recalls the previously displayed page. The page is also recalled automatically if any template or variable-sized template goes into alarm or if an automatic page change occurs.

**Tip:** If you are creating a PanelMate PC configuration, it is recommended that you use the Screen Blanking feature instead of the Windows screen saver.

**Automatic Cancel:** Determines the time the PanelMate unit waits, without operator input, before de-selecting a template. This function helps prevent accidental usage of the control buttons if you leave a template or variable-sized template selected after use.

Any operator input resets the Automatic Cancel timer.

Note that the Automatic Cancel time-out also resets the Screen Blanking timer.

## Fonts

**Redefine Quad Font:** Allows you to re-define the Quad Font. When the Redefine Quad Font box is selected, custom characters can be created in the Font Editor. Refer to the **Font Editor** topic for more information.

**Redefine Double-High Font:** Allows you to re-define the Double-High font. When the Redefine Double-High Font box is selected, custom characters can be created in the Font Editor. Refer to the **Font Editor** topic for more information.

**Enable Extended Fonts:** Allows you to extend the character set from 128 characters to 256 characters. The extended characters can be customized. Refer to table in the Selected Font section in the **Font Editor** topic for more information.

## Page

**Startup Page Number:** Allows you to enter the page number of the page to be displayed first when the PanelMate unit enters the Run Mode.

**Control Bit Reset Delay:** Sets the delay between the bit-set and bit-clear commands sent to a PLC from the control buttons. Since control buttons can be pressed (causing bit-set) and released (causing bit-clear) very quickly, some PLC programs need time to sense the bit-set command before receiving a bit-clear command.

**Page Status Line Display:** Determines how the Page Status Line is displayed during Run Mode. The Page Status Line will display only the pages in alarm in a first-in-first-out (FIFO) format.

Tip: If you are creating a V2.1X configuration for a PanelMate unit with 10 pages (numbered 0-9), the Standard selection can be selected if you wish to display all page numbers. The intensity or color of each number will indicate the status of that page.

**Enable Host Display Window:** Allows you to enable an extra page that can receive and display data from a host computer. The Host Display Window uses the entire 3x5 template display area. Data is sent from the host computer via the Generic Protocol.

Refer to the Generic Protocol Driver Manual for more information about the Host Display Window.

Note that if you are creating a PanelMate PC configuration, do not enable the Host Display Window.

**Allow Immediate Page Change:** Determines if a PLC can change the displayed page (through the Page Change Register field) while the PanelMate unit has a template or variable-sized template selected.

If the Allow Immediate Page Change field is selected, the page change can occur even if the operator is in the process of entering information.

If the operator is pressing a control button at the time a page change from the PLC occurs, the CANCEL key will need to be pressed to initiate the page change.

If the Allow Immediate Page Change field is not selected, the page change will not occur until all templates and variable-sized templates are de-selected (such as when the CANCEL key has been pressed).



**Direct Select (Touchscreen Only):** Allows one-touch selection on touchscreen units for variable-sized templates. For example, instead of having to step through multiple objects to get to a variable-sized template, you can touch the object to immediately select it.

The Direct Select feature also enables one-touch operation for the Variable-Sized Control Buttons. For more information about Variable-Sized Control Buttons, refer to the **Variable-Sized Control Button Template** topic.

Note that The Direct Select (Touchscreen Only) feature is intended for use on PanelMate touchscreen units and PanelMate PC units only.

**Flexible Page Layout:** Allows you to use the entire 640 x 464 pixel page for templates and PowerGraphics. When the Flexible Page Layout box is selected, you can determine which flexible items will not appear on the page by de-selecting the Page Status Banner box, Alarm Table box, Cancel Key box, or Default Buttons box in the **New Configuration Page** dialog box or the **Page Properties** dialog box. Refer to the **New Configuration Page** or **Page Properties** topic for more information.

Note that if a flexible item appears on top of a template or graphic on your configuration page, the underlying template or graphic will be deleted when the configuration is exported.

## System Parameters – Password Tab

The System Parameters - Password Tab dialog box is shown below.

The fields in the System Parameters - Password Tab dialog box are described below.

### Passwords

**Password A:** Allows you to enter a numeric password between 0 and 65535. Passwords can be used to limit operator access to pages, offline mode, date/time change, and numeric entry from templates.

The default Password A sent with the demonstration screens is 1.

Note that passwords above 65535 or passwords with leading zeroes are not supported in Run Mode.

**Overwrite Password A:** Determines whether Password A already set in the PanelMate online unit will be overwritten when a new configuration is downloaded. You may want the operator to learn a pair of passwords that will not change with every new configuration.

If the Overwrite Password A box is not selected, new passwords will be ignored when a new configuration is downloaded.

If the Overwrite Password A box is selected, the passwords saved in the new configuration become active when the configuration is downloaded.

**Allow Password A Change:** Determines whether Password A can be changed during Run Mode.

If the Allow Password A Change box is not selected, the password cannot be changed. Note that the Change Password A template will not appear on the Setup Page in Run Mode.

If the Allow Password A Change box is selected, the password can be changed by an operator having the password. To change the password in Run Mode, select the Change Password A Template on the Setup Page.

**Password B:** Allows you to enter a numeric password between 0 and 65535. Passwords can be used to limit operator access to pages, offline mode, date/time change, and numeric entry from templates.

The default Password B sent with the demonstration screens is 2.

Note that passwords above 65535 or passwords with leading zeroes are not supported in Run Mode.

**Overwrite Password B:** Determines whether password B already set in the PanelMate online unit will be overwritten when a new configuration is downloaded. You may want the operator to learn a pair of passwords that will not change with every new configuration.

If the Overwrite Password B box is not selected, new passwords will be ignored when a new configuration is downloaded.

If the Overwrite Password B box is selected, the passwords saved in the new configuration become active when the configuration is downloaded.

**Allow Password B Change:** Determines whether Password B can be changed during Run Mode.

If the Allow Password B Change box is not selected, the password cannot be changed. Note that the Change Password B Template will not appear on the Setup Page in Run Mode.

If the Allows Password B Change box is selected, the password can be changed by an operator having the password. To change the password in Run Mode, select the Change Password B Template on the Setup Page.

### Password Protection

**Entry into Offline Mode:** Allows you to select a type of protection for entering into the Offline Mode. The selections are listed below:

- None
- Keypress Only
- Keypress and Password A
- Keypress and Password B
- Keypress and Password A or B
- Password A Only
- Password B Only
- Password A or B

The page will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the Password A and Password B fields.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

**Set Date/Time:** Allows you to select a type of protection for setting the date and time. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

The page will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

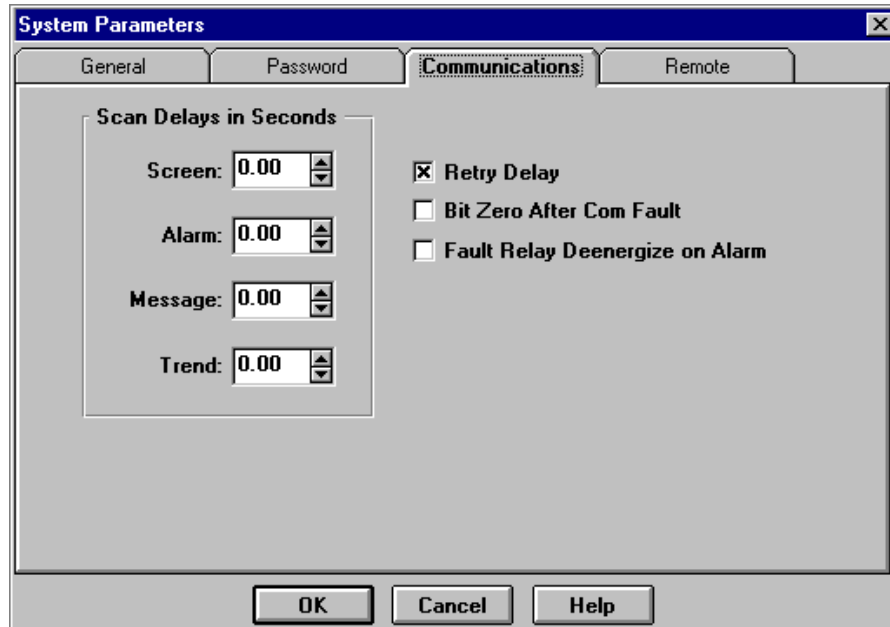
Password A and Password B are defined in the Password A and Password B fields.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

**Page Password Timeout:** Allows the password to be valid for a defined number of minutes before timing out. Note that a value of 0 (zero) indicates that there is no timeout period.

## System Parameters – Communications Tab

The System Parameters - Communications Tab dialog box is shown below.



The fields in the System Parameters - Communications Tab dialog box are described below.

### Scan Delay In Seconds

Scan delay is the amount of time the PanelMate unit will wait upon receiving data from the PLC before the it requests another update from the PLC.

Note that a value of 0 (zero) causes the PanelMate unit to continually scan. The maximum value is 99.99 seconds. For best performance, set the delay to the longest interval your application will permit. A minimum of 1.0 seconds is recommended.

**Screen:** Sets the scan delay for page updates while in Run Mode. A value of 0 causes the PanelMate unit to update a page as fast as possible. The maximum value is 99.99 seconds.

**Alarm:** Sets the scan delay for updates of all alarms while in Run Mode. A value of 0 causes the PanelMate unit to update background alarms as fast as possible. The maximum value is 99.99 seconds.

All PLC references in the System Parameters dialog box will be polled as part of the Alarm Scan.

**Message:** Sets the scan delay for updates from all register references (defined in messages) while in Run Mode. A value of 0 causes the PanelMate unit to update the register values as fast as possible. The maximum value is 99.99 seconds.

**Trend:** Sets the scan delay for updates from the PLC of all register references for Bar Trend Templates and Line Trend Templates while in Run Mode. A value of 0 causes the PanelMate unit to update the register values as fast as possible. The maximum value is 99.99 seconds.

Note that the interval evaluated in the Interval Expression field in the **Bar Trend Template - Bar Trend Attributes Tab** dialog box or the **Line Trend Template - Line Trend Attributes Tab** dialog box should be as long, if not longer, than the Trend Scan Delay.

For information about calculating the trend value sample rate, refer to Interval Expression field in the **Bar Trend Template - Bar Trend Attributes Tab** dialog box or the **Line Trend Template - Line Trend Attributes Tab** dialog box.

**Retry Delay:** Determines if there will be a delay between communication attempts when there is lost communications. When the Retry Delay box is selected, the PanelMate unit will increase the time interval of attempts to re-establish communications as the length of time that the PanelMate unit and the PLC are not communicating increases. If this feature is enable, it will prevent several PLCs on a network from becoming busy unnecessarily if communications have not taken place over a long period of time. When the Retry Delay box is not selected, the PanelMate unit will immediately and continuously attempt to re-establish communications. If this feature is not enabled, it will prevent any delays that may occur after successfully sending data to the PLC.

**Bit Zero After Comm Fault:** Provides the capability to reset (i.e., write zeroes to) all PLC bits configured in the PLC Bit Reference fields for each control button. Note that any bit writes in Variable-Sized Control Buttons configured as Normally Closed, Momentary will have a 1 written to PLC bits instead of a 0 when a reset operation occurs. The PLC bits will reset when a PLC communication error has been cleared (i.e., communication with the PLC has been re-established) and the **Enable Fault Relay** control button is pressed.

The Bit Zero After Comm Fault field also controls whether the PLC control bits are reset on power-up of the PanelMate unit. If the Bit Zero After Comm Fault box is selected, the automatic reset of all PLC bits will be enabled at both power-up and after a communications fault reset. If the Bit Zero After Comm Fault box is not selected, the automatic reset of PLC bits will be disabled at both power-up and after a communications fault reset.

Note: **If the Bit Zero After Comm Fault box is selected, the Fault Relay De-energize On Alarm box must be de-selected.**

If the fault relay is enabled via the Remote Enable Fault Relay Bit (from the PLC) field, the Bit Zero After Comm Fault field is disabled. The Bit Zeros After Com Fault field is only applicable when the **Enable Fault Relay** control button is pressed.

Refer to Appendix B, Momentary Pushbutton Operation, in the PanelMate Power Series Online Operation User's Guide for more information on momentary pushbutton precautions.


**Fault Relay De-energize On Alarm:** Allows you to control what happens to the PanelMate unit's fault relay when a alarm occurs. If the Fault Relay De-energize on Alarm box is selected, the fault relay will be de-energized when a communication error or system error occurs, when power is lost, when an alarm condition is detected, or when the PanelMate unit is put into offline mode. If the Fault Relay De-energize on Alarm box is not selected, the fault relay will only de-energize when a communication error or system error occurs, when power is lost, or when the PanelMate unit is put into offline mode.

If the Fault Relay De-energize On Alarm box is selected, the Bit Zero After Com Fault box must be disabled.

## System Parameters – Remote Tab

The System Parameters - Remote Tab dialog box is shown below.

The fields in the System Parameters - Remote Tab dialog box are described below.

Note: Bit references are used in the System Parameters – Remote Tab dialog box fields. If you have an associated .csv file for tags and have tags assigned for these references, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to Chapter 12: Using Tags.

### Remote Alarm Acknowledge Bit

Only bit references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

**To PLC:** Allows you to set a bit in the PLC when the **Acknowledge All Alarms** control button is pressed during Run Mode.

**From PLC:** Allows you to scan a bit in the PLC and acknowledge all current alarms when the bit is set.

### Remote Silence Alarm Horn Bit

Only bit references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

**To PLC:** Allows you to set a bit in the PLC when the **Silence Alarm Horn** button is pressed during Run Mode.

**From PLC:** Allows you to scan a bit in the PLC and silence the alarm horn when the bit is set.

### Remote Enable Fault Relay Bit

Only bit references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

**To PLC:** Allows you to set a bit in the PLC when the **Enable Fault Relay** control button is pressed during Run Mode.

**From PLC:** Allows you to scan a bit in the PLC and enable the fault relay when the bit is set.

### Page Change Register

For information on changing pages by pressing a control button, refer to the **Page Change with Delay Example** topic.

Only register references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

**To PLC:** Allows you to write the page number of the currently displayed page to a register in the PLC during Run Mode. Note that there are two unique page numbers. The Alarm Page number is 10000 and the Setup Page number is 10001. All other pages will use the page number defined in the **New Configuration Page** dialog box or the **Page Properties** dialog box.

**From PLC:** Allows you to scan a register in a PLC and change to the page number matching the register value. When a new valid page number is detected in the Page Change Register, the title bar will blink. The page does not change immediately if the operator has selected a control template, but waits until the control template is de-selected. This requirement can be changed if the Allow Immediate Page Change box is selected in the **Systems Parameters - General Tab** dialog box.

If the Page Change Register receives a valid page number that is the same as the number in the register, it will not change pages.

If the Page Change Register receives an invalid number, it will remain on the current page.

If the operator is pressing a control button at the time a page change from the PLC occurs, the **CANCEL** key will need to be pressed to initiate the page change.

Note that the Page Change Register will override Page Password Protection. If necessary, use Remote Sending of Passwords and PLC ladder logic to implement a protection scheme.

### Remote Sending Of Passwords

Only bit references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

**Password A:** Allows you to set a bit in the PLC when the operator enters valid passwords during Run Mode. The bit is set when the password is logged-in on the Setup Page during Run Mode.

**Password B:** Allows you to set a bit in the PLC when the operator enters valid passwords during Run Mode. The bit is set when the password is logged-in on the Setup Page during Run Mode.

**Hardware Selection:** Allows you to set a bit in the PLC when an external keyswitch is turned on during Run Mode. The bit is set when the hardware contact is closed and the keyswitch is closed (on).



**Reset Clock To 00:00:00 Bit:** Allows you to scan a bit in the PLC and reset the PanelMate unit's system clock when the bit is set. (The clock will reset each time you change to a page that has the reset clock bit set to 1.)

Note that only bit references are allowed in these boxes. Expressions may not be entered. If these boxes are left blank, the features will be disabled.

The date is changed to the day closest to the current time. The following examples show how the date is affected by the clock synchronization bit.

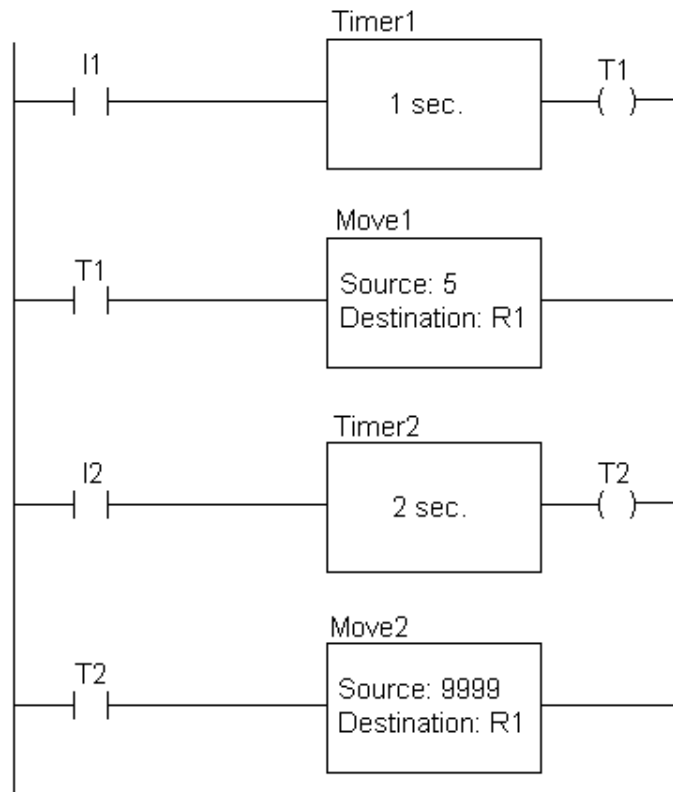
Time/Date Before Reset	Time/Date After Reset
23:30:10 December 10, 1997	00:00:00 December 11, 1997
00:30:10 December 13, 1997	00:00:00 December 13, 1997
12:00:00 December 24, 1997	00:00:00 December 25, 1997
11:59:59 December 27, 1997	00:00:00 December 27, 1997

**Remote Mode Change:** Allows the PanelMate unit to accept remote mode changes from Run Mode to Transfer Mode (or vice-versa) from a personal computer over a network. It also determines the manner in which the remote mode change will occur. The selections are listed below.

NEVER	A remote mode change is not allowed.
<small>IMMEDIATE</small>	The remote mode change will occur instantly.
DEFAULT	The remote mode change will occur when the PanelMate unit is in a default state (no templates or symbols are selected on screen).
ACCEPT	<small>An operator must accept the remote mode change at the online unit.</small>

### Page Change with Delay Example

The ladder program below shows a page change with a time delay.



This ladder program will allow the operator to change pages by pressing a control button on the PanelMate unit. The second move ensures that there will be a change in the register next time I1 is pressed.

Note that the timers can be adjusted to lengthen or shorten the time delay.

# PLC Name and Port Table



*In this chapter, you will learn:*

- *About the PLC Name and Port Table dialog box*
- *About the Port Settings dialog box*
- *About the Unsolicited Device dialog box*
- *About the Generic Protocol dialog box*
- *About the AB DH-485 Maximum Node Address dialog box*
- *About the Allen-Bradley Remote I/O Setup dialog box*
- *About the GE Fanuc Genius I/O dialog box*
- *About the Reliance DCSNet Interface Drop dialog box*
- *About the DeviceNet Setup dialog box*
- *About the Tag Name File dialog box*
- *About OPC Client Connectivity*
- *About DDE Client and Server Communications*

## PLC Name and Port Table

When you double click on the PLC Name and Port Table selection in the Database Treeview Window, the **PLC Name and Port Table** dialog box will appear.

The **PLC Name and Port Table** dialog box allows you to set communication port parameters, PLC device names, and ID numbers.

The fields in the **PLC Name and Port Table** dialog box are described below.

### Port Parameters

**Port/Device Use/Local ID:** Displays the configurable ports installed on your PanelMate unit, the device assigned to the port, and the local ID.

If a PanelMate PC configuration has a serial communications driver assigned to a serial port which is not available within Windows NT, an error message will appear when you run the configuration. To troubleshoot the possible conflicts, check the Ports configuration and Devices configuration in the Control Panel or check the Windows NT Diagnostics in the Administrative Tools (Common).

**Device Use:** Displays the device assigned to the port. You can select various PLC drivers, Serial Printer, or No Usage from the Device Use box. The selection chosen in the Device Use box will appear in the Port/Device Use/Local ID box. Different device drivers will appear in the list for the Device Use box depending on the port you have selected in the Port/Device Use/Local ID box. Note that only device drivers that have been installed from the driver disks will appear.

**Local ID:** Assigns a number to the PanelMate unit on a PLC network. See the appropriate Communication Driver Manual for PLC-dependent local ID# information.

Do not use the same number for the Local ID and the remote ID.

**<Port Settings>:** Displays the **Port Settings** dialog box. The **Port Settings** dialog box is used to select the communication parameters for the selected port. Refer to the **Port Settings** topic for more information.

**<Unsolicited Device>:** Displays the **Unsolicited Device** dialog box. The **Unsolicited Device** dialog box is used to assign a name and a model to an unsolicited device on the I/O port that is the only port that accepts unsolicited messages for communication. Refer to the **Unsolicited Device** topic for more information.

**<Generic>:** Displays the **Generic Protocol** dialog box. The **Generic** button appears when you select Generic Protocol in the Device Use box. Refer to the **Generic Protocol** topic for more information.

**<DH-485>:** Displays the **AB DH-485 Maximum Node Address** dialog box. The **DH-485** button appears when you select DH-485 in the Device Use box. Refer to the **AB DH-485 Maximum Node Address** topic for more information.

**<Remote I/O>:** Displays the **Allen-Bradley Remote I/O Setup** dialog box. The **Remote I/O** button appears when you select Allen-Bradley Remote I/O in the Device Use box. Refer to the **Allen-Bradley Remote I/O Setup** topic for more information.

**<Genius I/O>:** Displays the **Genius I/O** dialog box. The **Genius I/O** button only appears when you select Genius I/O in the Device Use box. Refer to the **GE Fanuc Genius I/O** dialog box topic for more information.

**<DCSNet>:** Displays the **Reliance DCSNet Interface Drop** dialog box. The **DCSNet** button appears when you select Reliance DCSNet in the Device Use box. Refer to the **Reliance DCSNet Interface Drop** topic for more information.

**<DeviceNet>:** Displays the **DeviceNet Setup** dialog box. The **DeviceNet** button appears when you select DeviceNet in the Device Use box. Refer to the **DeviceNet Setup** topic for more information.

## PLC Name Parameters

**Item/Name/Port/Model/Remote ID:** Displays the item number, PLC name, port number, model, and remote ID. If you choose the **<New Entry>** selection, you can configure a new PLC using default values for the Name, Port, Model, and Remote ID fields.

If you select **<New Entry>**, the **Copy**, **Paste**, and **Delete** buttons will be disabled.

**Name:** Allows you to enter names for each PLC to be addressed. This name is used by the PanelMate unit and does not make reference to the PLC directly. This name should be used when specifying word and bit addresses during page development

**Port:** Allows you to define which ports will be used to communicate to each PLC. If a port has been configured as No Usage or Serial Printer, the port number will not appear in the Port field.

**Model:** Allows you to choose from a list of model types for each device. You should choose the model most closely related to the device being used.

**Remote ID:** Allows you to define the ID or node of each device.

<**Add**>: Allows you to add a new entry to the Item/Name/Port/Model/Remote ID box. If you select a port in the Port field, select a model in the Model field, and configure the Name and Remote ID fields, you can click the **Add** button to add a new entry to the Item/Name/Port/Model/Remote ID box.

<**Change**>: Allows you to change a selected entry in the Item/Name/Port/Model/Remote ID box. If you select an entry in the Item/Name/Port/Model/Remote ID box and make a change to the Name, Port, Model, and Remote ID fields, you can click the **Change** button to change an entry in the Item/Name/Port/Model/Remote ID box.

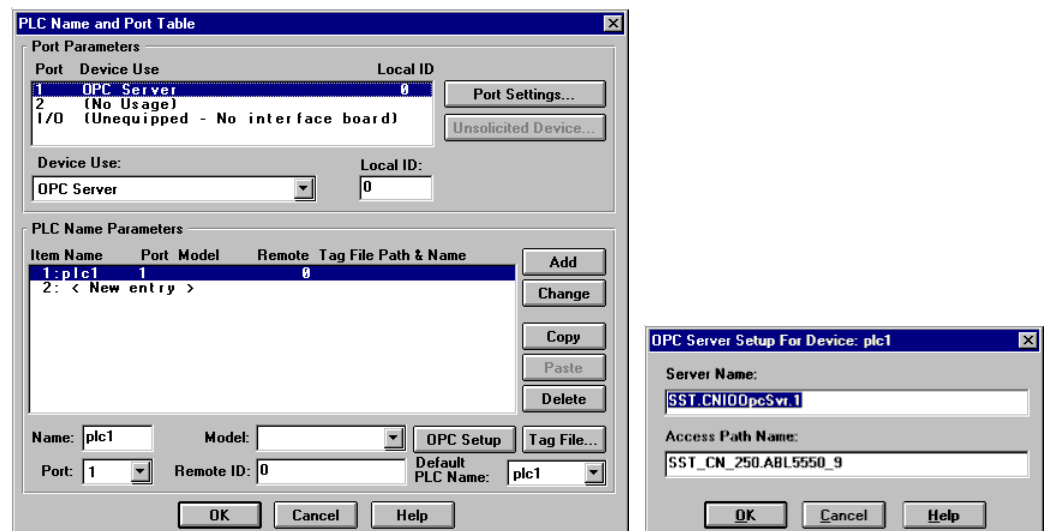
<**Copy**>: Allows you to copy a selected entry in the Item/Name/Port/Model/Remote ID box. If you select an entry in the Item/Name/Port/Model/Remote ID box and you can click the **Copy** button to copy an entry. After copying, you can use the **Paste** button to paste a copy of the entry elsewhere in the Item/Name/Port/Model/Remote ID box.

<**Delete**>: Allows you to remove an entry from the Item/Name/Port/Model/Remote ID box. If you select an entry in the Item/Name/Port/Model/Remote ID box and click the **Delete** button, the entry will be removed.

<**Paste**>: Allows you to paste an entry after copying an entry from the Item/Name/Port/Model/Remote ID box. If you select an entry in the Item/Name/Port/Model/Remote ID box and click the **Paste** button, the entry will be pasted after the entry you selected.

<**Tag File...**>: Displays the **Tag Name File** dialog box. The **Tag File...** button appears when you select any PLC in the Item/Name/Port/Model Remote ID box. Refer to the **Tag Name File** topic and **Chapter 12: Using Tags** for more information.

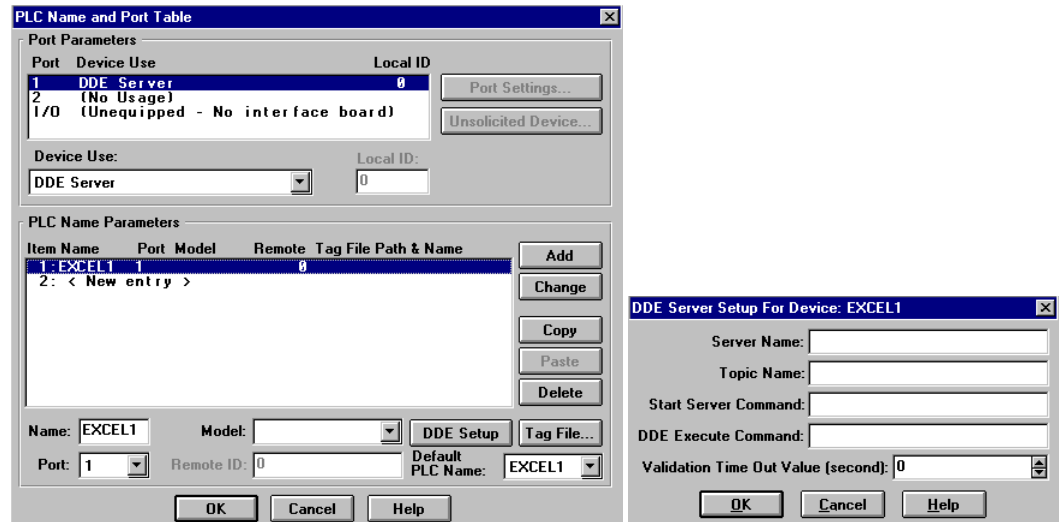
<**OPC Setup**>: This button only appears when OPC Server is selected in the **Device Use** field, and a device name is selected in the **PLC Name Parameters** that is assigned to the OPC Server. It is used to define the server name and the access path name. When selected, the **OPC Server Setup for Device** dialog box will appear.



**NOTE:** The format for determining an access path is server-dependent.

The OPC Server option is only available for PanelMate PC Pro configurations. For more information, refer to OPC Client Connectivity

**<DDE Setup>**: This button only appears when DDE Server is selected in the **Device Use** field, and a device name is selected in the **PLC Name Parameters** that is assigned to the DDE Server. When selected, the **DDE Server Setup for Device** dialog box will appear.



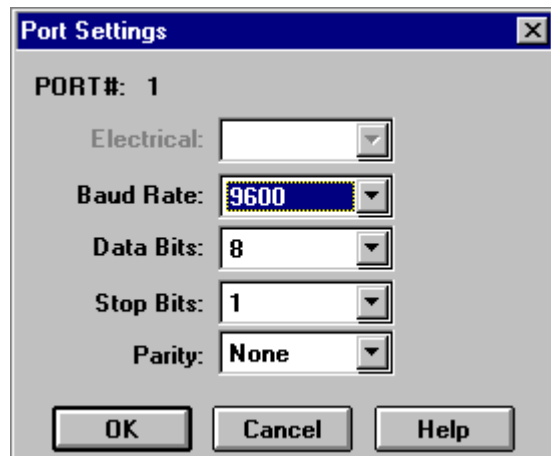
The DDE Server option is only available for PanelMate PC Pro configurations. For more information, refer to DDE Client and Server Communications and your DDE Communications Manual.

**<Default PLC Name>**: Allows you to enter one of the PLC names or Unsolicited Device names. Any word or bit address used in the configuration that does not specifically state the name of a PLC will be assumed to be referring to the default PLC. It is to your advantage to use the name of the PLC most often referenced.

If you delete or change the selected default name, the first name in the Item/Name/Port/Model/Remote ID box will automatically become the Default PLC Name.

## Port Settings

When the **Port Settings** button is clicked on the **PLC Name and Port Table** dialog box, the **Port Settings** dialog box will appear.



The **Port Settings** dialog box is used to select the communication parameters for the selected port.

Note that depending upon the device selected in the Device Use box, some communication parameters may be disabled. If one of the choices is disabled, refer to the appropriate Communication Driver Manual for the settings.

The fields in the **Port Settings** dialog box are described below.

**PORT#:** Displays the port selected in the Port/Device Use/Local ID box in the **PLC Name and Port Table** dialog box.

**Electrical:** Allows you to set the type of electrical communication for the port. You have three choices: RS232, RS422, and 485.

**Baud Rate:** Allows you to set the data transfer speed used in communications.

**Data Bits:** Allows you to set the number of data bits used in communication. You can select 5, 6, 7, and 8 data bits.

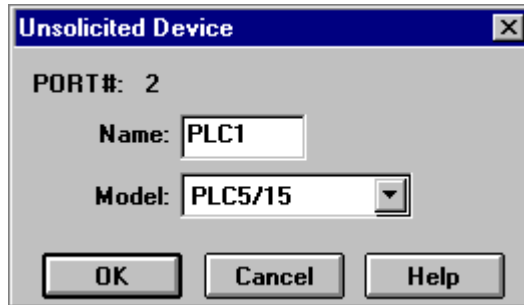
**Stop Bits:** Allows you to set the number of stop bits used in communications. You can select 1, 1.5, or 2 stop bits.

**Parity:** Allows you to set the parity type used in communication. You can select None, Odd, or Even.



## Unsolicited Device

When the **Unsolicited Device** button is clicked on the **PLC Name and Port Table** dialog box, the **Unsolicited Device** dialog box will appear.



The **Unsolicited Device** dialog box is used to assign a name and model to an unsolicited device.

The fields in the **Unsolicited Device** dialog box are described below.

**PORT#:** Displays the port selected in the Port/Device Use/Local ID box in the **PLC Name and Port Table** dialog box.

**Name:** Allows you to define names for each PLC to be addressed. You use this name when specifying word and bit addresses that will display unsolicited data only. References specified with an Unsolicited Device Name will not be polled by the PanelMate unit and will only be updated by an unsolicited write from the PLC.

Note that unsolicited references are initialized as zeroes.

**Model:** Allows you to define the model type of each PLC that supports unsolicited writes.

The PLC model type in the MSG instruction, configured in the PLC ladder logic, must match the PLC type in the Unsolicited Model field.

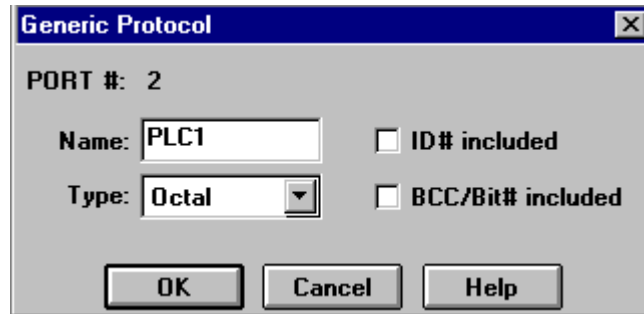
For more information about unsolicited data, refer to the Allen-Bradley Communication Driver Manual or the Modicon Communication Driver Manual.

## Generic Protocol

To configure the **Generic Protocol** dialog box, the following steps must be completed.

1. A port must be selected and Generic must be selected in the Device Use field in the **PLC Name and Port Table** dialog box.
2. Click the Generic button and the Generic Protocol dialog box will appear.

The **Generic Protocol** dialog box is shown below.



The **Generic Protocol** dialog box is used to configure serial ports that use the Generic Protocol for communication.

The fields in the **Generic Protocol** dialog box are described below.

**PORT#:** Displays the port selected in the Port/Device Use/Local ID box in the **PLC Name and Port Table** dialog box.

**Name:** Allows you to define names for each device to be addressed. This name is used when specifying word and bit addresses during page development.

**Type:** Defines the addressing method (octal or decimal) to be used in the PanelMate unit.

**ID# included:** Specifies whether the ID number of the PanelMate unit will be used in the communication frames.

**BCC/Bit# included:** Specifies whether each Generic Protocol frame includes BCC/Bit# error checking for the frame.

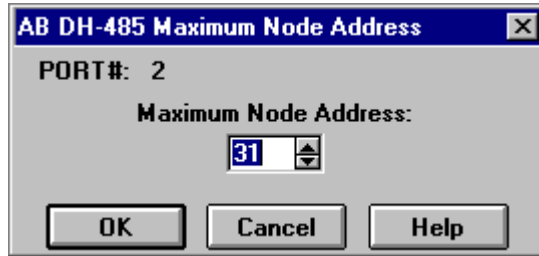
For more information about Generic Protocol, refer to the Generic Protocol Communication Driver Manual.

## AB DH-485 Maximum Node Address

To configure the **AB DH-485 Maximum Node Address** dialog box, the following steps must be completed.

1. The Allen-Bradley DH-485 box must be selected in the **New Configuration** dialog box or the **Configuration Properties** dialog box.
2. A port must be selected and Allen-Bradley Data Highway 485 must be selected in the Device Use field in the **PLC Name and Port Table** dialog box.
3. Click the **DH-485** button and the **AB DH-485 Maximum Node Address** dialog box will appear.

The **AB DH-485 Maximum Node Address** dialog box is shown below.



The **AB DH-485 Maximum Node Address** dialog box is used to select the maximum node address of the DH-485 network.

The fields in the **AB DH-485 Maximum Node Address** dialog box are described below.

**PORT#** Displays the I/O port which was selected in the Port/Device Use/Local ID box in the **PLC Name and Port Table** dialog box.

**Maximum Node Address:** Set the maximum node address. This parameter should be set as low as possible to minimize the amount of time used in soliciting data when initializing the link and minimizes the amount of unnecessary token passes.

The Maximum Node Address must match the maximum node address of all other devices on the DH-485.

For more information about Data Highway 485 communication, refer to the Allen-Bradley Communication Driver Manual.

## Allen-Bradley Remote I/O Setup

To configure the **Allen-Bradley Remote I/O Setup** dialog box, the following steps must be completed.

1. The I/O port must be selected and Allen-Bradley Remote I/O must be selected in the Device Use field in the **PLC Name and Port Table** dialog box.
2. Configure the Name, Port, Model, Remote ID, and Default PLC Name and click the **Add** button to place the information in the Item/Name/Port/Model/Remote ID box in the **PLC Name and Port Table** dialog box.
3. Note that the selection chosen in the Model field will determine the number of racks that will appear in the **Allen-Bradley Remote I/O Setup** dialog box. When configuring the I/O port for Allen-Bradley Remote I/O communication, select the PLC-3 model for PLCs with more than seven racks. PLC models (e.g., PLC 5/40, 5/60, 5/80, etc.) that have more than seven racks must use the PLC-3 model selection to address racks above seven.
4. Click the **Remote I/O** button and the **Allen-Bradley Remote I/O Setup** dialog box will appear.

The **Allen-Bradley Remote I/O Setup** dialog box is shown below.

PLC Model: PLC5/15

**Active Rack Table**

Rack	Quarter
1	
2	
3	

**Rack Size**

Qtr. 1: None  
 Qtr. 2: None  
 Qtr. 3: None  
 Qtr. 4: None

**Block Transfer Addressing**

Type: Octal

**Active Block Transfer Table**

Transfer	Direction	Rack	Group	Slot	Size
A	None	1	0	0	1
B	None	1	0	0	1
C	None	1	0	0	1
D	None	1	0	0	1
E	None	1	0	0	1
F	None	1	0	0	1
G	None	1	0	0	1
H	None	1	0	0	1
I	None	1	0	0	1
J	None	1	0	0	1
K	None	1	0	0	1

Direction: None  
 Rack: 1  
 Group: 0  
 Slot: 0  
 Size: 1

OK Cancel Help

The **Allen-Bradley Remote I/O Setup** dialog box is used to configure the PanelMate unit for remote I/O communication.

The fields in the **Allen-Bradley Remote I/O Setup** dialog box are described below.

**PLC Model:** Displays the PLC model selected in the **PLC Name and Port Table** dialog box.

**Active Rack:** Allows you to define which racks are to be simulated by the PanelMate unit on the network.

**Rack Size:** Selects the quarter racks. Each full rack can be split into a quarter rack or any multiple of a quarter racks (i.e.,  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , or full rack).

A blank entry shows the rack is inactive. A status of  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , or F shows the rack to be active and indicates the starting quarter for a fractional rack. A dash (-) indicates this rack is reserved.

See the **Active Rack Example**.

Note that when using a PLC 2/30, if the PanelMate unit is configured as active groups within a rack other than the highest group, then the PLC will not scan for any groups higher than those the PanelMate unit is simulating (physical groups or groups simulated on another AcceleratI/On board). To avoid this situation, make the PanelMate unit the highest active group within a rack and only configure one PanelMate unit active on any one rack.

**Block Transfer Addressing:** Allows you to define the word offset base in all monitored and active Block Transfers as OCTAL or DECIMAL. The default is octal.

The Block Transfer Addressing field only applies to the word offset. Bits within the words are addressed as octal (0-7 and 10-17).

**Active Block Transfer Table:** Allows you to configure active block transfers between the PanelMate unit and a PLC. You may define up to 16 active block transfers, A through P, each with up to 64 words.

**Direction:** This column defines the direction of the block transfer. The available selections are NONE, READ, WRITE, COMMON, and PASS-THROUGH.

NONE indicates that there will not be a transfer. Note that when NONE is selected the other boxes in this group are disabled.

READ allows the PLC to read a block of data from the PanelMate unit.

WRITE allows the PLC to write a block of data to the PanelMate unit.

COMMON allows the PLC to read data from and write data to the PanelMate unit.

PASS-THROUGH indicates that the block transfer is reserved for the pass-through feature. The PASS-THROUGH selection can only be configured for one block transfer.

All of the selections describe communication from the PLC's point of view.

**Rack:** Defines the rack being used by the block transfer. The available selections are determined by the Active Rack Table.

**Group:** Defines the group number within the quarter rack being used by the block transfer. The selections available are 0 through 7.

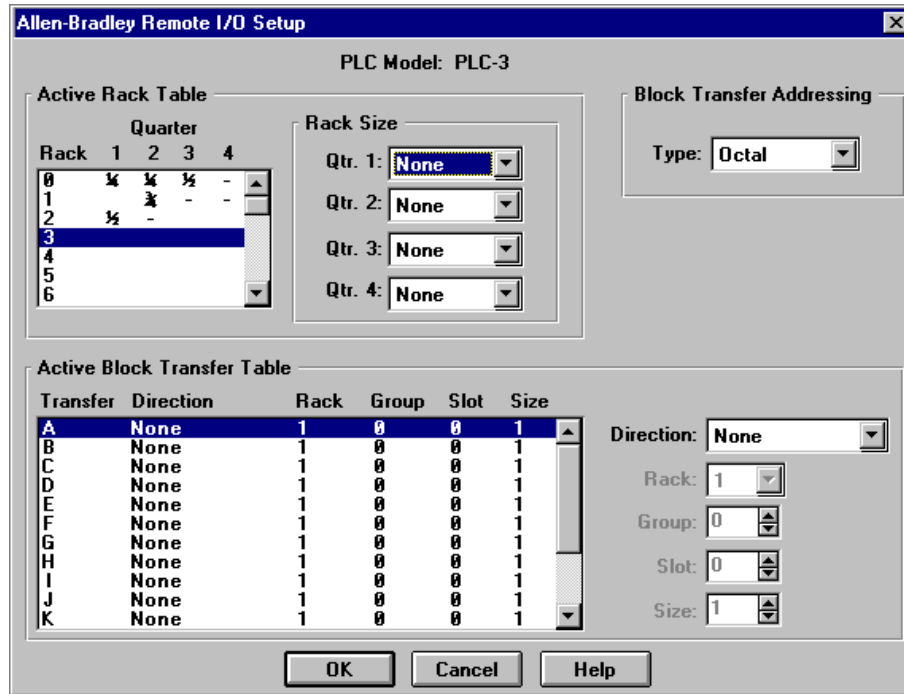
**Slot:** Defines the slot number within the group being used by the block transfer. The available selections are 0 and 1.

**Size:** Defines the size in 16-bit words of the block transfer. The available selections are decimal numbers from 1 to 64. If the Direction is selected as PASS-THROUGH, the size is fixed at 64.

For more information about Remote I/O, refer to the Allen-Bradley Communication Driver Manual.

### Active Rack Example

The example below shows a PanelMate unit simulating a full rack on rack 0, 3/4 of rack 1 beginning with quarter 2, and 1/2 of rack 2 beginning with quarter 1.

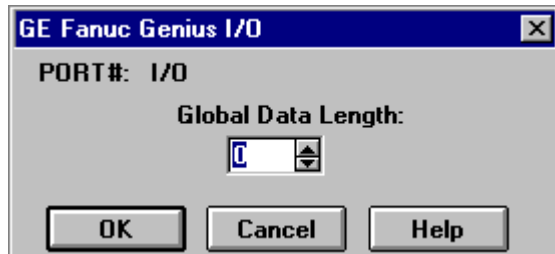


## GE Fanuc Genius I/O

To configure the **GE Fanuc Genius I/O** dialog box, the following steps must be completed.

1. The I/O port must be selected and Genius I/O must be selected in the Device Use field in the **PLC Name and Port Table** dialog box.
2. Click the Genius I/O button and the GE Fanuc Genius I/O dialog box will appear.

The **GE Fanuc Genius I/O** dialog box is shown below.



The fields in the **GE Fanuc Genius I/O** dialog box are described below.

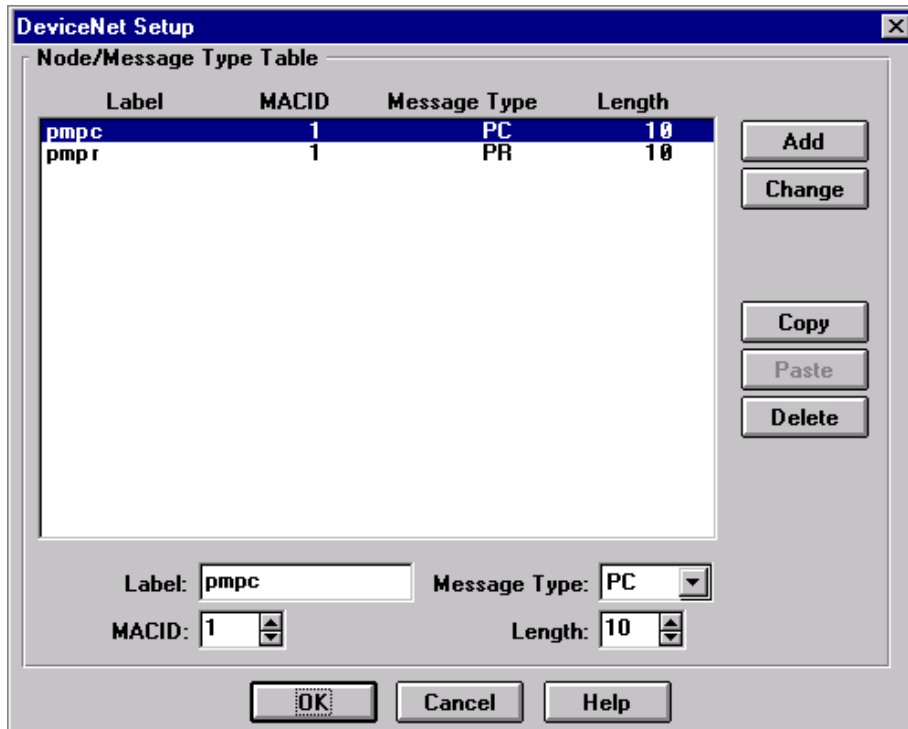
**Port#:** Displays the I/O port that was selected in the **PLC Name and Port Table** dialog box.

**Global Data Length:** Specifies the number of bytes of Global Data the PanelMate unit will transmit each bus scan onto the Genius I/O bus. The valid range for Global Data Length is 0 to 128 bytes (0 to 64 words).

For more information about Genius I/O, refer to the GE Fanuc Communication Driver Manual.

## DeviceNet Setup

To configure the **DeviceNet Setup** dialog box, the following steps must be completed.



1. The I/O port must be selected and DeviceNet must be selected in the Device Use field in the PLC Name and Port Table dialog box.
2. Click the **DeviceNet** button and the **DeviceNet Setup** dialog box will appear.

The **DeviceNet Setup** dialog box is shown below.

Note that when devices are added, changed, copied, or pasted to the Node/Message Type Table, the devices are sorted in ascending order by their MACID and then sorted in alphabetical order of their Label.

The **DeviceNet Setup** dialog box is used to configure the PanelMate unit for DeviceNet communication.

The fields in the **DeviceNet Setup** dialog box are described below.

**Label:** Allows you to enter a name that is used to reference messages. This field is limited to 13 alphanumeric characters. Note that the first letter must be an alpha character.

You can enter up to 379 labels.

**MACID:** Defines the MACID (node address) embedded in the 11-bit CAN (Controller Area Network) identifier. The valid range is 0 to 63.

In most cases, the MACID will contain the slave address. If the message type is BSC (bit strobe command), the MACID field must contain the master address.

A configuration will typically have only one BSC message type entered in the Node/Message Type Table.



**Message Type:** Allows you to define the type of message. The message types are listed below:

PC	Poll Command
PR	Poll Response
BSC	Bit Strobe Command
BSR	Bit Strobe Response
CS	Change of State
MCSA	Master Change of State Acknowledge
MCS	Master Change of State
CSA	Change of State Acknowledge

**Length:** Defines the length of the message in bytes. The range is 0 to 400 bytes.

**<Add>:** Allows you to add a device to the Node/Message Type Table by configuring the Label, MACID, Message Type, and Length fields and pressing the **Add** button.

**<Change>:** Allows you to change a device that has been selected in the Node/Message Type Table by re-configuring the Label, MACID, Message Type, and Length fields and pressing the **Change** button.

**<Copy>:** Allows you to copy a device that has been selected in the Node/Message Type Table.

**<Paste>:** Allows you to paste a device in the Node/Message Type Table. Note that a device must be copied from the Node/Message Type Table before you can paste a device in the table.

**<Delete>:** Allows you to delete a device in the Node/Message Type Table.

For more information about DeviceNet, refer to the DeviceNet Communication Driver Manual.

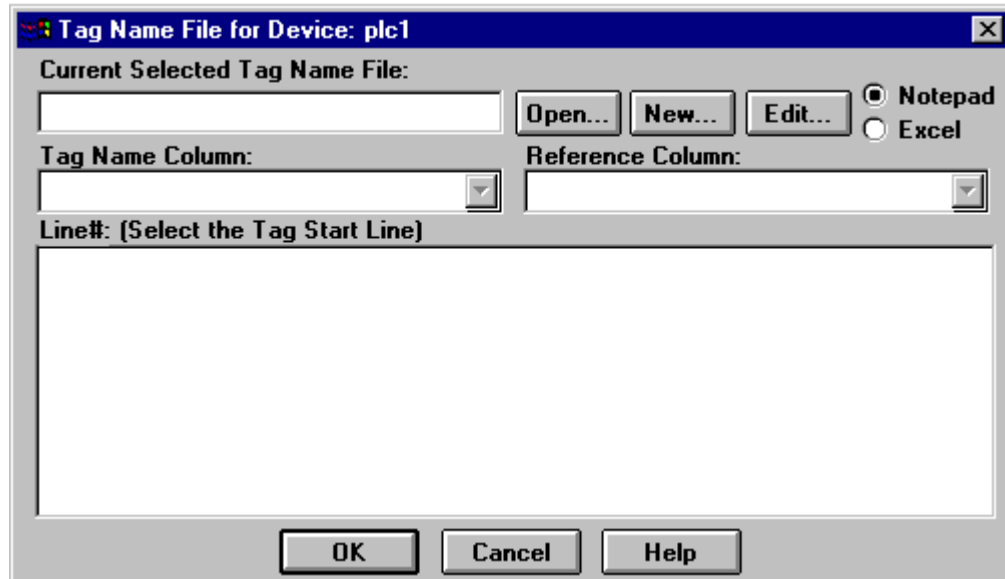
## Tag Name File

Note: It may be helpful to review Chapter 12: Using Tags prior to configuring the Tag Name File dialog box

To configure the Tag Name File dialog box, the following steps must be completed.

1. Select a PLC from the Device Use box in the PLC Name and Port Table.
2. Click on the PLC in the PLC Name Parameters box.
3. Click on the Tag File... button.

The Tag Name File dialog box is shown below.



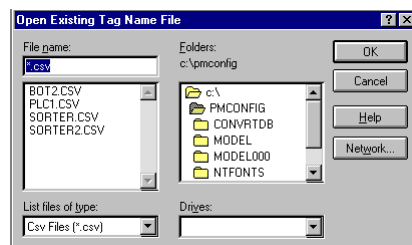
The fields in the Tag Name File dialog box are described below.

**Tag Name File:** Allows you to enter the path and name of the tag name .csv file. The **Open** button is available to assist you in locating your .csv file.

**Open:** Allows you to browse and select the path for the Tag Name file. When the **Open** button is pressed, the **Open Existing Tag Name File** dialog box will appear.

**Tag Name Column:** Allows you to select the column number of the .csv file that contains the Tag Name.

**Reference Column:** Allows you to select the column number of the .csv file that contains the PLC I/O



address reference.

Note: When using a Cutler-Hammer NetSolver Tag Name file, select the same column for both the Tag Name Column and the Reference Column.

**Select Tag Start Row:** Allows you to select the beginning row of the tag data. Since most .csv files contain some header information, it is necessary to identify the first row of actual tag data.

**Edit:** If you wish to modify, add or delete any tag information in your .csv file, you will need to use another Windows application such as Notepad or Excel. The **Edit** button, combined with your selection of either the **Notepad** or **Excel** radio buttons, will launch the selected program.

**New:** If you have a PanelMate configuration that was developed without tags, you can export your references to a .csv file using the **New...** button. Once created, you can associate the .csv file with a device in your source configuration or any other PanelMate configuration. Refer to **Chapter 12: Using Tags** for more information.

Note: **The Tag Name File information will be saved into the PLC Name and Port Table in the PanelMate database. Only devices defined in the PLC Name Parameters box can have an associated .csv file.**

## OPC Client Connectivity

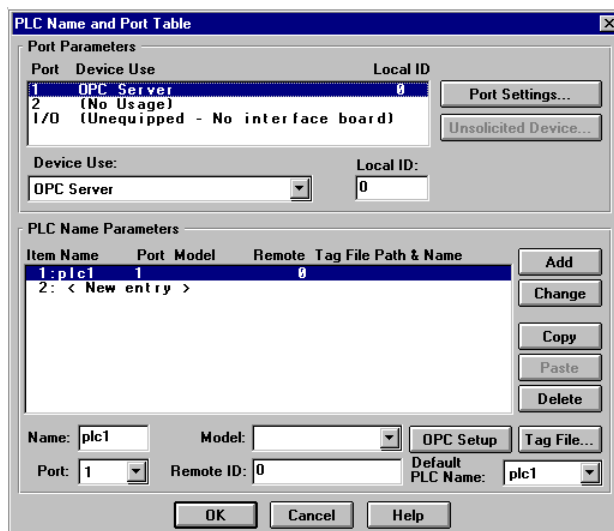
**Note:** OPC client connectivity is only available for PanelMate PC Pro. This functionality is not available for other PanelMate Power Series/Power Pro/Pro LT products.

OLE for Process Control (OPC) is based on Microsoft's COM/DCOM technology. OPC allows client applications access to any data source (device or database) in a consistent manner. PanelMate PC Pro is able to communicate as an OPC Client. Refer to the OPC Server documentation for information on installing, configuring, or troubleshooting the OPC Server.

### Operator Station Setup

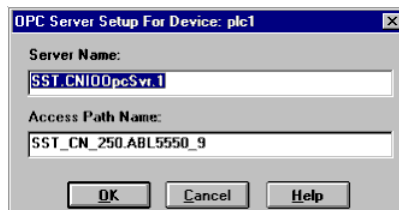
The following example outlines how to configure a PanelMate PC Pro operator station as an OPC Client.

1. Open the OPC server configuration utility/program, and configure the server. After the server has been configured, close the server configuration utility.
2. Open the **PLC Name and Port Table**. In the **Device Use** field, select **OPC Server**.



**Note:** The OPC Server can be configured on any port that is not being used. The port assignment is unrelated to the physical connection between the OPC Server and the PLC or device to which the OPC Server communicates.

3. In the **Name** field, enter the device name. In this example, the name is plc1.
4. Click on the Add button. The device's name will appear in the PLC Name **Parameters** window.
5. Select the device in the **PLC Name Parameters** window. The **OPC Setup** button will appear. Click on the button to open the **OPC Server Setup for Device** dialog box. The example dialog box below represents a potential setup for a PLC device. Note that the format for determining an access path is server-dependent and may be different than the example shown.



**Note:** As you configure each device and add it into the **PLC Name Parameters** field, you need to define the server name and access path for that device.

6. Develop the PanelMate PC Pro configuration pages.
7. Export the PanelMate PC Pro configuration. When you have completed your configuration, it must be exported before you can execute the configuration in the runtime software. To export a configuration, select the configuration name in the **Database Treeview Window** and choose the **Export** selection from the **File** menu.
8. Double-click on the .PPS file to run the PanelMate PC Pro application. You may also create a shortcut to run your PanelMate PC Pro configuration. To create a shortcut within Explorer:
  - Right-click on the .PPS filename and choose Create Shortcut.
  - Right-click on the new icon and choose Properties.
  - In the Shortcut Properties dialog box, choose the Shortcut Tab.
  - In the Target field, enter the PMC.EXE pathname, the .PPS configuration filename, and the unsecure mode parameter for the runtime software. Note that the unsecure mode parameter is entered to allow you to view both the OPC Server and OPC Client applications.

For an example of an entry in the **Target** field, refer to the line below.

```
c:\pmconfig\ntonline\pmc.exe opcdemo.pps -u
```

## DDE Client and Server Communications

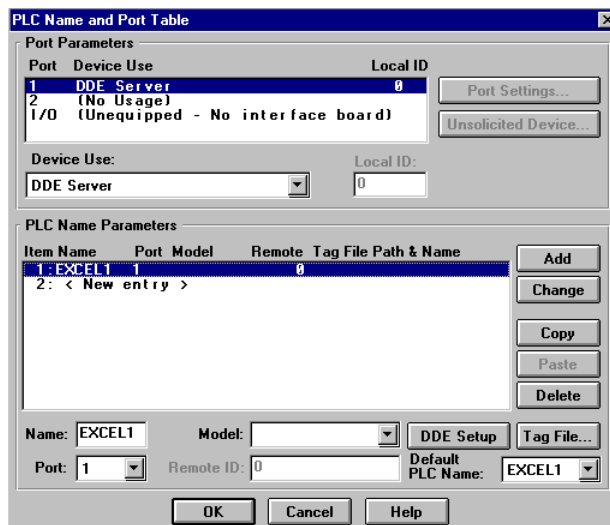
**Note:** DDE communications is only available for PanelMate PC Pro. This functionality is not available for other PanelMate Power Series/Power Pro/Pro LT products.

The PanelMate PC Pro operator station may be used as a **DDE Client** (i.e., obtain data from another Windows program.) Examples of other applications that may be used as DDE Servers to the PanelMate PC Pro operator station are listed below.

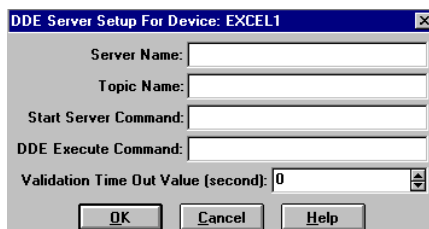
- A weigh scale feeder system that has a serial communication interface program running on the personal computer and with DDE Server capability.
- An SPC package that performs statistical calculations on data read from the PLC by the PanelMate PC Pro operator station (PanelMate PC Pro acting as a DDE Server) and provides results to the PanelMate operator station for display (PanelMate PC Pro acting as a DDE Client).

The following example outlines how to configure a PanelMate PC Pro operator station as a DDE Client.

1. Open the **PLC Name and Port Table**. In the **Device Use** field, select **DDE Server**.



2. In the **Name** field, enter the logical device's name. In this example, the name is EXCEL 1.
3. Click on the Add button. The device's name will appear in the PLC Name **Parameters** window.
4. Select the connection in the **PLC Name Parameters** window. The **DDE Setup** button will



appear. Click on the button to open the **DDE Server Setup for Device** dialog box.

5. In the **Server Name** field, enter the name of the program (e.g.Excel). Each DDE server has only one server name.
6. **Topic Name** field: All DDE servers support at least one topic.

7. **Start Server Command** field: This command is the pathname of the DDE server application if it is not already running. This field may be a blank line, which means that an attempt is not made to start the DDE server application if it is not already running. It is important to note that a line full of white spaces does not constitute a blank line. The white spaces will be sent to the DDE server application to be started, which will result in an error.
8. **DDE Execute** field: This command is sent to the DDE server after a conversation has been initiated with the DDE server. This conversation only occurs one time at PanelMate PC startup. This field may be a blank line, which means that a DDE execute command is not sent to the DDE server. It is important to note that a line full of white spaces does not constitute a blank line. The white spaces will be sent to the DDE server application to be started, which will result in an error.
9. In the **Validation Time Out Value** field, enter a value between 0 and 60 seconds. A zero value indicates that no connection validation will be done. Other values determine how often the PanelMate PC Pro operator station will check to make sure the DDE server is still running if data updates have not been sent within the time window.

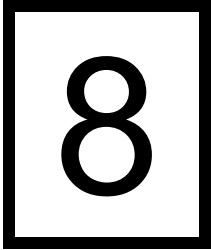
For information on configuring a PanelMate PC Pro operator station as a DDE client, refer to your **DDE Connectivity Communication Driver Manual**.

The PanelMate PC Pro operator station may also be used as a **DDE Server** (i.e., supply data to another Windows program.) Examples of other applications that may be used as DDE Clients to the PanelMate PC Pro DDE Server are listed below.

- A Microsoft Access database application which extracts PLC or controller data from the PanelMate PC Pro operator station and acts as an SQL Server to a host computer over an Ethernet network.
- A Microsoft Visual Basic application that displays pop-up windows that appear on top of PanelMate PC Pro screens.
- A Microsoft Visual Basic application or Microsoft Excel spreadsheet which configures a recipe or machine setup by writing to PanelMate PC Pro's DDE Server.
- A Microsoft Access database or Microsoft Excel spreadsheet that provides reports using data from a PanelMate configuration.

For information on using a PanelMate PC Pro operator station as a DDE server, refer to your **DDE Connectivity Communication Driver Manual**.

# Message Library



*In this chapter, you will learn:*

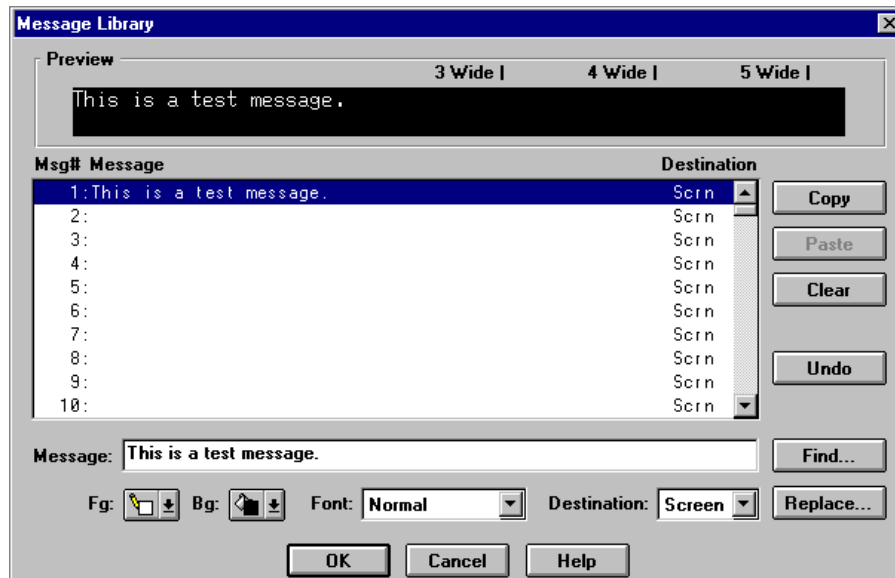
- *About the Message Library*
- *About Register References within Messages*



## Message Library

Note that all messages to be shown in a Display Template or a Variable-Sized Display Template must be defined in the Message Library. It is recommended to define the messages in the Message Library before configuring a Display Template or a Variable-Sized Display Template.

When you double click on the Message Library selection in the Database Treeview Window, the **Message Library** dialog box will appear.



The **Message Library** dialog box allows you to create new messages and edit or replace existing messages in the Message Library.

The fields in the **Message Library** dialog box are described below.

**Preview:** Displays the currently selected message with the selected colors and font.

Markings above the Preview box show the maximum message width for 3-wide, 4-wide, and 5-wide Display Templates. These markings indicate where the right edge of the Display Template will display the last character.

**Msg#/Message/Destination:** Displays the messages (as unformatted text) in the Message Library. The message selected in this box also displays in the Preview box. If more than one message is selected, the last one displays in the Preview box. The Msg#/Message/Destination box has three fields. The fields are described below.

**Msg#:** Displays the message number. The message number is used to recall the message in the Display Template and Variable-Sized Display Template. All messages appear in numerical order. The number of messages that can be entered will vary depending on the product model and the options installed.

Refer to the Capacity Expansion Kit section in the **Product Options** topic for information about the number of messages you can enter.

**Message:** Displays the message text. A single message may contain up to five register references and clock or calendar references. (Refer to the **Register References within Messages** topic or the **Clock and Calendar References within Messages** topic for more information.) While in Run Mode, the register references are replaced with the numeric register content from the PLC.

**Destination:** Displays the destination of the message (i.e., Screen, Printer, or Both).

To select one message, place the cursor on the message then click the left mouse button. A selected message displays in the highlight color.

To select a range of messages, select the first message, and then press the **Shift** key while you select the second message. All messages between the two messages will be selected. You can also drag the cursor to select a range of messages. Select the first message, then drag up or down.

To select two or more messages, select the first message, then press the **Ctrl** key while you select the second message. Both messages are selected, but messages in between will not be selected.

**Message:** Allows you to edit an existing message or create a new one. As you type, the message selected in the Msg#/Message/Destination box is updated.

To create a new message, select an unused message number in the Msg#/Message/Destination box. You can type your new message in the Message field.

To edit or replace a message, select a message in the Msg#/Message/Destination box. You can then edit the message in the Message field.

**FG:** Allows you to select the foreground color of the message (or messages) selected in the Msg#/Message/Destination box. Note that you can choose blinking or non-blinking colors.

**BG:** Allows you to select the background color of the message (or messages) selected in the Msg#/Message/Destination box. Note that you can choose blinking or non-blinking colors.

**Font:** Allows you to select a font for the message (or messages). The selections available are Normal, Double High, and Quad.

Note that you should test all message combinations that you expect to use before going online. Each line of text is totally independent, so be careful when making intensity or color and character size selections. Quad or double-high character lines can interfere with each other.

**Destination:** Allows you to select the destination of the message. The selections available are Screen, Printer, or Both. Note that Display Templates containing messages with the Destination field configured as Both or Printer will not print in Run Mode if a screen saver is active. This is not a characteristic of Variable-Sized Display Templates if the Global Message field is configured as Yes in the **Variable-Sized Display Template - Expressions Tab** dialog box.

<**Copy**>: Copies a selected message (or messages) to the Windows clipboard.

<**Paste**>: Places a message (or messages) from the clipboard to destinations you have selected in the Msg#/Message/Destination box. You can paste messages anywhere into the list, but the number of selected destinations must equal the number of messages on the clipboard.

<**Clear**>: Erases the selected message (or messages) from the Msg#/Message/Destination box, but does not place them on the clipboard.

<**Undo**>: Allows you to undo the previous editing or formatting change.

<**Redo**>: Allows you to redo the previous undo.

<**Find**>: Opens the **Find** dialog box. In the **Find** dialog box, enter the text string you wish to search for in the Find What field, choose the Match Whole Word Only or the Match Case selections if either or both selections apply, and select the direction of the search.

Once you have entered the text string, you may click the **Find Next** button to find the next occurrence of the text string or press the **Cancel** button to close the **Find** dialog box.

The Find and Replace functions start searching from the selected line in the Msg#/Message/Destination box.

<**Replace**>: Opens the **Replace** dialog box. In the **Replace** dialog box, enter the text string you wish to search for in the Find What field, enter the replacement text string in the Replace With field, and then choose the Match Whole Word or Match Case selections if either or both selections apply.

Once you have entered the text strings, you may click the **Find Next** button to find the next occurrence of the text string, click the **Replace** button to replace the text string, click the **Replace All** button to replace all occurrences of the text string, or press the **Cancel** button to close the **Replace** dialog box.

## Register References within Messages

Within the PanelMate unit, you can reference PLC register locations within a message to display the numeric register content within the message while in Run Mode. You may use the following format to display the contents of the registers.

*\$tw.d(expression)*

The following items need to be noted when putting register references in messages:

- If a value is too large to display in the specified format width, a string of Xs (XXXXXX) is displayed for the value. For example, if a message is defined as three characters, but the value from the PLC is four characters, the resultant will be displayed as XXX.
- When the Message Expression is true, embedded references are updated on the screen but not sent to the printer. Messages configured for BOTH or PRINTER are sent to the printer when the Message Expression changes, and also when you change pages.
- If a hard-coded value (e.g., 100) is placed in the Message Expression designated as Global, the message will only print once at bootup.
- A message containing multiple PLC references will print to the screen or printer multiple times—once for each reference in the message.

For more information on register reference formats, refer to the **General Format**, **Decimal-Based Formats**, **Decimal Place Formats**, **Binary-Based Formats**, or **Formatting Examples** topic.

### General Format

A message containing multiple PLC references will print to the screen or printer multiple times—once for each reference in the message.

The general format expression is shown below.

$\$tw.d(\text{expression})$

where ...

**\$** = format indicator

**t** = type of numeric display

I - Integer

H - Hexadecimal

B - Binary

E - Exponential

D - Floating decimal real value

O - Octal

F - Fixed decimal real value

A - ASCII character

**w** = Total field width including decimal point, negative sign (-), and positive sign (+)

**.** = Separator between width of format and the number of decimal places  
(used with F or E format)

**d** = Number of decimal places (used with F or E format)

Format type D (floating decimal point) permits the decimal point to float in the display depending on the register's value. This contrasts with format type F (fixed decimal point) which formats a value with a fixed decimal location. Format type F may be useful when creating a column of values.

Floating decimal point format type should not be confused with floating point mathematics or floating point data types that cannot be read or manipulated in the PanelMate unit.

Each format has a maximum number of characters it can display, and a number cannot be completely displayed if the format description is too small. The following are the width limits for each format type.

- I11 = Largest Integer value width is 11
- H8 = Largest Hexadecimal value width is 8
- O11 = Largest Octal value width is 11
- B32 = Largest Binary value width is 32
- D65 = Largest Floating Decimal Point value width is 65
- F65.d = Largest Fixed Decimal Point value width is 65
- E65.d = Largest Exponential value width is 65
- A = Largest ASCII character width is 2. (The least significant 16 bits are used in this order: high byte, low byte). When using both characters, ensure the PanelMate unit's default format can read numbers that use the high byte. An alternate word reference format may be necessary, i.e., #U16.
- d = decimal places

For examples using the General Format Expression, refer to the **General Format Expression Examples** topic.

## General Format Examples

If the message is:

“Current tank level is \$I3([123]) gallons.” and the value in register 123 is 567, the online message will be:

“Current tank level is 567 gallons.”

If the message is:

“Production rate per press is \$D5([456]/17) units per hr.” and the value in register 456 is 7890, the online message will be:

“Production rate per press is 464.1 units per hr.”

If the message is:

“Part name in line 1 is \$A([200#U16]).” and the value in register 200 is 16693, the online message will be:

“Part name in line 1 is A5”

Note that with the #U16 format, the PanelMate unit can read and display the ASCII equivalent of 16693.

### Decimal-Based Formats

The decimal-based format types are:

1. Integer
2. Floating decimal point real value
3. Fixed decimal point real value
4. Exponential

All the decimal-based numeric formats are right-justified and padded with leading blanks if necessary.

If a value for a decimal format has too many digits for the specified format size, a string of \*s (\*\*\*\*) is displayed for the value.

### Decimal Place Formats

For the fixed decimal point format (F), the number for the total width of the formatted value (w) must be at least one greater than the number of decimal places (d). If negative values will be displayed, “w” must be at least two greater than “d”.

For the exponential format (E), the total width of the formatted value (w) must be at least eight greater than the number of decimal places (d).

### Binary-Based Formats

The binary-based format types are:

1. Hexadecimal
2. Octal
3. Binary

For binary-based formats, digits are inserted for the entire width of the format size; there is no blank padding. If a value for a binary format has too many digits for the specified format size, the most significant digits of the value are truncated until the number will fit in the size specified.

Example:

value = 300

Presentation with H4 format: 012C

Presentation with H2 format: 2C



## Formatting Examples

The following table shows examples of the different formatting types. The data type, actual data, and visual appearance are shown. The heading on the column for visual appearance marks 13 column locations to help reference the placement of characters.

Type	Data	Columns													
		0	1	2	3	4	5	6	7	8	9	0	1	2	
I5	324												3	2	4
I4	521												5	2	1
I2	-8.73												-	9	
I3	7321												*	*	*
I4	824.67												8	2	5
D7	421.45												4	2	1
D4	23.45												2	3	5
H3	255												0	F	F
H5	-255												F	F	F
H2	300												2	C	
O4	54												0	0	6
O3	88.45												1	3	0
O1	21												5		
B9	100												0	0	1
B4	86												0	1	1
F5.1	523.46												5	2	3
F10.4	253.21												2	5	3
F5.2	326.23												*	*	*
F8.3	-43.888												-	4	3
F5.0	397.52												3	9	8
E12.3	-324.1												-	3	2
E13.2	0.06734												6	7	3
E9.0	156.2												2	E	+
D4	999.89												1	0	0
D6	6245.21												6	2	4
D1	0.04												0		
D1	9.12												9		
D4	82345.2												*	*	*
D3	-1.444												-	1	
F7.3	619.52												6	1	9
F7.2	619.52												6	1	9
F6.2	619.52												6	1	9
F5.3	619.52												-	-	-
F5.1	619.52												6	1	9
D7	619.52												6	1	9
D6	619.52												6	1	9
D5	619.52												6	1	9
D4	619.52												6	2	0
D3	619.52												6	2	0
E12.4	619.52												6	1	9
E12.3	619.52												6	1	9
A	16693												A	5	

### Clock and Calendar References within Messages

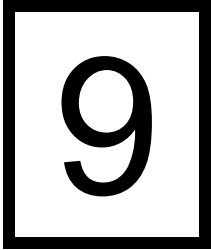
Time and date information from the PanelMate unit's internal clock can be included in messages sent to the screen and/or printer. The Clock and Calendar Access formats are as follows:

\$(mon)	month
\$(day)	day
\$(year)	year
\$(hour)	hour (24 hour time format)
\$(min)	minutes
\$(sec)	seconds
\$(time)	hour:minute:second
\$(date)	month/day/year
\$(clk)	hour:minute:second month/day/year

Note the following items:

- Parameter names are not case sensitive.
- This information is updated when the page is displayed, but is not updated dynamically.

# System Online Labels

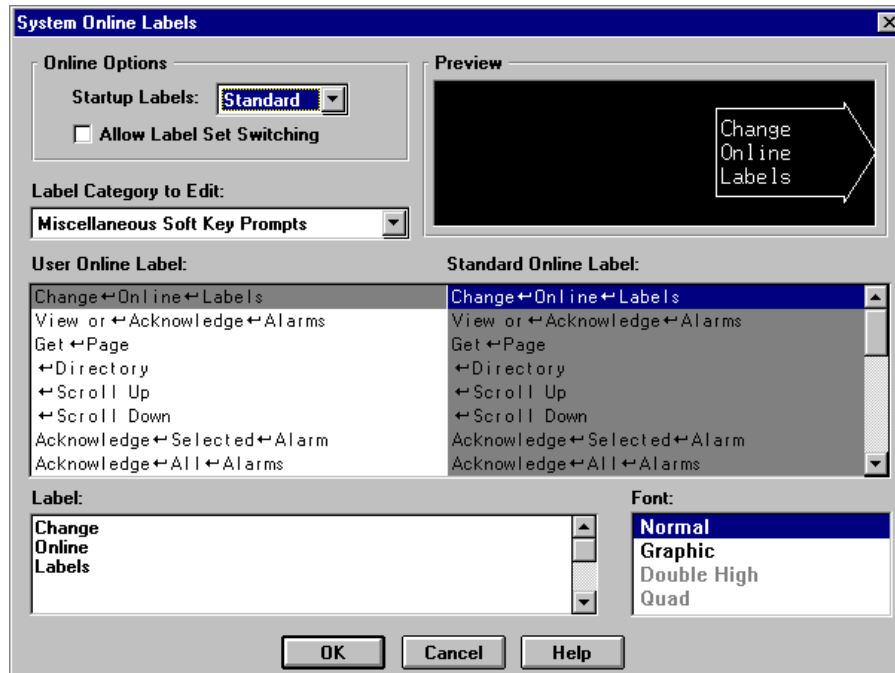


*In this chapter, you will learn:*

- *About the System Online Labels*

## System Online Labels

When System Online Labels is selected from the Database Treeview Window, the **System Online Labels** dialog box will appear.



The **System Online Labels** dialog box is used to change the labeling for most of the PanelMate unit screens.

The fields in the **System Online Labels** dialog box are described below.

### Online Options

**Startup Labels:** Allows you to select the Standard or User labels to display at startup. If you select Standard, the PanelMate unit will display the default label set. If you select User, the PanelMate unit will display the labels you create in the **System Online Labels** dialog box.

**Allow Label Set Switching:** Allows you to switch between the two label sets during online operation if this field is checked. If this field is not checked, only the labels selected in the Startup Labels field will be displayed.

**Preview:** Previews the online label you are working on.

**Label Category To Edit:** Allows you to select the label category you wish to edit. When you select a label category, the user-defined labels will appear in the User Online Label field and the standard labels will appear in the Standard Online Label field.

The following list shows the label categories that may be edited:

- Miscellaneous Soft Key Prompts
- Maintenance Template Soft Key Prompts
- User Entry Soft Key Prompts
- Setup Page
- Error Messages
- Miscellaneous Text
- Display System/Configuration Info
- Alarm Text
- Contrast Adjustment Soft Key Prompts
- Touchscreen Button Templates
- Touchscreen Keypad Entry Labels
- Touchscreen Control Keys

**User Online Label:** Displays user-defined labels for the label category selected in the Label Category to Edit field. If you select a label in this list, the label will display in the Label field where it can be edited.

**Standard Online Label:** Displays default standard labels for the label category selected in the Label Category to Edit field. Most labels that appear in the Standard Online Labels scroll box cannot be edited.

For safety purposes when creating online labels in another language, the Change Online Labels label in the Miscellaneous Soft Key Prompts category will remain in English when User Online Labels are displayed. The user-defined label for Change Online Labels will only be shown when the Standard Online Labels are displayed.

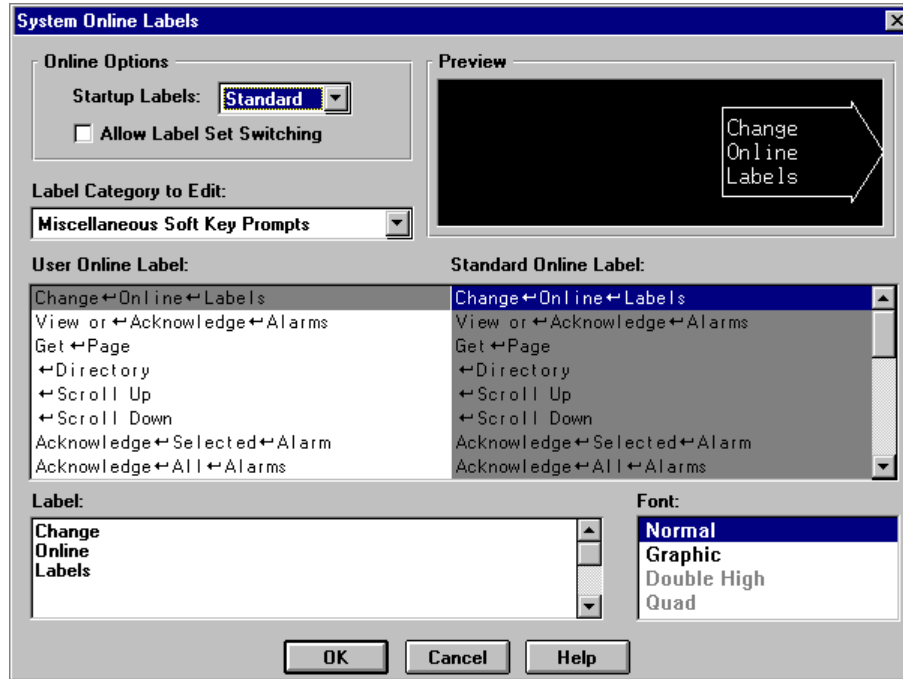
**Label:** Allows you to edit the label selected in the User Online Label scroll box. Any labels that are edited in the Label field will be reflected in the Preview box and in the User Online Label scroll box.

**Font:** Allows you to select a font for the label you are editing. The choices are Normal, Graphic, Double High, and Quad font.

In order to select the Double High or Quad font, the Redefine Double High Font field or the Redefine Quad Font field must be selected in the **System Parameters - General Tab** dialog box. Once one or both fields are selected, the characters must be redefined in the Font Editor before the characters will appear in the Preview field in the **System Online Labels** dialog box.

## System Online Labels – Miscellaneous Soft Key Prompts

When Miscellaneous Soft Key Prompts is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Miscellaneous Soft Key Prompts is selected in the Label Category to Edit field.

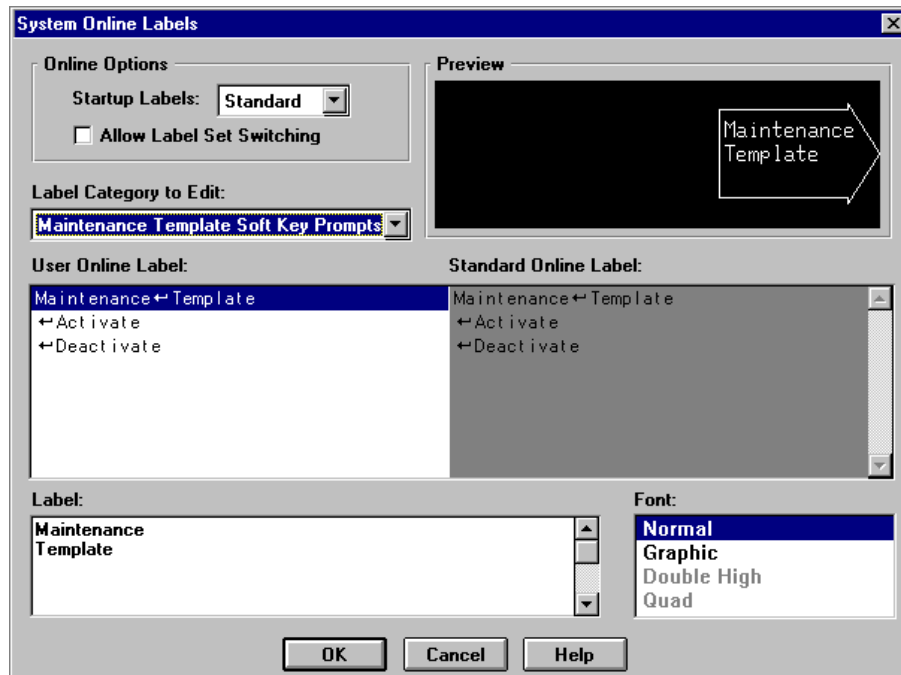
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

**Standard Online Labels**

- Change Online Labels
- View or Acknowledge Alarms
- Get Page
- Directory
- Scroll Up
- Scroll Down
- Acknowledge Selected Alarm
- Acknowledge All Alarms
- Get Alarm Page
- Host Display Window
- Silence Alarm Horn
- Enable Fault Relay (PanelMate PC and all PanelMate Power Series models excluding PanelMate Power Series 1500 and PanelMate Pro LT 1100)
- Reset PLC Com (PanelMate Power Series 1500 and PanelMate Pro LT 1100)
- Change Value
- Clear
- Home
- Select Table Entry
- Return and Select
- More Buttons
- Setup Page
- Execute
- Set Date
- Set Time
- Yes
- No

## System Online Labels – Maintenance Template Soft Key Prompts

When Maintenance Template Soft Key Prompts is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Maintenance Template Soft Key Prompts is selected in the Label Category to Edit field.

**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

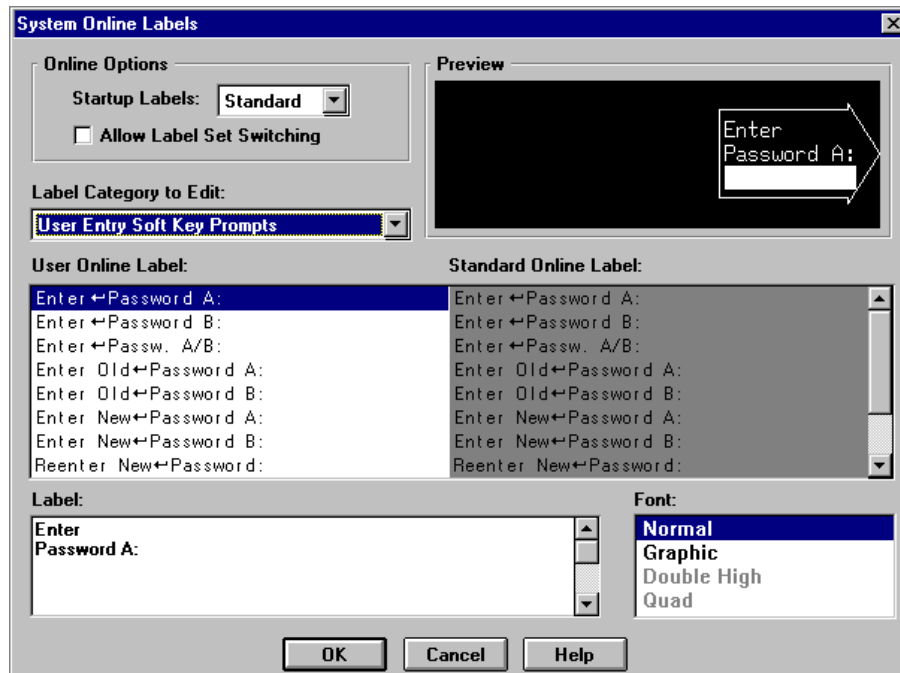
### Standard Online Labels

- Maintenance Template
- Activate
- Deactivate



## System Online Labels – User Entry Soft Key Prompts

When User Entry Soft Key Prompts is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when User Entry Soft Key Prompts is selected in the Label Category to Edit field.

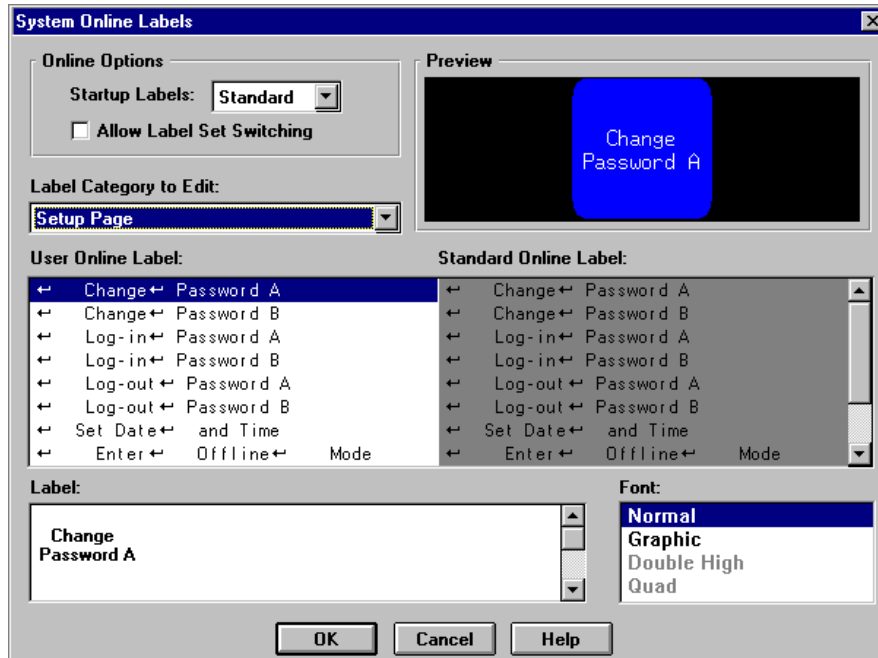
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Enter Password A:
- Enter Password B:
- Enter Passw. A/B:
- Enter Old Password A:
- Enter Old Password B:
- Enter New Password A:
- Enter New Password B:
- Reenter New Password:
- Enter Date (MM-DD-YY):
- Enter Time (HH-MM-SS):
- Enter New Value:

## System Online Labels – Setup Page

When Setup Page is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Setup Page is selected in the Label Category to Edit field.

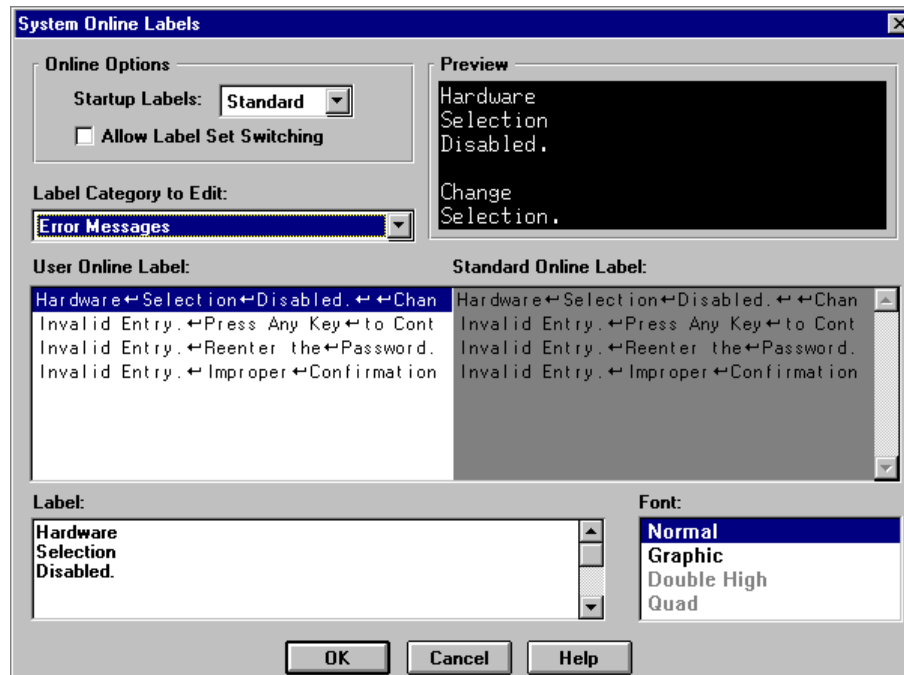
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Change Password A
- Change Password B
- Log-in Password A
- Log-in Password B
- Log-out Password A
- Log-out Password B
- Set Date and Time
- Enter Offline Mode
- Display System/Config. Information
- Switch to Two Column Keypad
- Switch to Three Column Keypad

## System Online Labels – Error Messages

When Error Messages is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Error Messages is selected in the Label Category to Edit field.

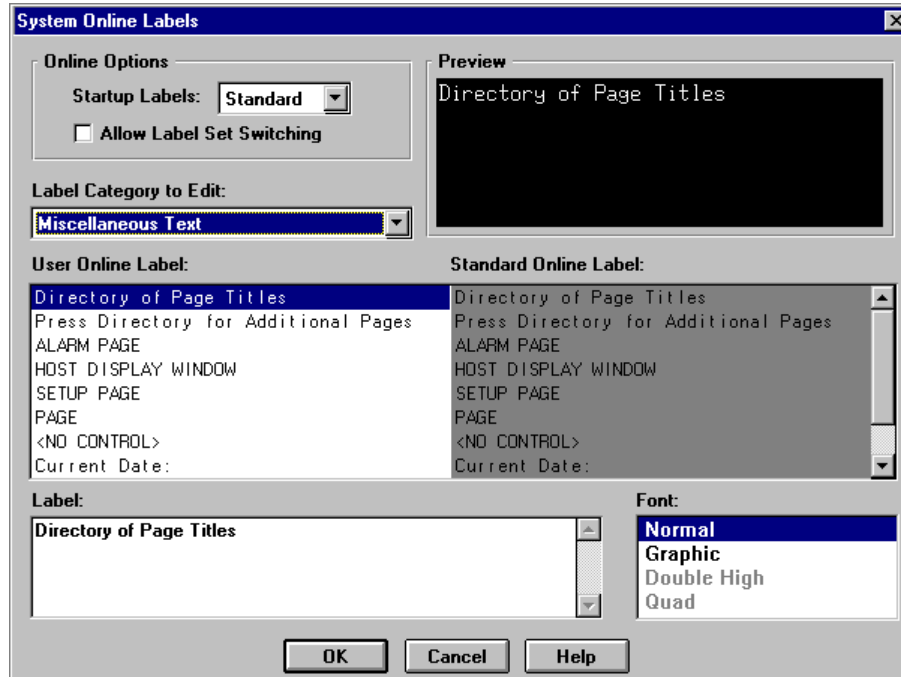
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Hardware Selection Disabled. Change Selection.
- Invalid Entry. Press Any Key to Continue.
- Invalid Entry. Reenter the Password.
- Invalid Entry. Improper Confirmation. Reenter the Password.

## System Online Labels – Miscellaneous Text

When Miscellaneous Text is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Miscellaneous Text is selected in the Label Category to Edit field.

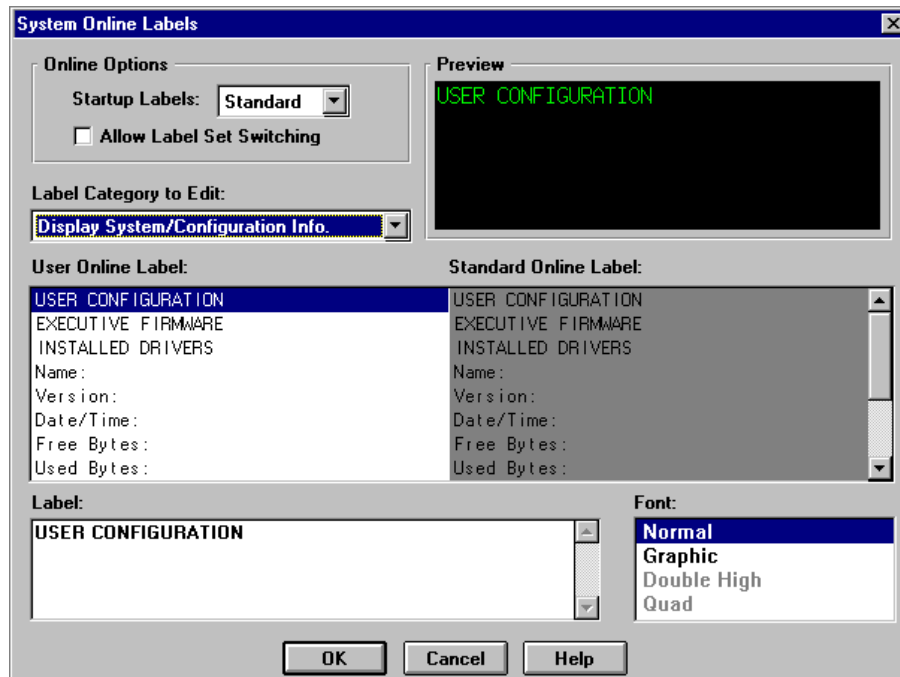
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Directory of Page Titles
- Press Directory for Additional Pages
- ALARM PAGE
- HOST DISPLAY WINDOW
- SETUP PAGE
- PAGE
- <NO CONTROL>
- Current Date:
- Press Page Number Below
- Remote Mode Change Requested OK to Proceed?

## System Online Labels – Display System/Configuration Info.

When Display System/Configuration Info. is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Display System/Configuration Info. is selected in the Label Category to Edit field.

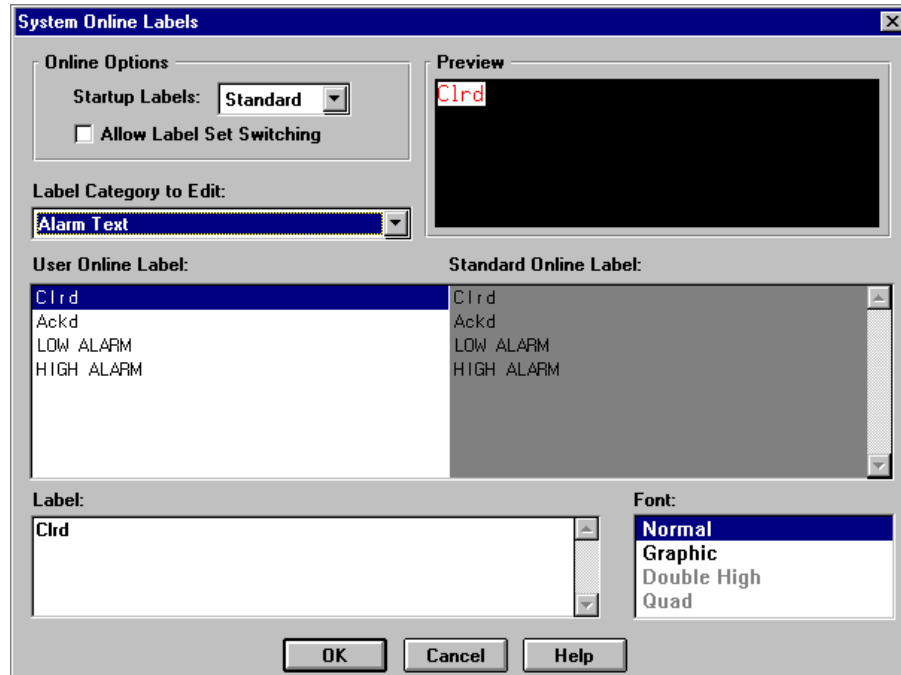
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- USER CONFIGURATION
- EXECUTIVE FIRMWARE
- INSTALLED DRIVERS
- Name:
- Version:
- Date/Time:
- Free Bytes:
- Used Bytes:
- Options:
- Company/ID:
- Model:
- Product:
- Network:

## System Online Labels – Alarm Text

When Alarm Text is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Alarm Text is selected in the Label Category to Edit field.

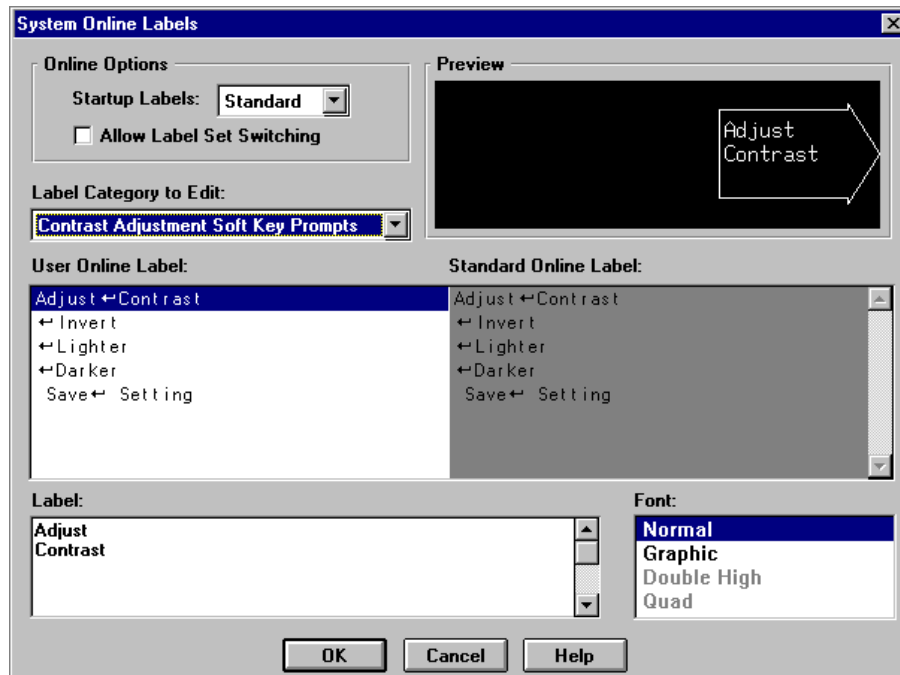
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Clrd
- Ackd
- LOW ALARM
- HIGH ALARM

## System Online Labels – Contrast Adjustment Soft Key Prompts

When Contrast Adjustment Soft Key Prompts is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Contrast Adjustment Soft Key Prompts is selected in the Label Category to Edit field.

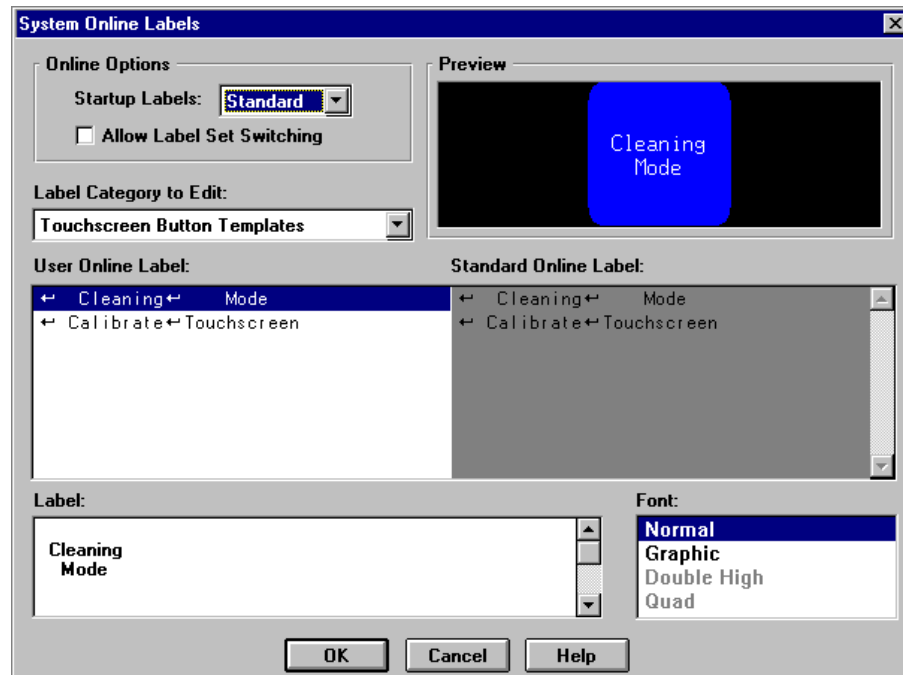
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Adjust Contrast
- Invert
- Lighter
- Darker
- Save Setting

## System Online Labels – Touchscreen Button Templates

When Touchscreen Button Templates is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Touchscreen Button Templates is selected in the Label Category to Edit field.

**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

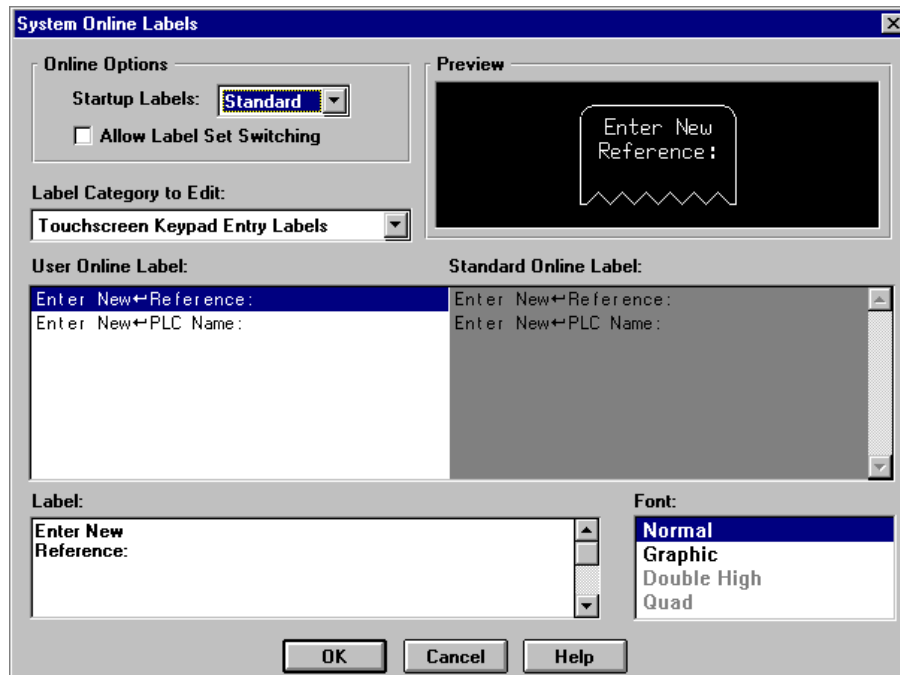
### Standard Online Labels

- Cleaning Mode
- Calibrate Touchscreen



## System Online Labels – Touchscreen Keypad Entry Labels

When Touchscreen Keypad Entry Labels is selected in the Label Category to Edit field, the following dialog box will appear.



The following set of online labels can be edited in the **System Online Labels** dialog box when Maintenance Template Soft Key Prompts is selected in the Label Category to Edit field.

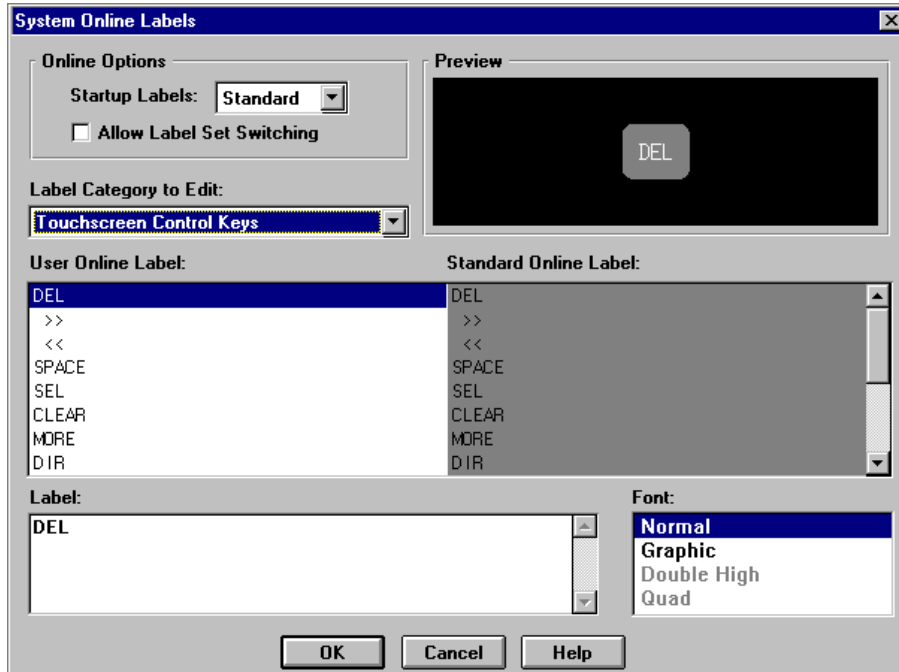
**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

### Standard Online Labels

- Enter New Reference:
- Enter New PLC Name:

## System Online Labels – Touchscreen Control Keys

When Touchscreen Control Keys is selected in the Label Category to Edit field, the following dialog box will appear.



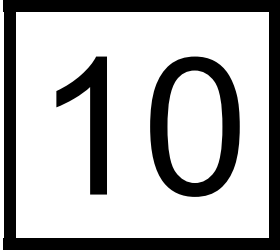
The following set of online labels can be edited in the **System Online Labels** dialog box when Touchscreen Control Keys is selected in the Label Category to Edit field.

**Tip:** When changing online labels, be aware of the spaces before and after the new label. The spaces will determine the placement of the label when the PanelMate unit enters Run Mode.

**Standard Online Labels**

- DEL
- >>
- <<
- SPACE
- SEL
- CLEAR
- MORE
- DIR
- ENTER
- RSEL
- ALARM
- ACCPT
- PREV
- NEXT
- RETRN

# Templates

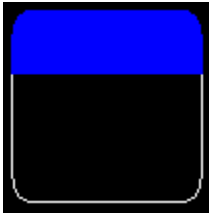


*In this chapter, you will learn:*

- *About the Indicator Template*
- *About the Readout Template*
- *About the Bar Template*
- *About the Table Template*
- *About the Bar Trend Template*
- *About the Line Trend Template*
- *About the Display Template*

## Indicator Template

Indicator Templates are designed to be used as the lights and buttons of a control panel and are used to indicate the status of devices and to control them, e.g., by turning them on or off.

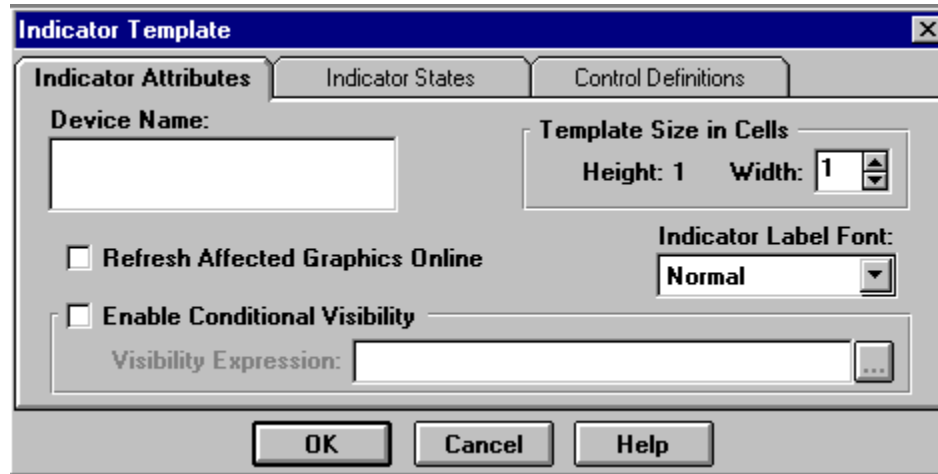


The Indicator Template consists of three tabbed dialog boxes that are listed below.

- Indicator Template - Indicator Attributes Tab
- Indicator Template - Indicator States Tab
- Indicator Template - Control Definitions Tab

## Indicator Template – Indicator Attributes Tab

The **Indicator Template - Indicator Attributes Tab** dialog box is shown below.



The fields in the **Indicator Template - Indicator Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Displays the height of the Indicator Template as 1. This value cannot be changed.

**Width:** Allows you to enter the width of the Indicator Template as 1 or 2.


**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Indicator Label Font:** Defines the font used in the status (lower) area of the template. You can select Normal, Double-High, or Quad font. For maximum readability, choose the largest size that fits in the template.

**Enable Conditional Visibility:** Allows you to determine if the template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

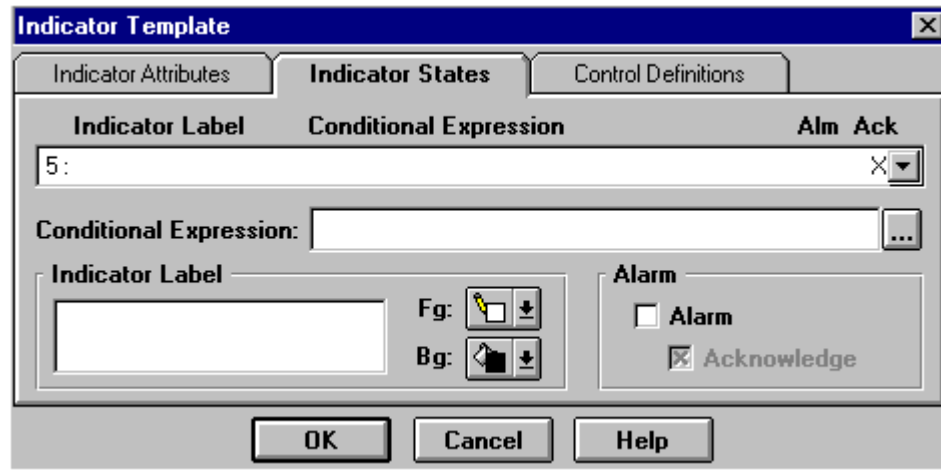
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Indicator Template – Indicator States Tab

The **Indicator Template - Indicator States Tab** dialog box is shown below.




The fields in the **Indicator Template - Indicator States Tab** dialog box are described below.

**Indicator Label/Conditional Expression/Alm/Ack:** Displays five lines that define various states of the device. This includes indicator label text, conditional expressions, alarm status, and acknowledgment status

**Conditional Expression:** Allows you to enter a conditional expression. The conditional expression can be a numerical, logical or relational expression that evaluates to true or false. When a numerical expression is evaluated if the result is even (least significant bit = 0), the value is false, and if the result is odd (least significant bit = 1), the value is true.

In Run Mode, if an expression is satisfied (true or false), the characteristics defined for that line are used to display the template. If more than one expression is satisfied at the same time, the line with the highest priority displays. Line 1 has the highest priority and line 5 has the lowest.

When an expression results in an invalid equation (e.g., division by zero, etc.), no value or graphics are displayed. If a true expression goes false in a later scan, the display for the true expression is erased.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

Refer to the list of Conditional Expression Operators for more information.

**Indicator Label:** Allows you to enter a label for the Indicator Template. This field accepts normalized characters entered in the Indicator Label box. The Indicator Template will limit the number of characters you can enter depending upon the template size (normal or double-wide) or character size (normal, double high, or quad).

Be sure to view the template on the page to ensure the desired appearance.

The Indicator Label field has an auto centering capability. If you wish to center the Indicator Label, check the Indicator Labels box in the Auto Centering field in the **Configuration Properties** dialog box.



**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

### Alarm

**Alarm:** Allows you to designate any line of the template definition as an alarm state. If the Alarm box is selected and the conditional expression evaluates to be true, an alarm message will be placed in the alarm list and sent to the printer if one is configured.

If the Alarm box is selected, the condition associated with the alarm will be monitored at all times, regardless of the page being displayed. Judicious use of the alarm state is recommended to maximize the response time of the PanelMate unit.

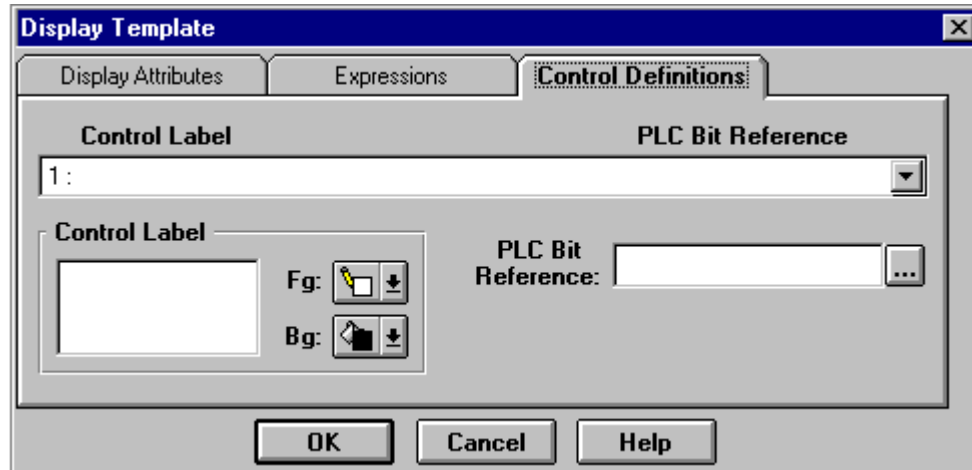
**Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

## Indicator Template – Control Definitions Tab

The **Indicator Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Indicator Template - Control Definitions Tab** dialog box are described below.

**Control Label/PLC Bit Reference:** Displays the control labels and PLC bit references and allows you to define the control buttons on the right side of the PanelMate unit. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at a particular location.

If a control button is defined, a small arrow will be displayed in the lower left corner of a template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., 120 00) to 1. When the button is released, a separate command is sent to set the bit to a 0 (zero), thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.


**Control Label:** Allows you to enter a label for a control button. This field accepts three lines of normal-sized alphanumeric characters. The text does not automatically wrap. Press the **Return** key to insert a carriage return.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference for the control button. This field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. You cannot use expressions or conditional logic.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Readout Template

Readout Templates are designed to be used as numerical readout devices on a control panel and are used to display a digital value. The PanelMate unit also provides two ways for the operator to change a PLC value.

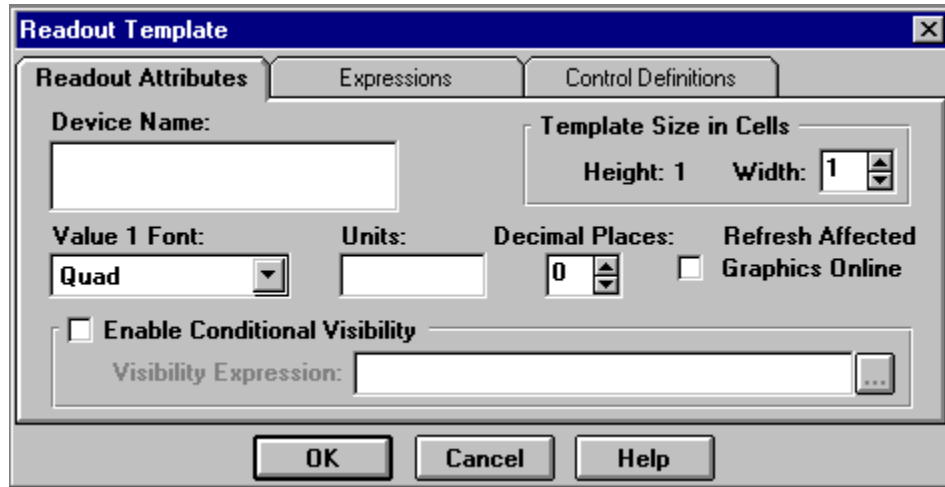


The Readout Template consists of three tabbed dialog boxes that are listed below.

- Readout Template - Readout Attributes Tab
- Readout Template - Expressions Tab
- Readout Template - Control Definitions Tab

## Readout Template – Readout Attributes Tab

The **Readout Template - Readout Attributes Tab** dialog box is shown below.



The fields in the **Readout Template - Readout Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Displays the height of the Readout Template as 1. This value cannot be changed.

**Width:** Allows you to enter the width of the Readout Template as 1 or 2.

**Value 1 Font:** Allows you to select the font for the characters used in the status (lower) area of the Readout Template. The selections are Normal, Double-High, or Quad. For maximum readability, choose the largest size that fits in the template.

Note that redefining the Double-High or Quad fonts limits your character size choices.

The maximum number of digits for a Readout Template is based upon the combination of template size and character size.

- A 1-wide template with normal characters can display 9 digits.
- A 1-wide template with quad characters can display 6 digits.
- A 1-wide template with double high characters can display 9 digits.
- A 2-wide template with normal characters can display 18 digits.
- A 2-wide template with quad characters can display 12 digits.
- A 2-wide template with double high characters can display 18 digits.

**Units:** Allows you to define the type of units that will be displayed to the operator, such as “Deg. F” or “gals”. The Units field accepts alphanumeric characters. This field is not displayed on a single-width template when Value 2 is displayed.


**Decimal Places:** Allows you to determine how the number will be formatted when displayed. This field accepts the numbers 0 through 9.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Readout Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

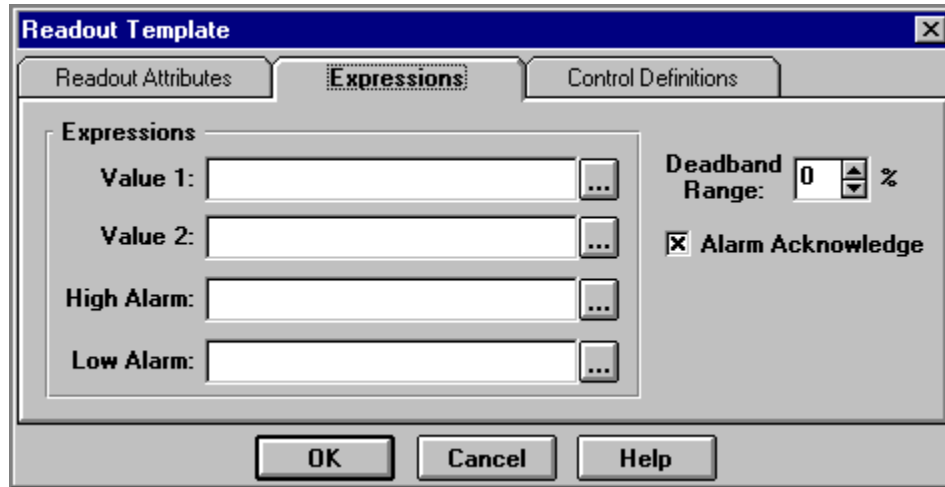
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Readout Template – Expressions Tab

The **Readout Template - Expressions Tab** dialog box is shown below.



The fields in the **Readout Template - Expressions Tab** dialog box are described below.

**Value 1:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Readout Template.

When viewing the Readout Template, Value 1 will be in the center of the template.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

The following examples of expressions use a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

**[123]**

The expression can be a single word reference. This example references word 123.

**[(123)\*10]+[124]**

This mathematical expression includes PLC references and constants that solve to a value.

**[name1,242]+[name2,243]**


Information from multiple PLCs can be included in the same expression. In this expression, word 242 in PLC name1 is added to word 243 in PLC name2.

Refer to the list of Conditional Expression Operators for more information.

**Value 2:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Readout Template.

When viewing the Readout Template, Value 2 will be at the bottom of the template. It is most often used as the setpoint for the device.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.


If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**High Alarm:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 exceeds the High Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the template will be displayed as follows:

- For PanelMate Grayscale units, the template will be displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the template will be displayed with white characters on a blinking red background.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical and Boolean expressions may be used including multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.

**Low Alarm:** Allows you to enter a Low Alarm Expression. The results of the Low Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 is less than the Low Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the template will be displayed as follows:

- For PanelMate Grayscale units, the template will be displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the template will be displayed with white characters on a blinking red background.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical and Boolean expressions may be used including multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

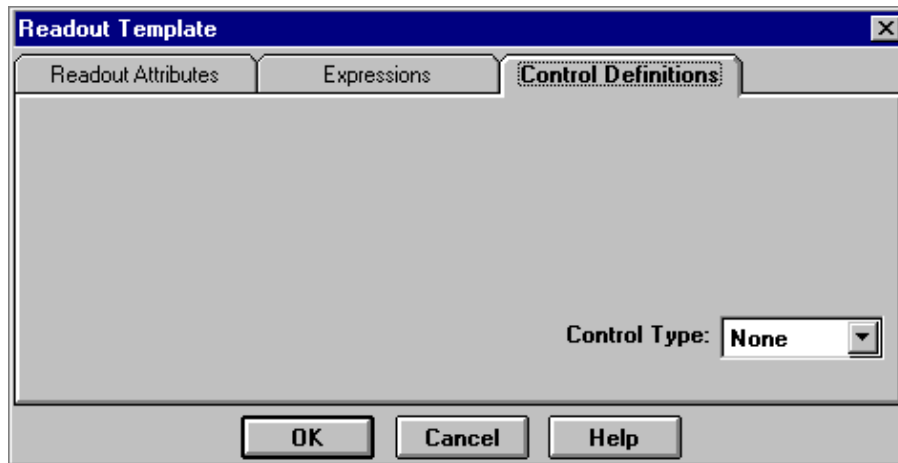
If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.



## Readout Template – Control Definitions Tab

The **Readout Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Readout Template - Control Definitions Tab** dialog box are described below.

**Control Type:** Allows you to define the control type used for the template. The selections are described below.

**None:** Allows the template to show a value that the operator cannot control.

**Buttons:** Requires the operator to use control buttons to change a setpoint value. If you choose Buttons, the dialog box will change. Refer to the **Readout Template - Control Definitions Tab with Button Control** topic for more information.

**Numeric:** Requires the operator to enter a setpoint value. If you choose Numeric, the dialog box will change. Refer to the **Readout Template - Control Definitions Tab with Numeric Control** topic for more information.

Note that if Numeric or Button is selected, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

## Readout Template – Control Definitions Tab with Button Control

The **Readout Template - Control Definitions Tab** dialog box with button control is shown below.



The **Readout Template - Control Definitions Tab** dialog box with button control defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available. When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Readout Template - Control Definitions Tab** dialog box are described below.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

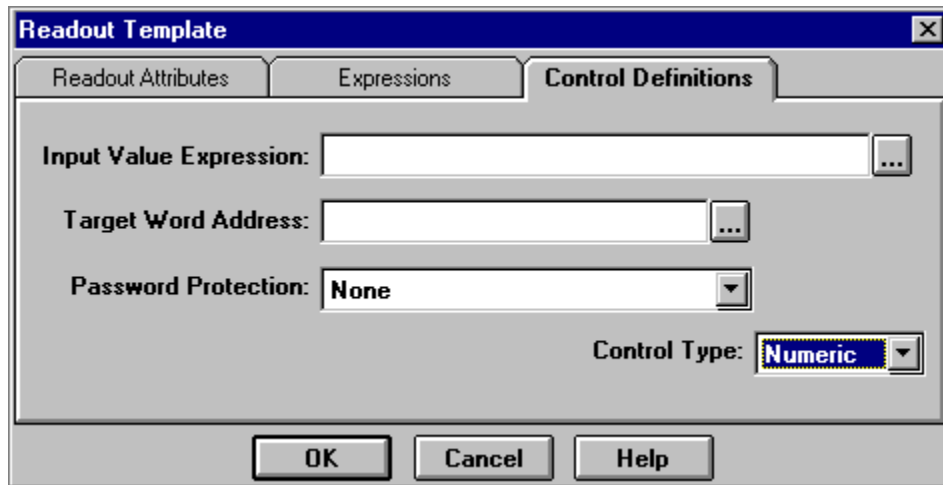
**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


### Readout Template – Control Definitions Tab with Numeric Control

The **Readout Template - Control Definitions Tab** dialog box with numeric control is shown below.



The fields in the **Readout Template - Control Definitions Tab** dialog box with numeric control are described below.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

**[?]-32)\*5/9**

The operator's input is changed from Fahrenheit to Celsius.

**[?]\*(?[>=0)\*([?]<=100)+([?]<0)\*[123]+([?]>100)\*[123]**

**Target Word Address is [123]**

This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

Refer to the list of Conditional Expression Operators for more information.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

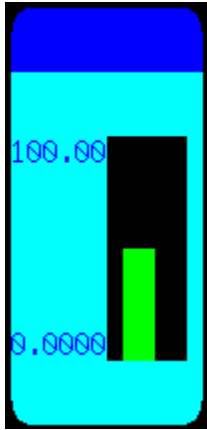
The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

## Bar Template

Bar Templates are designed to be used as the analog meters and faceplates on a control panel and are used to indicate a value in analog fashion, with a bar graph. The bar graph can show current value, setpoint, and high and low alarm levels. The current value and setpoint are also displayed digitally. The PanelMate unit also provides two ways for the operator to change a PLC value.

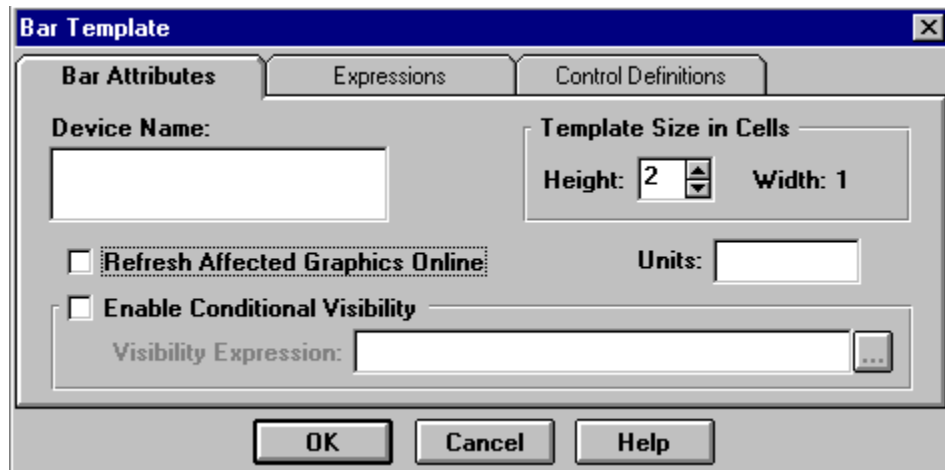


The Bar Template consists of three tabbed dialog boxes that are displayed below.

- Bar Template - Bar Attributes Tab
- Bar Template - Expressions Tab
- Bar Template - Control Definitions Tab

## Bar Template – Bar Attributes Tab

The **Bar Template - Bar Attributes Tab** dialog box is shown below.



The fields in the **Bar Template - Bar Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Allows you to enter the height of the Bar Template as 2 or 3.

**Width:** Displays the width of the Bar Template as 1. This value cannot be changed.


**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Units:** Allows you to define the type of units that will be displayed to the operator, such as “Deg. F” or “gals”. The Units field accepts alphanumeric characters.

**Enable Conditional Visibility:** Allows you to determine if the Bar Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

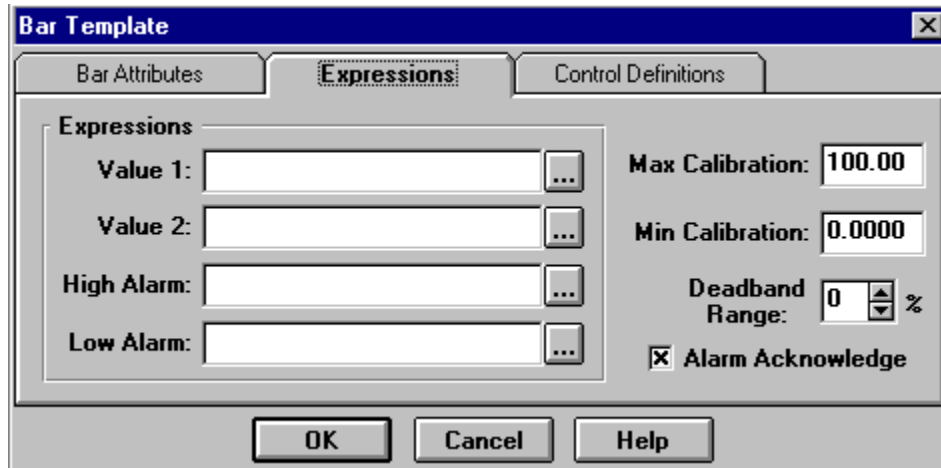
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Bar Template – Expression Tab

The **Bar Template - Expressions Tab** dialog box is shown below.




The fields in the **Bar Template - Expressions Tab** dialog box are described below.

**Value 1:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Bar Template.

When viewing the Bar Template, Value 1 will be displayed as follows:

- For PanelMate Grayscale units, Value 1 is displayed as a high intensity bar on the template.
- For PanelMate Color units, Value 1 is displayed as a green bar on the template.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

The following examples of expressions use a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

**[123]**

The expression can be a single word reference. This example references word 123.

**[(123)\*10]+[124]**

This mathematical expression includes PLC references and constants that solve to a value.

**[name1,242]+[name2,243]**

Information from multiple PLCs can be included in the same expression. In this expression, word 242 in PLC name1 is added to word 243 in PLC name2.

Refer to the list of Conditional Expression Operators for more information.




**Value 2:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Bar Template.

When viewing the Bar Template, Value 2 will be displayed as follows:

- For PanelMate Grayscale units, Value 2 is displayed as a medium intensity horizontal line to the right of the Value 1 bar.
- For PanelMate Color units, Value 2 is displayed as a white horizontal line to the right of the Value 1 bar. It is most often used as the setpoint for the device.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.


If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**High Alarm:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 exceeds the High Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the bar will be displayed as follows:

- For PanelMate Grayscale units, ALARM! will appear on the template (below the Device Name) in medium foreground intensity on blinking high intensity background. A High Alarm bar is shown in high intensity to the right of the Value 1 bar.
- For PanelMate Color units, ALARM! will appear on the template (below the Device Name) in white on blinking red. A High Alarm bar is shown in red to the right of the Value 1 bar.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.


If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Low Alarm:** Allows you to enter a Low Alarm Expression. The results of the Low Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 is less than the Low Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the bar will be displayed as follows:

- For PanelMate Grayscale units, ALARM! will appear on the template (below the Device Name) in medium foreground intensity on blinking high intensity background. A Low Alarm bar is shown in high intensity to the right of the Value 1 bar.
- For PanelMate Color units, ALARM! will appear on the template (below the Device Name) in white on blinking red. A Low Alarm bar is shown in red to the right of the Value 1 bar.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Max Calibration:** Allows you to determine the highest point of the Value 1 bar. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

On a 3-high Bar Template, the PanelMate unit will use the Maximum and Minimum Calibrations to calculate the bar's midpoint and will place that value on the template.

**Min Calibration:** Allows you to determine the lowest point of the Value 1 bar trend. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

On a 3-high Bar Template, the PanelMate unit will use the Maximum and Minimum Calibrations to calculate the bar's midpoint and will place that value on the template.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

## Bar Template – Control Definitions Tab

The **Bar Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Bar Template - Control Definitions Tab** dialog box are described below.

**Control Type:** Allows you to define the control type used for the template. The selections are described below.

**None:** Allows the template to show a value that the operator cannot control.

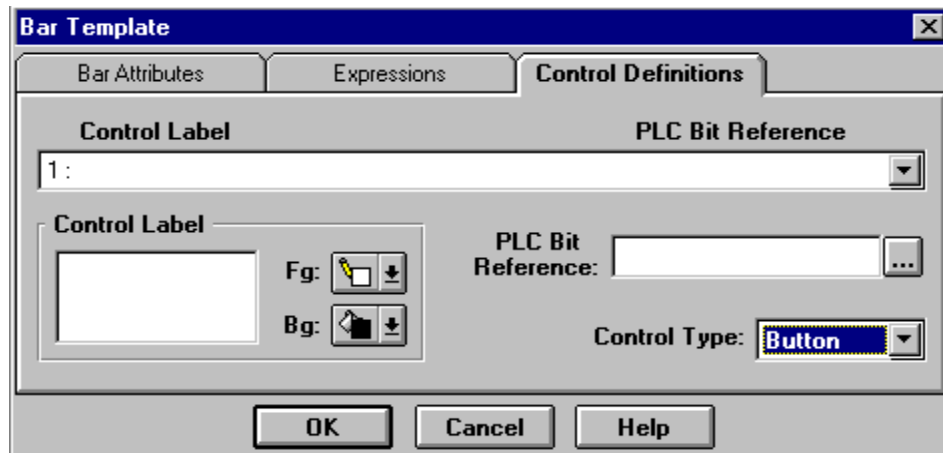
**Buttons:** Requires the operator to use control buttons to change a setpoint value. If you choose Buttons, the dialog box will change. Refer to the **Bar Template - Control Definitions Tab with Button Control** topic for more information.

**Numeric:** Requires the operator to enter a setpoint value. If you choose Numeric, the dialog box will change. Refer to the **Bar Template - Control Definitions Tab with Numeric Control** topic for more information.

Note that if Numeric or Button is selected, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

## Bar Template – Control Definitions Tab with Button Control

The **Bar Template - Control Definitions Tab** dialog box with button control is shown below.



The **Bar Template - Control Definitions Tab** dialog box with button control defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Bar Template - Control Definitions Tab** dialog box are described below.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


### Bar Template – Control Definitions Tab with Numeric Control

The **Bar Template - Control Definitions Tab** dialog box with numeric control is shown below.



The fields in the **Bar Template - Control Definitions Tab** dialog box with numeric control are described below.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

$([?]-32)*5/9$

The operator's input is changed from Fahrenheit to Celsius.

$[?]*([?]>=0)*([?]<=100)+([?]<0)*[123]+([?]>100)*[123]$

**Target Word Address is [123]**

This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

Refer to the list of Conditional Expression Operators for more information.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

## Table Template

Table Templates are designed to display a table of values and accept numeric entry for all the items in the table. Table Templates can be used for machine setup, recipe entry, or for any application requiring a high-density display and entry of information.



Table Templates can support up to 50 independent entries. Each entry has a tag name, current value, edit value, and a units field. The Table Template has built-in scroll capabilities to allow you to select the desired entry field. A scroll indicator at left side of the template indicates top and bottom with stop bars. The presence of more items is identified by up or down arrows. The control buttons on the right of the screen permit up/down scrolling, return to home or open a selected field for numeric entry.

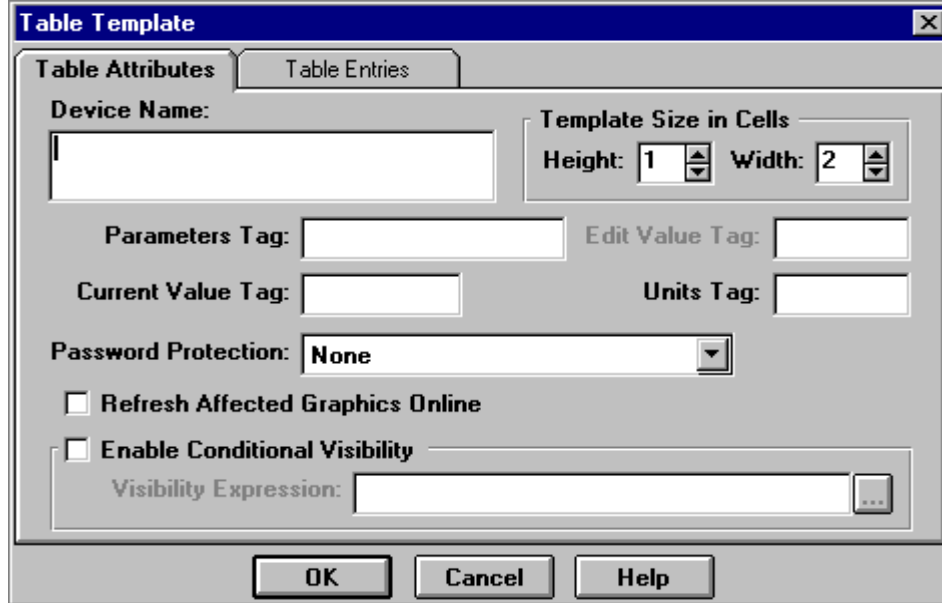
The control indicator at the bottom left of the template indicates control is available for a particular entry. You can configure each entry for numeric entry or for display only.

The Table Template consists of two tabbed dialog boxes that are listed below.

- Table Template - Table Attributes Tab
- Table Template - Table Entries Tab

## Table Template – Table Attributes Tab

The **Table Template - Table Attributes Tab** dialog box is shown below.



The fields in the **Table Template - Table Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Allows you to enter the height of the Table Template as 1, 2, or 3. The height of the Table Template determines the number of table entries that can be displayed at one time.

- A 1-high template can display 2 table entries.
- A 2-high template can display 9 table entries.
- A 3-high template can display 16 table entries.

**Width:** Allows you to enter the width of the Table Template as 2 or 3.

**Parameters Tag:** Allows you to enter a title for the Parameters column in the Table Template. The Parameters Tag field accepts 12 normal-sized characters in a 2-wide template and accepts 18 normal-sized characters in a 3-wide template.

**Edit Value Tag:** Allows you to enter a title for the Edit Values column in the Table Template. The Edit Value field is enabled only when a 3-Wide template is being configured. The field accepts up to 6 normal-sized characters. These values are the operator's input. The Edit Value Tag field values remain until the Table Template is re-selected or when the page is first displayed. Refer to the Input Value Expression field in the **Table Template - Table Entries Tab** topic for more information.



**Current Value Tag:** Allows you to enter a title for the Current Values column in the Table Template. The Current Value Tag field accepts up to 7 normal-sized characters. Refer to the Value Expression field in the **Table Template - Table Entries Tab** topic for more information.

**Units Tag:** Allows you to enter a title for the Units column in the Table Template. The Units Tag field accepts up to 5 normal-sized characters.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.


The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Table Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

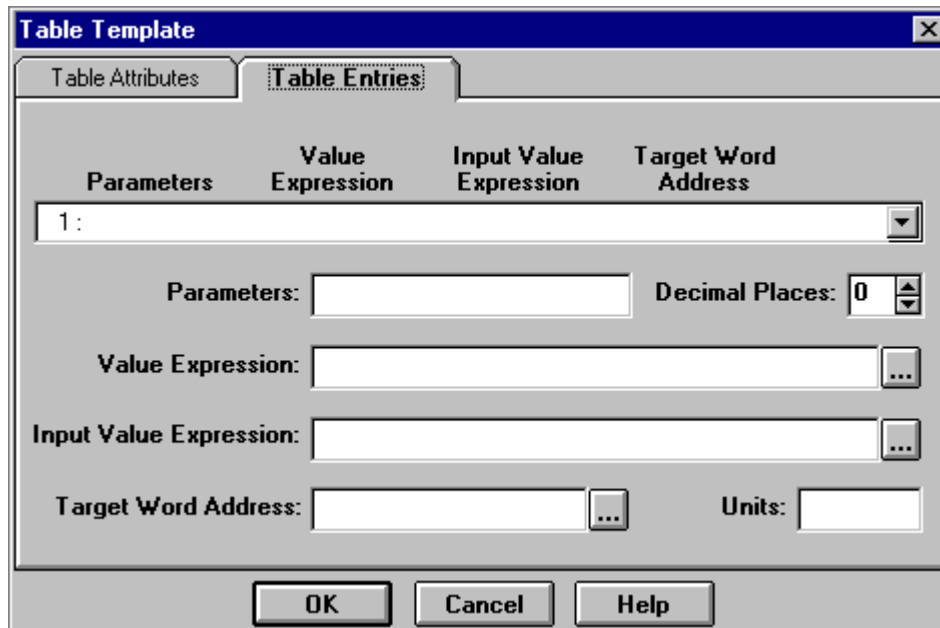
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


## Table Template – Table Entries Tab

The **Table Template - Table Entries Tab** dialog box is shown below.



The fields in the **Table Template - Table Entries Tab** dialog box are described below.

**Parameters/Value Expression/Input Value Expression/Target Word Address:** Displays parameters, value expression, input value expressions, and target word address configured for the Table Template. You can configure up to 50 independent display/entry fields.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


Line 1 of the table corresponds to the first item, line 2 corresponds to the second line, etc. It is not necessary to use all 50 lines. When the PanelMate unit goes online, the scroll will stop at the last completed entry. You may leave blank lines in the table and use lines for display purposes only.

**Parameters:** Allows you to enter the descriptor for each individual table entry.

The Parameter field information is saved to disk only if there is a number in the Value Expression Column. To save parameter text for test purposes, enter a Value Expression of 1.

**Decimal Places:** Allows you to determine how the number will be formatted when displayed in the Current Value field and the Edit Value field. This field accepts the numbers 0 through 5.

**Value Expression:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Table Template. This expression is any mathematical operation to be performed on the monitored value before it is displayed on the screen.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

The following examples of expressions use a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

**[123]**

The expression can be a single word reference. This example references word 123.

**[(123)\*10]+[124]**


This mathematical expression includes PLC references and constants that solve to a value.

**[name1,242]+[name2,243]**

Information from multiple PLCs can be included in the same expression. In this expression, word 242 in PLC name1 is added to word 243 in PLC name2.

Refer to the list of Conditional Expression Operators for more information.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

**([?]-32)\*5/9**

The operator's input is changed from Fahrenheit to Celsius.

**[?]\*([?]>=0)\*([?]<=100)+([?]<0)\*[123]+([?]>100)\*[123]**


**Target Word Address is [123]**

This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

Refer to the list of Conditional Expression Operators for more information.

If an expression is defined for an individual entry, a small arrow will be displayed in the lower left corner of the template to indicate that numeric entry is available while the template is selected.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

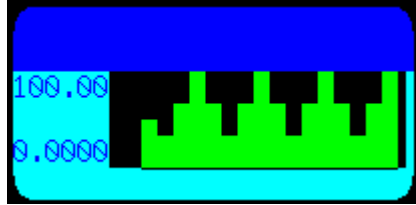
If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Units:** Allows you to define the type of units that will be displayed to the operator, such as "Deg. F" or "gals". The Units field accepts alphanumeric characters.

## Bar Trend Template

Bar Trend Templates are designed to collect, store, and represent data in a manner that provides a historical perspective on how a single data point has changed and that provides some insight on how the data point may behave in the future.

The Bar Trend Template shows current value, setpoint, and high and low alarm levels. The current value and setpoint display digitally.

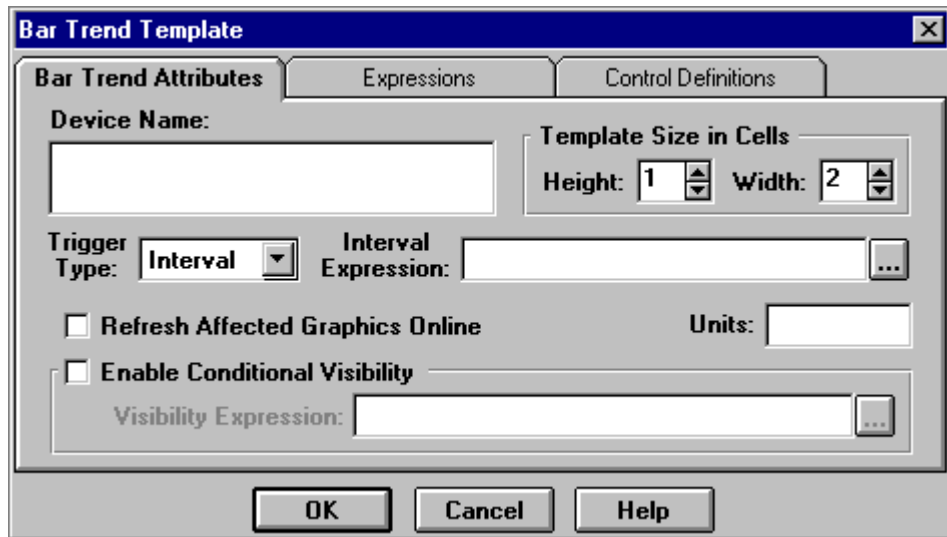


The Bar Trend Template consists of three tabbed dialog boxes that are listed below.

- Bar Trend Templates - Bar Trend Attributes Tab
- Bar Trend Templates - Expressions Tab
- Bar Trend Templates - Control Definitions Tab

## Bar Trend Template – Bar Trend Attributes Tab

The **Bar Trend Template - Bar Trend Attributes Tab** dialog box is shown below.



The fields in the **Bar Trend Template - Bar Trend Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Allows you to enter the height of the Bar Trend Template as 1, 2, or 3.

**Width:** Allows you to enter the width of the Bar Trend Template as 2 or 3. The width of the Bar Trend Template determines the number of trend samples that can be displayed at one time.

- A 2-wide template can display 16 trend samples.
- A 3-wide template can display 29 trend samples.

**Trigger Type:** Allows you to select the trigger type for the trending. The selections are described below.

**Interval:** Allows you to sample a trend value when a time period has elapsed. The Interval in conjunction with the Trend Scan Delay designates the time interval between trend samples. (The Trend Scan Delay is configured in the **System Parameters - Communications Tab** dialog box.)

The following equation is used to calculate the time interval between trend samples:

$$\text{Trend Scan Delay} \times \text{Interval} = \text{Sample Rate}$$

For example, if the Trend Scan Delay is 2 seconds and the Interval is 3, the sample rate will be 6 seconds.

If the Interval trigger type is selected, the Interval Expression field will be displayed.

**Discrete:** Allows you to sample a trend value when an external value (e.g., a bit reference in the PLC) changes resulting in the Interval Expression value changing from false to true. If the Discrete trigger type is selected, the Discrete Expression field will be displayed.

**Change:** Allows you to sample a trend value when the Value 1 Expression (trend value) changes. If the Change trigger type is selected, the Interval Expression field and the Discrete Expression field will not be displayed.

If the Bar Trend Template has the Change trigger type configured and the source data is floating point instead of integer, the data in the template will only update when the value prior to the decimal point changes. When trending floating point values, it is better to use either the Interval or Discrete trigger types.


**Interval Expression:** Appears only when the Interval trigger type is selected. The Interval Expression field allows you to enter an expression that will determine the trend value sample rate. The result of the Interval Expression multiplied by the Trend Scan Delay (set in the **System Parameters - Remote Tab** dialog box) determines the trend value sample rate. The sample rate can range from 1 to 2,147,483 seconds.

For example, if the Trend Scan Delay is configured for 2 seconds and the Interval Expression evaluates to 5, the trend will be updated every 10 seconds. If the resulting sample rate is 0, the data collection for the trend template will be disabled. If the Trend Scan Delay is 0, it is assumed as 1 second when calculating the sample rate.

Note that if an interval is selected that is too rapid for the PanelMate unit or PLC to keep up with the request, a blank bar will appear where any interval has been missed. Low sample values might also cause a blank bar to appear. To distinguish a low sample value from a missed interval, configure the minimum calibration lower than the lowest expected minimum value.


- For PanelMate Grayscale units, Interval is the value that displays as a medium intensity horizontal bar to the right of the Value 1 bar.
- For PanelMate Color units, Interval is the value that displays as a blue horizontal bar to the right of the Value 1 bar.

Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Discrete Expression:** Appears only when the Discrete trigger type is selected. The Discrete Expression field allows you to enter an expression so that a trend will be sampled when the result of the expression changes from false to true.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Units:** Allows you to define the type of units that will be displayed to the operator, such as “Deg. F” or “gals”. The Units field accepts alphanumeric characters.

**Enable Conditional Visibility:** Allows you to determine if the Bar Trend Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

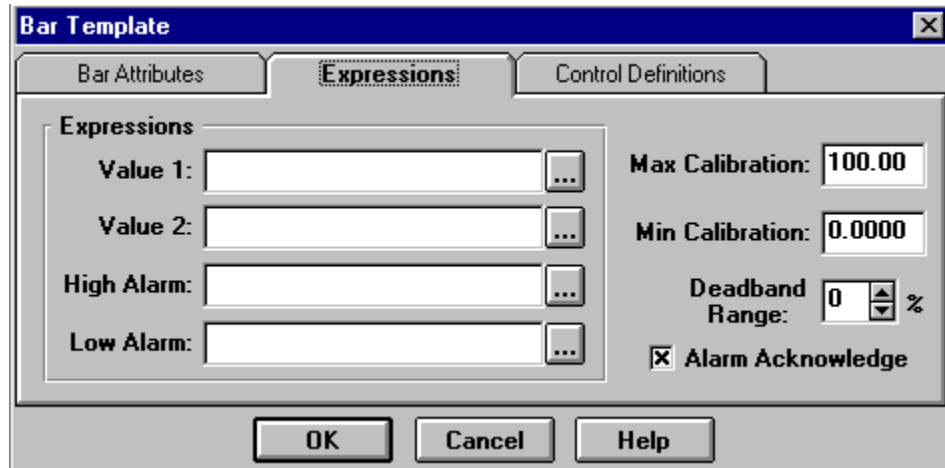
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Bar Trend Template – Expressions Tab

The **Bar Trend Template - Expressions Tab** dialog box is shown below.




The fields in the **Bar Trend Template - Expressions Tab** dialog box are described below.

**Value 1:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Bar Trend Template.

When viewing the Bar Trend Template, Value 1 will be displayed as follows:

- For PanelMate Grayscale units, Value 1 is displayed as a no intensity horizontal bar in the center of the template.
- For PanelMate Color units, Value 1 is displayed as a green horizontal bar in the lower center of the template.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

The following examples of expressions use a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

**[123]**

The expression can be a single word reference. This example references word 123.

**[(123)\*10]+[124]**

This mathematical expression includes PLC references and constants that solve to a value.

**[name1,242]+[name2,243]**

Information from multiple PLCs can be included in the same expression. In this expression, word 242 in PLC name1 is added to word 243 in PLC name2.

Refer to the list of Conditional Expression Operators for more information.

Note that Bar Trend Templates will not update if all references in these templates are unsolicited. If at least one reference in a Bar Trend Template is not unsolicited, then all references will update.




When floating point references are used, be certain the maximum possible value will not exceed the PanelMate unit's unsigned 32-bit word limit (4,294,967,295). A value exceeding the limit will cause a Watchdog Time-out error or generate an Exception error during online or runtime operation. You may wish to consider using scaled integer values instead of floating point values.

**Value 2:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Bar Trend Template.

When viewing the Bar Trend Template, Value 2 will be displayed as follows:

- For PanelMate Grayscale units, Value 2 is displayed as a high intensity bar to the left of the Value 1 bar.
- For PanelMate Color units, Value 2 is displayed as a white horizontal bar to the left of the Value 1 bar. It is most often used as the setpoint for the device.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.


Note that Bar Trend Templates will not update if all references in these templates are unsolicited. If at least one reference in a Bar Trend Template is not unsolicited, then all references will update.

When floating point references are used, be certain the maximum possible value will not exceed the PanelMate unit's unsigned 32-bit word limit (4,294,967,295). A value exceeding the limit will cause a Watchdog Time-out error or generate an Exception error during online or runtime operation. You may wish to consider using scaled integer values instead of floating point values.

**High Alarm:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 exceeds the High Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the trend sample will be displayed as follows:

- For PanelMate Grayscale units, the trend sample is displayed in high intensity. The trend sample will continue to be displayed in high intensity as other trend samples are being collected as long as Value 1 exceeds the High Alarm Expression value. A High Alarm bar is shown in high intensity to the left of the Bar Trend Template.
- For PanelMate Color units, the trend sample is displayed in red. The trend sample will continue to be displayed in red as other trend samples are being collected as long as Value 1 exceeds the High Alarm Expression value. A High Alarm bar is shown in red to the left of the Bar Trend Template.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.

**Low Alarm:** Allows you to enter a Low Alarm Expression. The results of the Low Alarm Expression are compared to the results of the Value 1 Expression. If Value 1 is less than the Low Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the trend sample will be displayed as follows:

- For PanelMate Grayscale units, the variable-sized template is displayed in high intensity. The trend sample will continue to be displayed in high intensity as other trend samples are being collected as long as Value 1 is less than the Low Alarm Expression value. A Low Alarm bar is shown in high intensity to the left of the Bar Trend Template.
- For PanelMate Color units, the variable-sized template is displayed in red. The trend sample will continue to be displayed in red as other trend samples are being collected as long as Value 1 is less than the Low Alarm Expression value. A Low Alarm bar is shown in red to the left of the Bar Trend Template.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.

**Max Calibration:** Allows you to determine the highest point of the line trend. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Min Calibration:** Allows you to determine the lowest point of the line trend. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

## Bar Trend Template – Control Definitions Tab

The **Bar Trend Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Bar Trend Template - Control Definitions Tab** dialog box are described below.

**Control Type:** Allows you to define the control type used for the template. The selections are described below.

**None:** Allows the template to show a value that the operator cannot control.

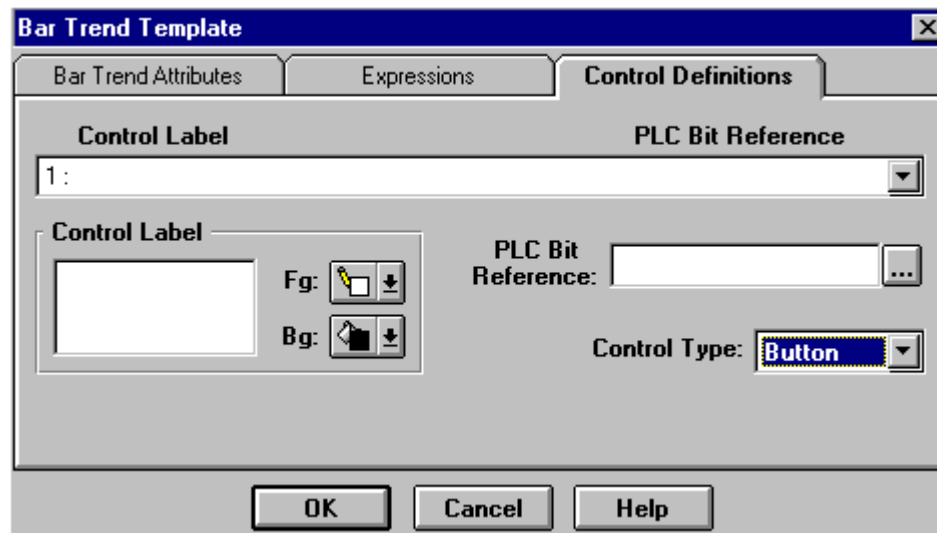
**Buttons:** Requires the operator to use control buttons to change a setpoint value. If you choose Buttons, the dialog box will change. Refer to the **Bar Trend Template - Control Definitions Tab with Button Control** topic for more information.

**Numeric:** Requires the operator to enter a setpoint value. If you choose Numeric, the dialog box will change. Refer to the **Bar Trend Template - Control Definitions Tab with Numeric Control** topic for more information.

Note that if Numeric or Button is selected, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

### Bar Trend Template – Control Definitions Tab with Button Control

The **Bar Trend Template - Control Definitions Tab** dialog box with button control is shown below.



The **Bar Trend Template - Control Definitions Tab** dialog box with button control defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Bar Trend Template - Control Definitions Tab** dialog box with button control are described below.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

### Bar Trend Template – Control Definitions Tab with Numeric Control

The **Bar Trend Template - Control Definitions Tab** dialog box with numeric control is shown below.



The fields in the **Bar Trend Template - Control Definitions Tab** dialog box with numeric control are described below.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

$([?]-32)*5/9$


The operator's input is changed from Fahrenheit to Celsius.

$[?]*([?]>=0)*([?]<=100)+([?]<0)*[123]+([?]>100)*[123]$

**Target Word Address is [123]**

This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.


Refer to the list of Conditional Expression Operators for more information.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

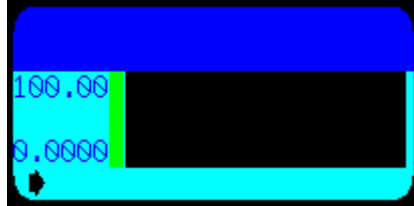
The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

## Line Trend Template

Note that the Advanced Trending option must be installed in the PanelMate unit and the Advanced Trending Template box must be selected in the **New Configuration** dialog box or in the **Configuration Properties** dialog box before a Line Trend Template can be created.

Line Trend Templates are designed to collect, store, and represent data in a manner that provides a historical perspective on how a single data point has changed and some insight on how the data point may behave in the future.

The Line Trend Template shows current value, setpoint, and high and low alarm levels. The current value and setpoint display digitally.



The Line Trend Template consists of three tabbed dialog boxes that are listed below.

- Line Trend Template - Line Trend Attributes Tab
- Line Trend Template - Pen Definitions Tab
- Line Trend Template - Control Definitions Tab



## Line Trend Template – Line Trend Attributes Tab

The Line Trend Template - Line Trend Attributes Tab dialog box is shown below.

The screenshot shows the 'Line Trend Template' dialog box with the 'Line Trend Attributes' tab selected. The dialog is divided into three tabs: 'Line Trend Attributes', 'Pen Definitions', and 'Control Definitions'. The 'Line Trend Attributes' tab contains the following controls:

- Device Name:** A text input field.
- Template Size in Cells:** Two spinners for 'Height' (set to 1) and 'Width' (set to 2).
- Trigger Type:** A dropdown menu set to 'Interval'.
- Interval Expression:** A text input field with a browse button (...).
- Deadband Range:** A spinner set to 0, followed by a percentage sign (%).
- Alarm Acknowledge:** A checked checkbox.
- Chart Bg:** A color selection button.
- Grid Line Setup:** A section containing:
  - Horizontal Lines:** A spinner set to 0.
  - Vertical Lines Every:** A spinner set to 0.
  - Samples:** A text input field.
  - Color:** A color selection button.
- Refresh Affected Graphics Online:** An unchecked checkbox.
- Enable Conditional Visibility:** An unchecked checkbox.
- Visibility Expression:** A text input field with a browse button (...).

At the bottom of the dialog are three buttons: 'OK', 'Cancel', and 'Help'.

The fields in the **Line Trend Template - Line Trend Attributes Tab** dialog box are described below.

**Device Name:** Allows you to enter a device name. The device name will display in the upper area of the template in the normal font. You may press the **Return** key to insert a carriage return.

The Device Name field has an auto centering capability. If you wish to center the Device Name, check the Device Names box in the Auto Centering field in the **Configuration Properties** dialog box.

Note that the name used in the Device Name field may be part of an alarm message. Be aware that only 22 characters for the Device Name will appear when the alarm message displays in Run Mode. The Device Name field allows you to enter more than 22 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

### Template Size In Cells

**Height:** Allows you to enter the height of the Line Trend Template as 1, 2, or 3. The height of the Line Trend Template determines the number of trend samples that can be displayed at one time.

**Width:** Allows you to enter the width of the Line Trend Template as 2, 3, 4, or 5.

**Trigger Type:** Allows you to select the trigger type for the trending. The selections are described below.

**Interval:** Allows you to sample a trend value when a time period has elapsed. The Interval in conjunction with the Trend Scan Delay designates the time interval between trend samples. (The Trend Scan Delay is configured in the **System Parameters - Communications Tab** dialog box.)

The following equation is used to calculate the time interval between trend samples:

$$\text{Trend Scan Delay} \times \text{Interval} = \text{Sample Rate}$$

For example, if the Trend Scan Delay is 2 seconds and the Interval is 3, the sample rate will be 6 seconds.

If the Interval trigger type is selected, the Interval Expression field will be displayed.

**Discrete:** Allows you to sample a trend value when an external value (e.g., a bit reference in the PLC) changes resulting in the Interval Expression value changing from false to true. If the Discrete trigger type is selected, the Discrete Expression field will be displayed.

**Change:** Allows you to sample a trend value when the Value 1 Expression (trend value) changes. If the Change trigger type is selected, the Interval/Discrete Expression field will not be displayed.

If the Line Trend Template has the Change trigger type configured and the source data is floating point instead of integer, the data in the template will only update when the value prior to the decimal point changes. When trending floating point values, it is better to use either the Interval or Discrete trigger types.


**Interval Expression:** Appears only when the Interval trigger type is selected. The Interval Expression field determines the trend value sample rate. The result of the Interval Expression multiplied by the Trend Scan Delay (set in the **System Parameters - Remote Tab** dialog box) determines the trend value sample rate. The sample rate can range from 1 to 2,147,483 seconds.

For example, if the Trend Scan Delay is configured for 2 seconds and the Interval Expression evaluates to 5, the trend will be updated every 10 seconds. If the resulting sample rate is 0, the data collection for the trend template will be disabled. If the Trend Scan Delay is 0, it is assumed as 1 second when calculating the sample rate.

Note that if an interval is selected that is too rapid for the PanelMate unit or PLC to keep up with the request, a blank space will appear where any interval has been missed. Low sample values might also cause a blank space to appear. To distinguish as low sample value from a missed interval, configure the minimum calibration lower than the lowest expected minimum value.


- For PanelMate Grayscale units, Interval is the value that displays as a medium intensity horizontal bar to the right of the Value 1 bar.
- For PanelMate Color units, Interval is the value that displays as a blue horizontal bar to the right of the Value 1 bar.

Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Discrete Expression:** Appears only when the Discrete trigger type is selected. The Discrete Expression field allows you to enter an expression so that a trend will be sampled when the result of the expression changes from false to true.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be removed from the list when the alarm condition clears. Note that a cleared alarm message will be sent to the printer if one is configured.

**Chart Bg:** Allows you to select the background color or intensity for the chart. The **Chart Bg** button will display the standard Color Selection Palette.

### Grid Line Setup

These controls define a grid that displays on the Line Trend Template.

**Horizontal Lines:** Allows you to elect the number of horizontal grid lines displayed for the Line Trend Template.

**Vertical Lines Every n Samples:** Allows you to determine the spacing of the vertical grid lines.


**Color:** Allows you to select the foreground color or intensity for the grid lines. The **Color** button will display the standard Color Selection Palette.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Line Trend Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Line Trend Template – Pen Definitions Tab

The **Line Trend Template - Pen Definitions Tab** dialog box is shown below.

The screenshot shows the 'Line Trend Template' dialog box with the 'Pen Definitions' tab active. The dialog features a list box with the following entry:

Name	Max Cal.	Min Cal.	Value Expression
1 :	100.00	0.0000	


Below the list box, there are several input fields and buttons:

- Name:** An empty text box.
- Units:** An empty text box.
- Value Expression:** An empty text box with a browse button (...).
- High Alarm Expression:** An empty text box with a browse button (...).
- Low Alarm Expression:** An empty text box with a browse button (...).
- Pen Color:** A color selection button showing a white square and a downward arrow.
- Alarm Color:** A color selection button showing a red square and a downward arrow.
- Max Calibration:** A text box containing '100.00'.
- Min Calibration:** A text box containing '0.0000'.

At the bottom of the dialog are three buttons: **OK**, **Cancel**, and **Help**.

The fields in the **Line Trend Template - Pen Definitions Tab** dialog box are described below.

**Name/Max. Cal./Min. Cal. Value Expression:** Line 1 in this list box corresponds to the top pen; line 2 corresponds to the next pen, etc. It is not necessary to use all pens. If you do not want a particular pen, leave the line blank.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

**Name:** Allows you to enter a name for the pen. The Name field accepts alphanumeric characters.

**Units:** Allows you to define the type of units that will be displayed to the operator, such as “Deg. F” or “gals”. The Units field accepts alphanumeric characters.

**Pen Color:** Allows you to select the foreground color or intensity for the pen. The **Pen Color** button will display the standard Color Selection Palette.


**Alarm Color:** Allows you to select the foreground color or intensity for the pen when the monitored value goes into an alarm condition. The **Alarm Color** button will display the standard Color Selection Palette.

**Max Calibration:** Allows you to determine the highest point of the line trend. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Min Calibration:** Allows you to determine the lowest point of the line trend. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Value Expression:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Line Trend Template. This expression is any mathematical operation to be performed on the monitored value before it is displayed on the screen.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

The following examples of expressions use a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

**[123]**

The expression can be a single word reference. This example references word 123.

**[(123)\*10]+[124]**

This mathematical expression includes PLC references and constants that solve to a value.

**[name1,242]+[name2,243]**

Information from multiple PLCs can be included in the same expression. In this expression, word 242 in PLC name1 is added to word 243 in PLC name2.

Refer to the list of Conditional Expression Operators for more information.


Note that Line Trend Templates will not update if all references in these templates are unsolicited. If at least one reference in a Line Trend Template is not unsolicited, then all references will update.

When floating point references are used, be certain the maximum possible value will not exceed the PanelMate unit's unsigned 32-bit word limit (4,294,967,295). A value exceeding the limit will cause a Watchdog Time-out error or generate an Exception error during online or runtime operation. You may wish to consider using scaled integer values instead of floating point values.

**High Alarm Expression:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value Expression. If Value exceeds the High Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the trend sample will be displayed as follows:

- For PanelMate Grayscale units, the trend sample is displayed in the color defined in the Alarm Color field. The trend sample will continue to be displayed in the alarm color as other trend samples are being collected as long as Value exceeds the High Alarm Expression value. A High Alarm bar is shown in high intensity to the left of the Line Trend Template.
- For PanelMate Color units, the trend sample is displayed in the color defined in the Alarm Color field. The trend sample will continue to be displayed in the alarm color as other trend samples are being collected as long as Value exceeds the High Alarm Expression value. A High Alarm bar is shown in red to the left of the Line Trend Template.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.

**Low Alarm Expression:** Allows you to enter a Low Alarm Expression. The results of the Low Alarm Expression are compared to the results of the Value Expression. If Value is less than the Low Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the trend sample will be displayed as follows:

- For PanelMate Grayscale units, the trend sample is displayed in the Alarm Color field high intensity. The trend sample will continue to be displayed in the alarm color as other trend samples are being collected as long as Value is less than the Low Alarm Expression value. A Low Alarm bar is shown in high intensity to the left of the Line Trend Template.
- For PanelMate Color units, the trend sample is displayed in the Alarm Color field. The trend sample will continue to be displayed in the alarm color as other trend samples are being collected as long as Value is less than the Low Alarm Expression value. A Low Alarm bar is shown in red to the left of the Line Trend Template.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations.

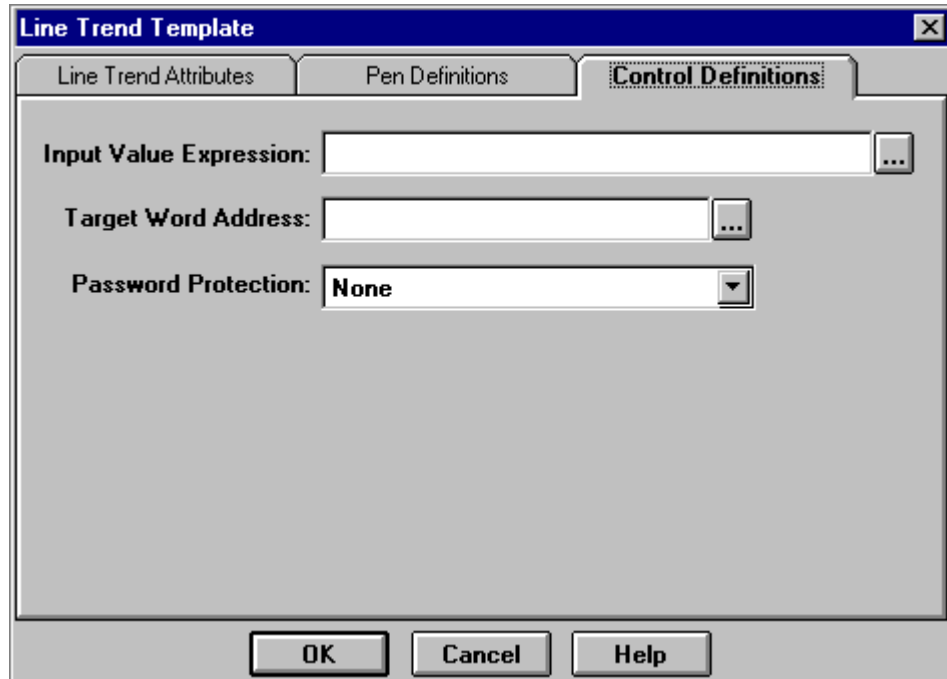
If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

This is an optional entry. If no alarm is desired for this device, leave this field blank.

Refer to the list of Conditional Expression Operators for more information.


## Line Trend Template – Control Definitions Tab

The **Line Trend Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Line Trend Template - Control Definitions Tab** dialog box are described below.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

$([?]-32)*5/9$

The operator's input is changed from Fahrenheit to Celsius.

$[?]*([?]>=0)*([?]<=100)+([?]<0)*[123]+([?]>100)*[123]$

**Target Word Address is [123]**


This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

Refer to the list of Conditional Expression Operators for more information.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.



## Display Template

Display Templates are designed to be used like standard LED or LCD message units or displays. They are most effective when used for informational messages and not as alarm messages. Up to three independent lines of text can be written in a Display Template.



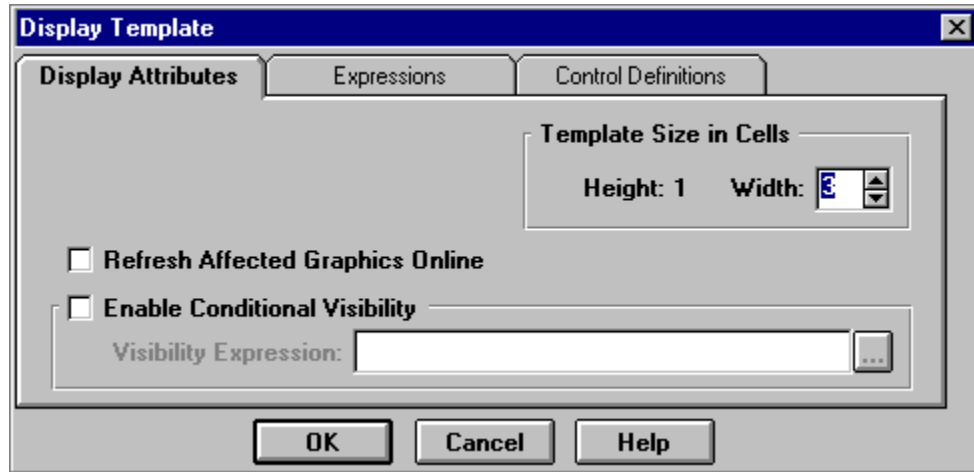
The actual creation of the message is done in the Message Library that can be selected from the **Display Template - Expressions Tab** dialog box or the Database Treeview Window.

The Display Template consists of three tabbed dialog boxes that are listed below.

- Display Template - Display Attributes Tab
- Display Template - Expressions Tab
- Display Template - Control Definitions Tab

## Display Template – Display Attributes Tab

The **Display Template - Display Attributes Tab** dialog box is shown below.



The fields in the **Display Template - Display Attributes Tab** dialog box are described below.

### Template Size In Cells

**Height:** Displays the height of the Display Template as 1. This value cannot be changed.

**Width:** Allows you to enter the width of the Display Template as 3, 4, or 5.


- A 3-wide template can display a message of up to 36 normal font characters
- A 4-wide template can display up to 49 characters
- A 5-wide template can display up to 62 characters.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Display Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

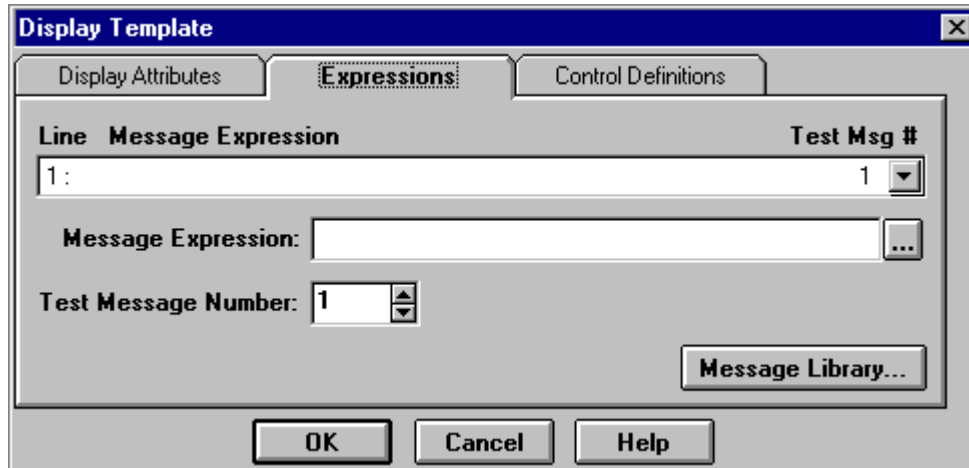
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Display Template – Expressions Tab


The **Display Template - Expressions Tab** dialog box is shown below.



The fields in the **Display Template - Expressions Tab** dialog box are described below.

**Line/Message Expression/Test Msg#:** Displays line numbers, message expressions, and test message numbers configured for the Display Template. The Line/Message Expression/Test Msg# box may contain up to three message expressions. Each line represents a single message and is numbered 1, 2, and 3 at the left of the line.

**Message Expression:** Allows you to enter a message expression. The value of the Message Expression selects which message will be displayed. The result of the Message Expression should be a number that represents the number of a message in the Message Library. The message will be displayed in the Display Template. If the Message Expression results in a number greater than the maximum number allowed in the Message Library or less than 0 when running online, the previously displayed message will be erased.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the message expression results in an invalid equation (e.g., division by a value of zero, etc.), no message displays. If a message expression previously resulted in a valid value, but in a later scan results in an invalid equation, the previously displayed message will be erased.

To display a message based on a bit, multiply the bit reference times the message number to produce the message number. For example, to display message #25 when bit [127 14] is on, enter [127 14]\*25 in the Message Expression field.

The message expression can be as simple as a word reference (e.g., [253]) or a mathematical expression which solves to a value corresponding to a message number (e.g., [254]+12). The message expression can contain multiple PLC references. Note that the preceding examples are shown using a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

When the Message Expression is true, embedded references are updated on the screen and not sent to the printer. Messages configured for BOTH or PRINTER are sent to the printer when the Message Expression changes and also when changing pages.

Note that when going to a new page that has non-global messages, messages set for PRINTER or BOTH will print once for each PLC reference in the message expression. Non-global messages on a page set for PRINTER or BOTH will print when returning from the Alarm Page, Screen Blanking, and when pressing the **Enable Fault Relay** control button, since these actions are treated as page changes.

Refer to the list of Conditional Expression Operators for more information.

The Display Template also supports the display of ASCII strings from the PLC. To display ASCII strings, place the starting address of the ASCII characters within the Message Expression field, followed by the format specifier #ASC which then is followed by the number of characters to be displayed. When the PanelMate unit recognizes an ASCII format specifier (#ASC) in the message expression, the PanelMate unit will display the ASCII string from the PLC. Optionally, a byte-swap format specifier, #BSW, can be added to swap the order of character presentation on a word-by-word basis. The following table shows a block of generic PLC registers and the decimal, hex, and ASCII values for the registers.

Registers	Decimal Value	Hex Value	ASCII Value
100	16706	4142	AB
101	17220	4344	CD
102	17734	4546	EF
103	18248	4748	GH
104	18762	494A	IJ
105	19276	4B4C	KL
106	19790	4D4E	MN
107	20304	4F50	OP
108	20818	5152	QR
109	21332	5354	ST

If the following expressions are entered in the Message Expression field, the string will be displayed as shown below.

Message Expression	Displayed String
[100#ASC20]	ABCDEFGHIJKLMN OPQRS T
[100#BSW#ASC20]	BADCFEHGJILKN MPORQT S
[105#ASC7]	KLMNOPQ
[105#BSW#ASC7]	LKNMPOR

ASCII registers displayed in this manner will appear in normal font with white foreground and black background. These display attributes (font size, foreground color, and background color) may be changed by defining them in the first two words of the string.

The most significant byte of the first word must contain a 1. This will signal the PanelMate unit that the attributes are to be altered. The least significant byte of the first word must contain the font size key.

- 01 = Normal
- 02 = Graphic
- 03 = Double-High
- 04 = Quad

The most significant byte of the second word contains the foreground color, and the least significant byte contains the background color. The colors are numbered 1 through 255 and can be determined by using the Color Palette in the Configuration Software, counting left to right and top to bottom (e.g., black=1, blue=2, green=3, cyan=4, red=5, magenta=6, yellow=7, etc.). Refer to the examples below.

Examples:

If register 98 has a value of 260 (Hex 0104), and register 99 has a value of 1287 (hex 0507), then the message [98#ASC6] would display the string ABCDEF in Quad font with red characters on yellow background.

If the byte swap format is used, then the bytes of the first two words need to be swapped. Register 98 will have a value of 1025 (hex 0401) and register 99 will have a value of 1797 (Hex 0705). The message [98#BSW#ASC6] would then display the string BADC FE in Quad font with yellow characters on a red background.

**Test Message Number:** Allows you to enter a test message number. To view a message on the page during configuration, a message number may be entered into the Test Message field. The message corresponding to this number will be displayed at the Display Template's origin. If there is not a message defined for that number, the template will be blank.

**<Message Library>:** Opens the **Message Library** dialog box. Refer to the **Message Library** topic for more information.

## Display Template – Control Definitions Tab

The **Display Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Display Template - Control Definitions Tab** dialog box are described below.

**Control Label/PLC Bit Reference:** Displays the control labels and PLC bit references and allows you to define the control buttons on the right side of the PanelMate unit. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at a particular location.

If a control button is defined, a small arrow will be displayed in the lower left corner of a template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to a 0 (zero), thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.


**Control Label:** Allows you to enter a label for a control button. This field accepts three lines of normal-sized alphanumeric characters. The text does not automatically wrap. Press the **Return** key to insert a carriage return.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

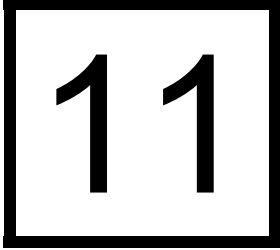
**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference for the control button. This field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. You cannot use expressions or conditional logic.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

# Variable-Sized Templates

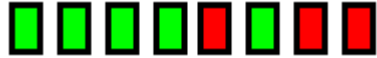


*In this chapter, you will learn:*

- *About the Variable-Sized Indicator Template*
- *About the Variable-Sized Bar Template*
- *About the Variable-Sized Readout Template*
- *About the Variable-Sized Display Template*
- *About the Variable-Sized Graphic Template*
- *About the Variable-Sized Control Button Template*

## Variable-Sized Indicator Template

Variable-Sized Indicator Templates provide the ability to create high-density status displays. One of 5 pre-defined indicators can be used to indicate the status of a device. To tie a state to information in the PLC, a conditional expression may be entered which, when evaluated to true, displays the characteristics defined for that line. The expression may be as simple as the condition of a single bit in the PLC (true = ON; false = OFF), a value comparison (register > constant), or a Boolean expression of up to 70 characters in length.



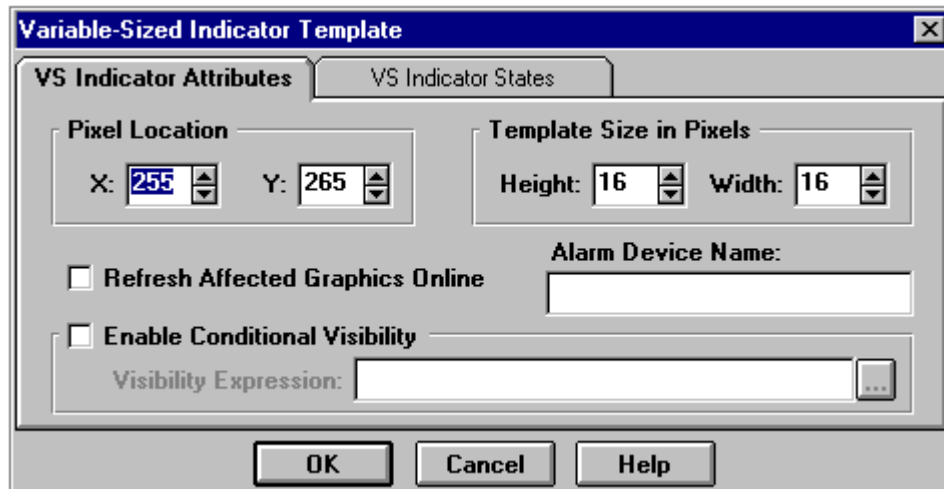
The Variable-Sized Indicator Template consists of two tabbed dialog boxes which are listed below.

- Variable-Sized Indicator Template - VS Indicator Attributes Tab
- Variable-Sized Indicator Template - VS Indicator States Tab



## Variable-Sized Indicator Template – VS Indicator Attributes Tab

The Variable-Sized Indicator Template - VS Indicator Attributes Tab dialog box is shown below.



The fields in the Variable-Sized Indicator Template - VS Indicator Attributes Tab dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Indicator Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Indicator Template.

### Template Size In Pixels

**Height:** Allows you to enter the height in pixels for the Variable-Sized Indicator Template. Note that you can also re-size the template by dragging one of the selection handles (squares) in any direction.

**Width:** Allows you to enter the width in pixels for the Variable-Sized Indicator Template. Note that you can also re-size the template by dragging one of the selection handles (squares) in any direction.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the variable-sized template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.


**Alarm Device Name:** Allows you to enter a device name to be used as part of an alarm message. The Alarm Device Name field accepts normal-sized characters.

The name used in the Alarm Device Name field may be part of an alarm message. Be aware that only 25 characters for the Alarm Device Name will appear when the alarm message displays in Run Mode. The Alarm Device Name field allows you to enter more than 25 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Indicator Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

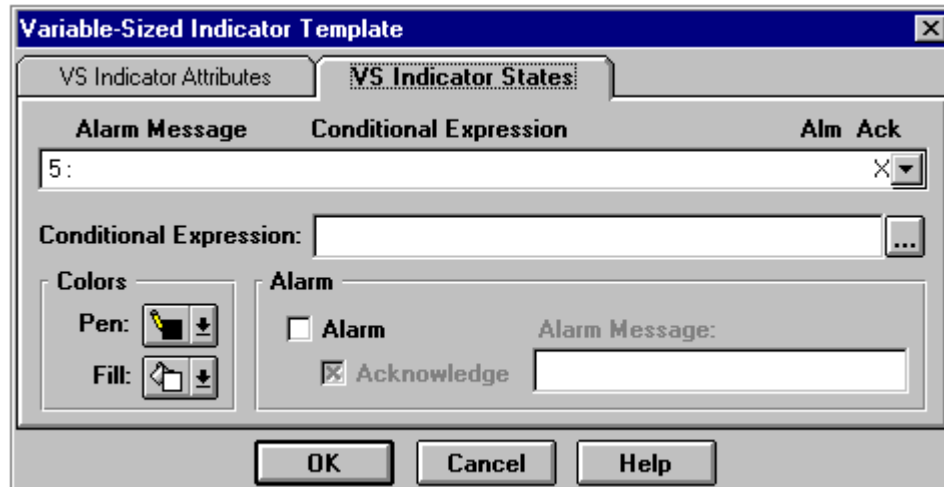
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Indicator Template – VS Indicator States Tab

The Variable-Sized Indicator Template - VS Indicator States Tab dialog box is shown below.




The fields in the Variable-Sized Indicator Template - VS Indicator States Tab dialog box are described below.

**Alarm Message/Conditional Expression/Alm/Ack:** Displays alarm messages, conditional expressions, alarms, and alarm acknowledgments configured for the Variable-Sized Indicator Template. If the conditional expression evaluates to true, the associated template characteristics will be displayed in Run Mode. Each Variable-Sized Indicator Template can display up to five alarm messages, depending upon conditions you define. Each line in this list represents one of the alarm messages.

**Conditional Expression:** Allows you to enter a conditional expression. The conditional expression can be a numerical, logical or relational expression that evaluates to true or false. When a numerical expression is evaluated if the result is even (least significant bit = 0), the value is false, and if the result is odd (least significant bit = 1), the value is true.

In Run Mode, if an expression is satisfied (true or false), the characteristics defined for that line are used to display the template. If more than one expression is satisfied at the same time, the line with the highest priority displays. Line 1 has the highest priority and line 5 has the lowest.

When an expression results in an invalid equation (e.g., division by zero, etc.), no value or graphics are displayed. If a true expression goes false in a later scan, the display for the true expression is erased.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

Refer to the list of Conditional Expression Operators for more information.

## Colors

**Pen:** Allows you to select the foreground color or intensity for the template. The **Pen** button will display the standard Color Selection Palette.

**Fill:** Allows you to select the background color or intensity for the template. The **Fill** button will display the standard Color Selection Palette.

## Alarm

**Alarm:** Allows you to designate any line of the template definition as an alarm state. If the Alarm box is selected and the conditional expression evaluates to be true, an alarm message will be placed in the alarm list and sent to the printer if one is configured.

If the Alarm box is selected, the condition associated with the alarm will be monitored at all times, regardless of the page being displayed. Judicious use of the alarm state is recommended to maximize the response time of the PanelMate unit.

**Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

**Alarm Message:** Allows you to enter the alarm message that will be displayed on the alarm line when the state goes into alarm and to a printer if one is configured.

## Variable-Sized Bar Template

Variable-Sized Bar Templates are designed to replace analog meters and face plates found on a conventional control panel. The Variable-Sized Bar Templates can also be used along with Symbols or Graphic elements to simulate tank fills, pipe flow, conveyors, and other specific applications. They also allow for definition of high and low alarm levels.

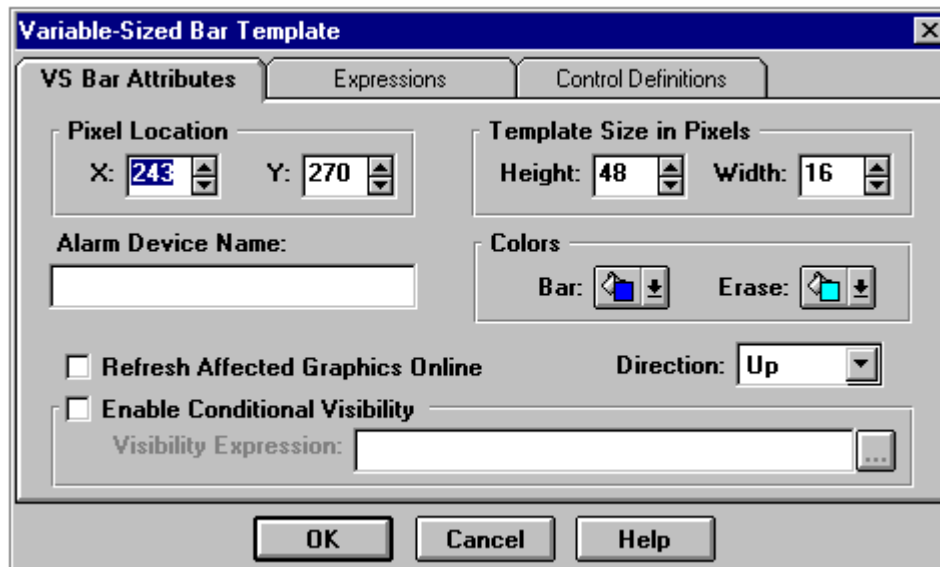


The Variable-Sized Bar Template consists of three tabbed dialog boxes which are listed below.

- Variable-Sized Bar Template - VS Bar Attributes Tab
- Variable-Sized Bar Template - Expressions Tab
- Variable-Sized Bar Template - Control Definitions Tab

## Variable-Sized Bar Template – VS Bar Attributes Tab

The **Variable-Sized Bar Template - VS Bar Attributes Tab** dialog box is shown below.



The fields in the **Variable-Sized Bar Template - VS Bar Attributes Tab** dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Bar Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Bar Template.

### Template Size In Pixels

**Height:** Allows you to enter the height in pixels for the Variable-Sized Bar Template. Note that you can also re-size the template by dragging one of the selection handles (squares) in any direction.

**Width:** Allows you to enter the width in pixels for the Variable-Sized Bar Template. Note that you can also re-size the template by dragging one of the selection handles (squares) in any direction.

**Alarm Device Name:** Allows you to enter a device name to be used as part of an alarm message. The Alarm Device Name field accepts normal-sized characters.

The name used in the Alarm Device Name field may be part of an alarm message. Be aware that only 25 characters for the Alarm Device Name will appear when the alarm message displays in Run Mode. The Alarm Device Name field allows you to enter more than 25 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

## Colors

**Bar:** Allows you to select the foreground color or intensity for the template. The **Bar** button will display the standard Color Selection Palette.

**Erase:** Allows you to select the background color or intensity for the template. The **Erase** button will display the standard Color Selection Palette.


**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the variable-sized template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Direction:** Allows you to determine which direction the dynamic portion of the bar will move. The selections are Up, Down, Left, and Right.

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Bar Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

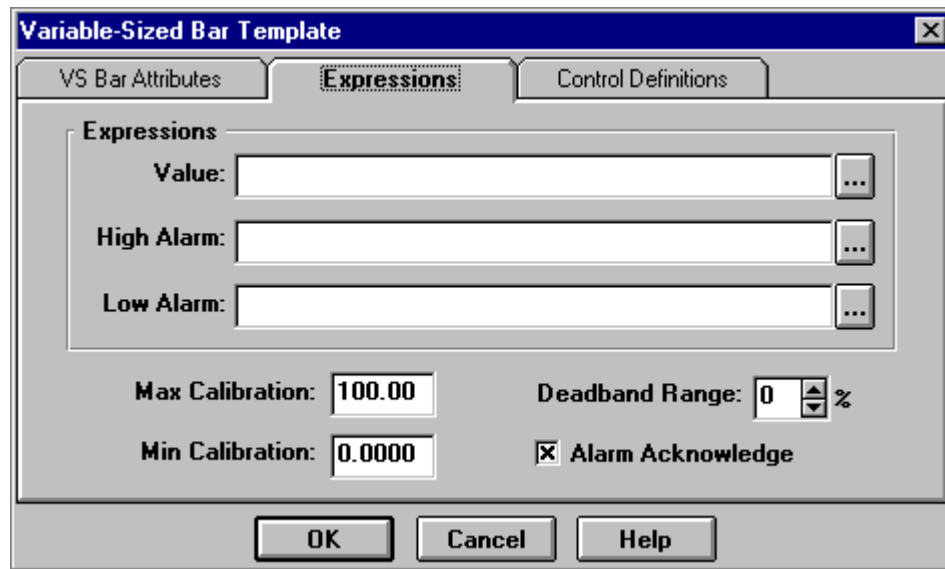
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket (I) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Bar Template – Expressions Tab

The Variable-Sized Bar Template - Expressions Tab dialog box is shown below.



The fields in the Variable-Sized Bar Template - Expressions Tab dialog box are described below.

### Expressions

**Value:** Allows you to enter a value expression. The result of this expression will be the bar height displayed in the Variable-Sized Bar Template.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.


**High Alarm:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value Expression. If Value exceeds the High Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the bar color will be displayed as follows:

- For PanelMate Grayscale units, the Variable-Sized Bar template is displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the variable-sized template is displayed in white with a blinking red background.

Note that if the high alarm value is greater than or equal to the Max Calibration value, the entire bar will be displayed in white and no blinking red will be shown.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.



If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


Refer to the list of Conditional Expression Operators for more information.

**Low Alarm:** Allows you to enter a Low Alarm Expression. The results of the Low Alarm Expression are compared to the results of the Value Expression. If Value is less than the Low Alarm Expression value, an alarm message is placed in the alarm list. When in an alarm state, the bar colors will be displayed as follows:

- For PanelMate Grayscale units, the variable-sized template is displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the variable-sized template is displayed in white with a blinking red background.

Note that if the low alarm value is less than or equal to the Min Calibration, the entire bar will be displayed in blinking red and no white will be shown.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Maximum Calibration:** Allows you to determine the highest point of the bar. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Minimum Calibration:** Allows you to determine the lowest point of the bar. This value displays on the template. This six-character text box accepts 6 digits, or 5 digits with a decimal point placed anywhere in the field.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

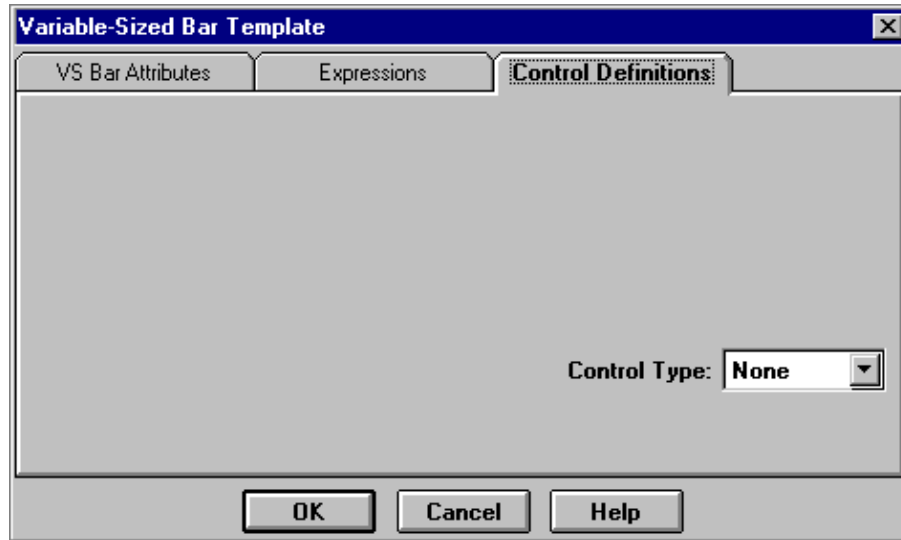
**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

## Variable-Sized Bar Template – Control Definitions Tab

The **Variable-Sized Bar Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Variable-Sized Bar Template - Control Definitions Tab** dialog box are described below.

**Control Type:** Allows you to define the control type used for the template. The selections are described below.

**None:** Allows the template to show a value that the operator cannot control.

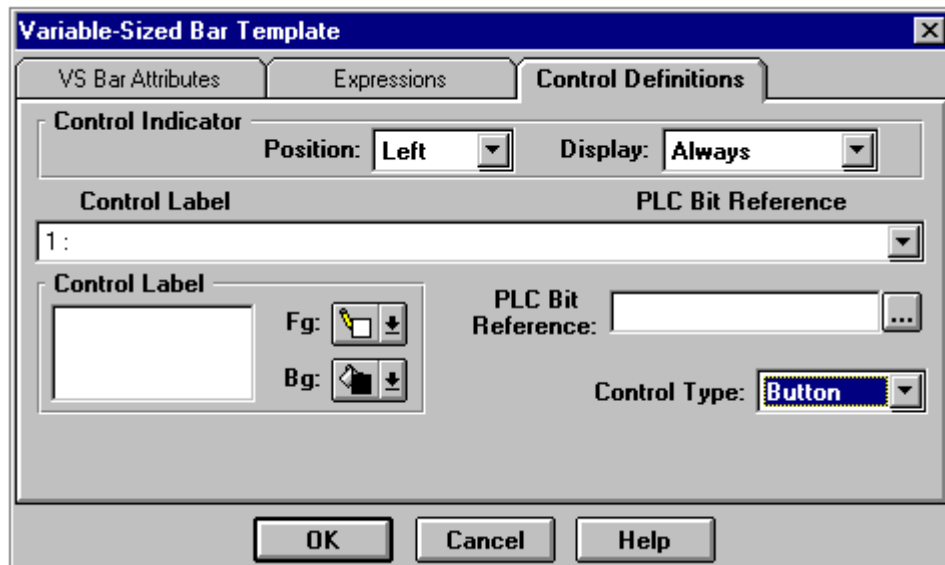
**Buttons:** Requires the operator to use control buttons to change a setpoint value. If you choose Buttons, the dialog box will change. Refer to the **Variable-Sized Bar Template - Control Definitions Tab with Button Control** topic for more information.

**Numeric:** Requires the operator to enter a setpoint value. If you choose Numeric, the dialog box will change. Refer to the **Variable-Sized Bar Template - Control Definitions Tab with Numeric Control** topic for more information.

Note that if Numeric or Button is selected, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

### Variable-Sized Bar Template – Control Definitions Tab with Button Control

The **Variable-Sized Bar Templates - Control Definitions Tab** dialog box with button control is shown below.



The **Variable-Sized Bar Template - Control Definitions Tab** dialog box with button control defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Variable-Sized Bar Template - Control Definitions Tab** dialog box with button control are described below.

#### Control Indicator

**Position:** Allows you to select the position inside of the Variable-Sized Bar Template for control indicator arrow. The selections are listed below.

- *Left*
- *Below*
- *Right*
- *Above*

**Display:** Allows you to determine if the arrow will always be visible or visible only when the template is selected. The selections are Always and On Selection.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

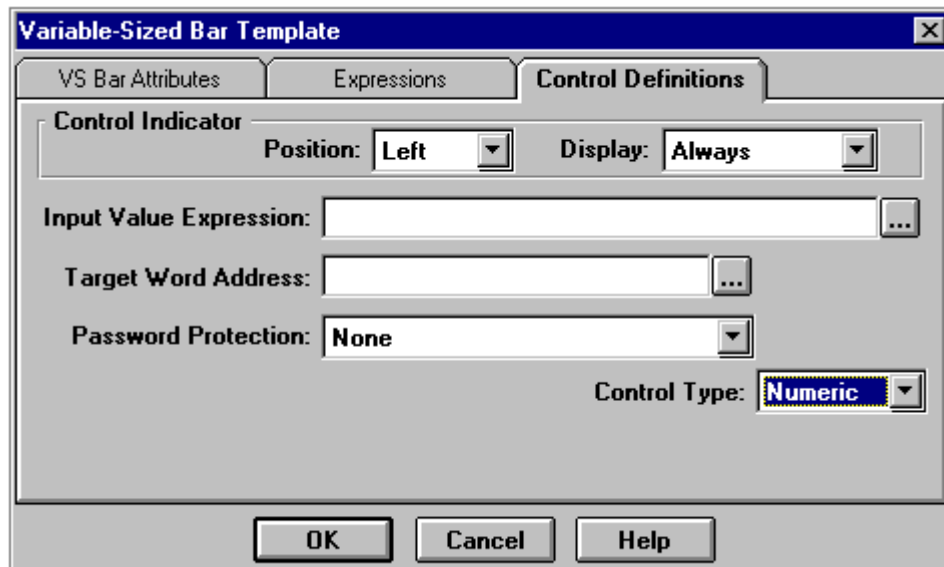
**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

### Variable-Sized Bar Template – Control Definitions Tab with Numeric Control

The **Variable-Sized Bar Templates - Control Definitions Tab** dialog box with numeric control is shown below.



The fields in the **Variable-Sized Bar Template - Control Definitions Tab** dialog box with numeric control are described below.


#### Control Indicator

**Position:** Allows you to select the position inside of the Variable-Sized Bar Template for control indicator arrow. The selections are listed below.

- *Left*
- *Below*
- *Right*
- *Above*

**Display:** Allows you to determine if the arrow will always be visible or visible only when the template is selected. The selections are Always and On Selection.

**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

$([?]-32)*5/9$

The operator's input is changed from Fahrenheit to Celsius.

$[?]*([?]>=0)*([?]<=100)+([?]<0)*[123]+([?]>100)*[123]$

**Target Word Address is [123]**

This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.


Refer to the list of Conditional Expression Operators for more information.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

## Variable-Sized Readout Template

Variable-Sized Readout Templates are designed to replace numeric and digital readout devices found on a conventional control panel, and to supply the functionality often provided by CRT-based devices. Displayed values can be scaled by the PanelMate unit without requiring any additional logic in the PLC.

⇒ **RPM: 1600**

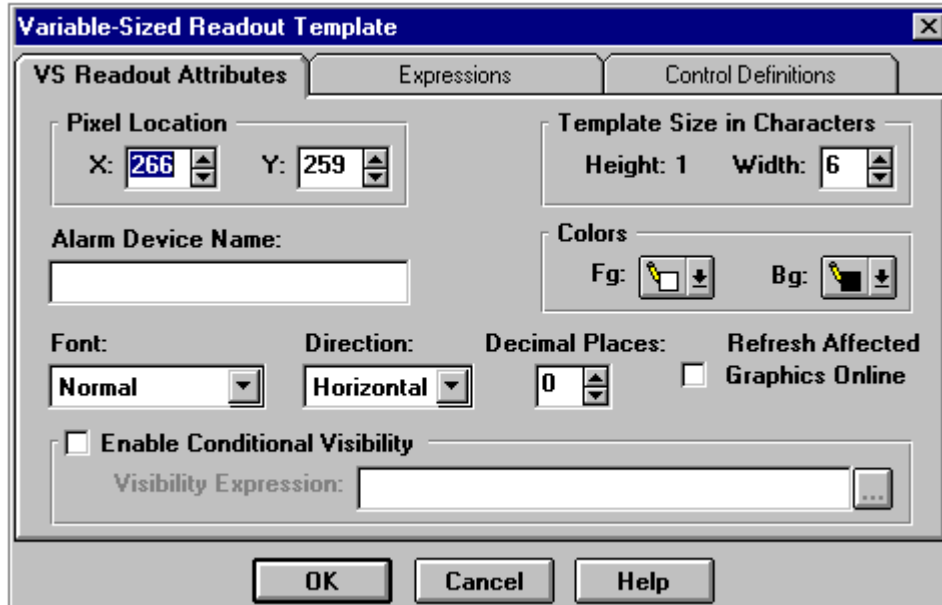
The Variable-Sized Readout Template consists of three tabbed dialog boxes that are listed below.

- Variable-Sized Readout Template - VS Readout Attributes Tab
- Variable-Sized Readout Template - Expressions Tab
- Variable-Sized Readout Template - Control Definitions Tab



## Variable-Sized Readout Template – VS Readout Attributes Tab

The Variable-Sized Readout Template - VS Readout Attributes Tab dialog box is shown below.



The fields in the Variable-Sized Readout Template - VS Readout Attributes Tab dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Readout Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Readout Template.

### Template Size In Characters

**Height:** Displays the height of the Variable-Sized Readout Template as 1. This value cannot be changed.

**Width:** Allows you to enter the width of the Variable-Sized Readout Template. Note that you can also re-size the width of the template by dragging the middle selection handle (square) on the right of the template.

**Alarm Device Name:** Allows you to enter a device name to be used as part of an alarm message. The Alarm Device Name field accepts normal-sized characters.

The name used in the Alarm Device Name field may be part of an alarm message. Be aware that only 25 characters for the Alarm Device Name will appear when the alarm message displays in Run Mode. The Alarm Device Name field allows you to enter more than 25 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

## Colors

**FG:** Allows you to select the foreground color or intensity for the template. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the template. The **BG** button will display the standard Color Selection Palette.

**Font:** Allows you to choose the font that is used to display the Variable-Sized Readout Template on the page. The selections are Normal, Double High and Quad.

If redefined fonts are used in a Variable-Sized Readout Template, the associated Control Arrow may appear in the wrong position during online or runtime operation.

**Direction:** Allows you to select the orientation in which the readout value is displayed. The selections are Horizontal (left-to-right) and Vertical (top-to-bottom).


**Decimal Places:** Allows you to determine how the number will be formatted when displayed. This field accepts the numbers 0 through 9.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the variable-sized template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Readout Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

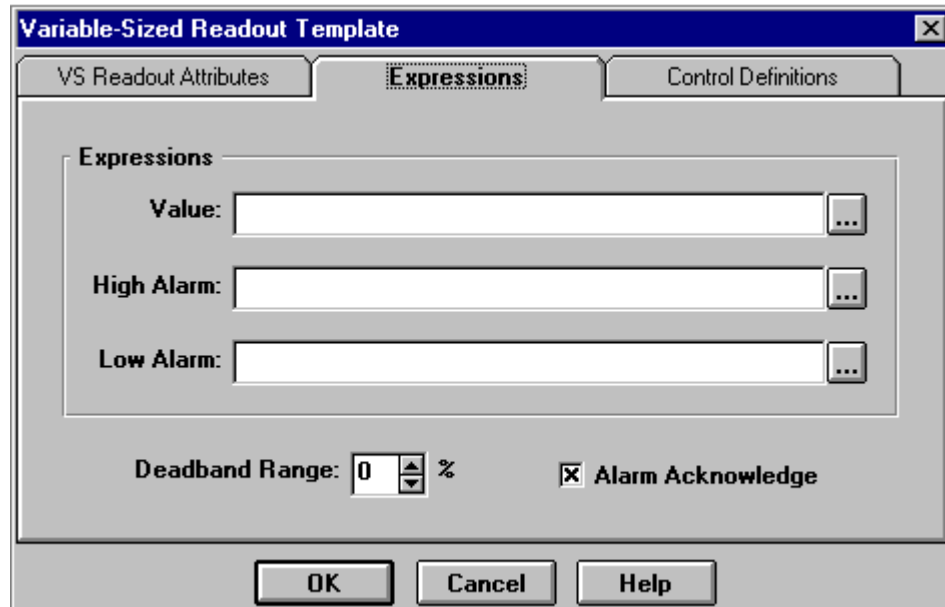
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Readout Template – Expression Tab

The Variable-Sized Readout Template - Expressions Tab dialog box is shown below.



The fields in the Variable-Sized Readout Template - Expressions Tab dialog box are described below.

### Expressions

**Value:** Allows you to enter a value expression. The result of this expression will be the value displayed in the Variable-Sized Readout Template.

The expression entered may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


Note that if a value is too large to display in the variable-size template, a string of Xs (XXXXXX) will be displayed for the value. For example, if a Variable-Sized Readout Template was defined as three characters in length, but the value to be displayed was four characters, XXX would be displayed for the value.

Refer to the list of Conditional Expression Operators for more information.

**High Alarm:** Allows you to enter a High Alarm Expression. The results of the High Alarm Expression are compared to the results of the Value Expression. If Value exceeds the High Alarm Expression value, an alarm message is placed in the alarm list.

- For PanelMate Grayscale units, the variable-sized template is displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the variable-sized template is displayed with white characters on a blinking red background.

The High Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.


If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Low Alarm:** The results of the Low Alarm Expression are compared to the results of the Value Expression. If Value is less than the Low Alarm Expression value, an alarm message is placed in the alarm list.

- For PanelMate Grayscale units, the variable-sized template is displayed with medium intensity characters on a blinking high intensity background.
- For PanelMate Color units, the template is displayed with white characters on a blinking red background.

The Low Alarm Expression can include multiple PLC word and bit references. Mathematical operations that may be used are multiplication, division, addition, and subtraction. You may also enter a single constant value (e.g., 900) as an expression. Parentheses may be used to change the order of operations. This is an optional entry. If no alarm is desired for this device, leave this field blank.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

Refer to the list of Conditional Expression Operators for more information.

**Deadband Range:** Allows you to enter a number between 0-99 that will represent the percentage of the high alarm value minus the low alarm value that defines the width of the deadband.

The deadband range is an area below the high alarm value and above the low alarm value, that must be crossed before Value is considered to have returned to normal status (go out of alarm). The deadband range prevents multiple alarm messages from being generated when Value is hovering around an alarm threshold.

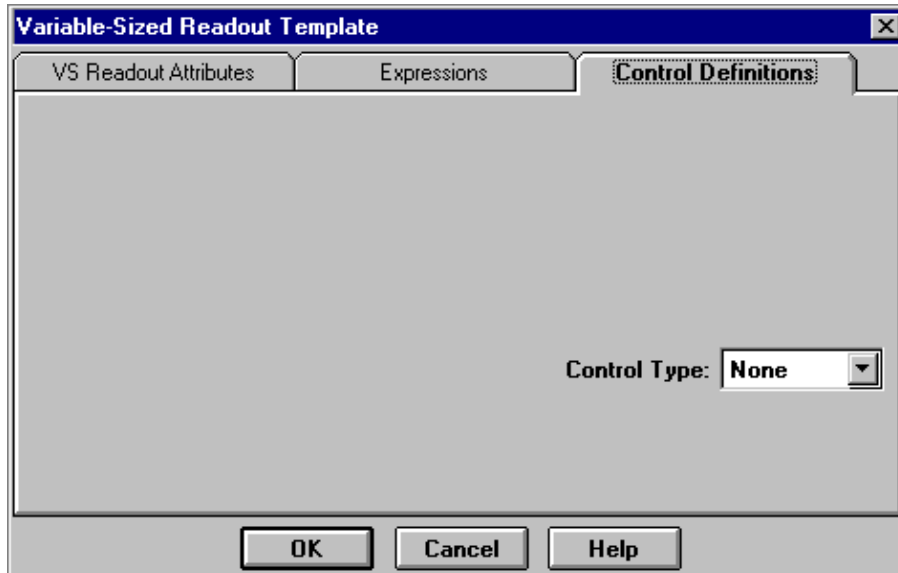
**Alarm Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

If the Alarm Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Alarm Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

## Variable-Sized Readout Template – Control Definitions Tab

The **Variable-Sized Readout Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Variable-Sized Readout Template - Control Definitions Tab** dialog box are described below.

**Control Type:** Allows you to define the control type used for the template. The selections are described below.

**None:** Allows the template to show a value that the operator cannot control.

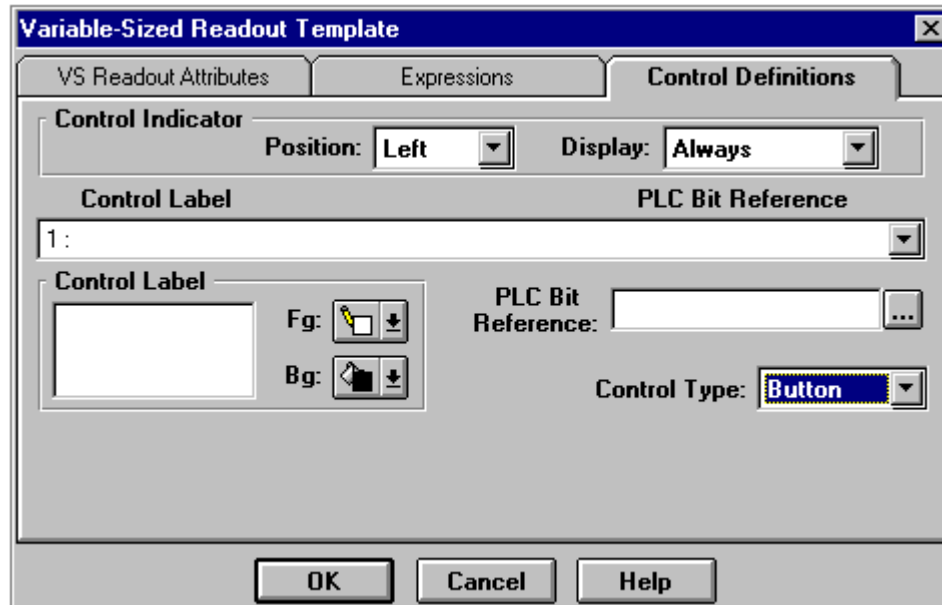
**Buttons:** Requires the operator to use control buttons to change a setpoint value. If you choose Buttons, the dialog box will change. Refer to the **Variable-Sized Readout Template - Control Definitions Tab with Button Control** topic for more information.

**Numeric:** Requires the operator to enter a setpoint value. If you choose Numeric, the dialog box will change. Refer to the **Variable-Sized Readout Template - Control Definitions Tab with Numeric Control** topic for more information.

Note that if Numeric or Button is selected, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

### Variable-Sized Readout Template – Control Definitions Tab with Button Control

The **Variable-Sized Readout Template - Control Definitions Tab** dialog box with button control is shown below.



The **Variable-Sized Readout Template - Control Definitions Tab** dialog box with button control defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00] to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Variable-Sized Readout Template - Control Definitions Tab** dialog box with button control are described below.

#### Control Indicator

**Position:** Allows you to select the position inside of the Variable-Sized Readout Template for control indicator arrow. The selections are listed below.

- Left
- Below
- Right
- Above

When redefined fonts are used, the position of the control indicator arrow for a Variable-Sized Readout Template may appear in the wrong position in Run Mode.

**Display:** Allows you to determine if the arrow will always be visible or visible only when the template is selected. The selections are Always and On Selection.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

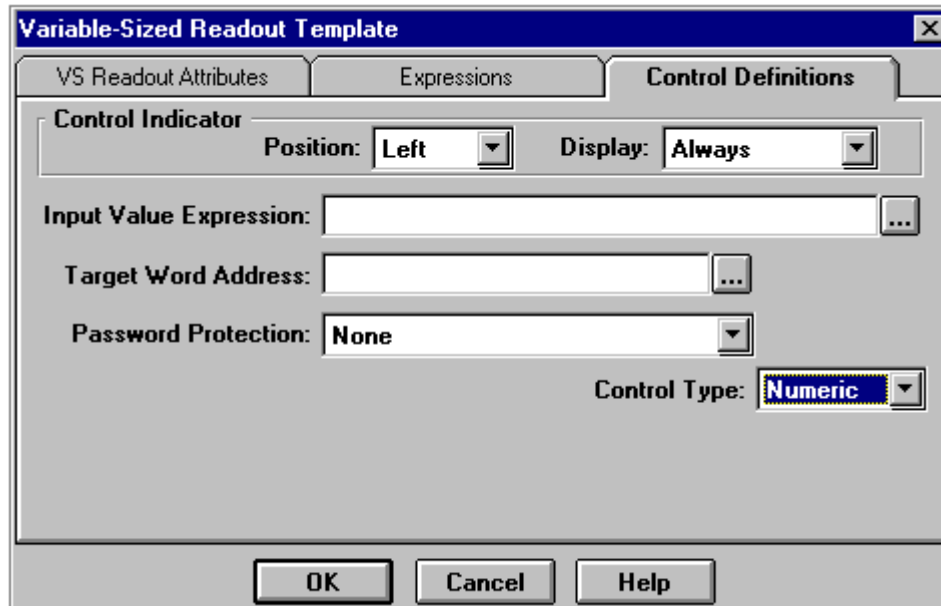
**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

### Variable-Sized Readout Template – Control Definitions Tab with Numeric Control

The **Variable-Sized Readout Templates - Control Definitions Tab** dialog box with numeric control is shown below.



The fields in the **Variable-Sized Readout Template - Control Definitions Tab** dialog box with numeric control are described below.

#### Control Indicator


**Position:** Allows you to select the position inside of the Variable-Sized Readout Template for control indicator arrow. The selections are listed below.

- *Left*
- *Below*
- *Right*
- *Above*

**Display:** Allows you to determine if the arrow will always be visible or visible only when the template is selected. The selections are Always and On Selection.



**Input Value Expression:** Allows you to enter any mathematical expression that must be performed on the operator's input before the number is stored in the PLC. A question mark inside brackets, [?], is used to designate the operator input. The expression entered here may include as many PLC word or bit references as needed, as well as mathematical operations. Parentheses may be used to change the order of operations.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the operator input is to be entered in the PLC as-is, enter [?] in the field. Refer to the examples below.

**[?]-32)\*5/9**

The operator's input is changed from Fahrenheit to Celsius.

**[?]\*([?]>=0)\*([?]<=100)+([?]<0)\*[123]+([?]>100)\*[123]**

**Target Word Address is [123]**


This expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

Refer to the list of Conditional Expression Operators for more information.

**Target Word Address:** Allows you to define the location of the operator's input in the PLC as the result of the Input.

For example, to store a value in register 364 as a signed, 16-bit integer, use Target Word Address [364#S16].

Note that the example uses a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the template is configured to have numeric control, a target address and input expression must be entered. Failure to include this information will result in a Watchdog Time-out error when the template is selected online.

**Password Protection:** Allows you to lock out access to numeric entry unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit. The selections are listed below:

- None
- Keyswitch Only
- Keyswitch and Password A
- Keyswitch and Password B
- Keyswitch and Password A or B
- Password A Only
- Password B Only
- Password A or B

Password protection must be validated each time the template is selected for numeric entry.

The template will not be displayed unless the operator provides the correct password or unlocks the security keyswitch wired to the PanelMate unit.

Password A and Password B are defined in the **System Parameters - Password Tab** dialog box.

The security keyswitch is an option that may be ordered as a spare part from the Cutler-Hammer Customer Service Department. Note that a security keyswitch cannot be connected to the PanelMate Power Series 1500 or PanelMate Pro LT 1100, and is not available for PanelMate PC.

## Variable-Sized Display Template

Variable-Sized Display Templates are designed to replace LED or LCD message units or display readouts. They are most effective when used for informational messages (e.g., prompting or diagnostic information).



### Motor Overtemperature

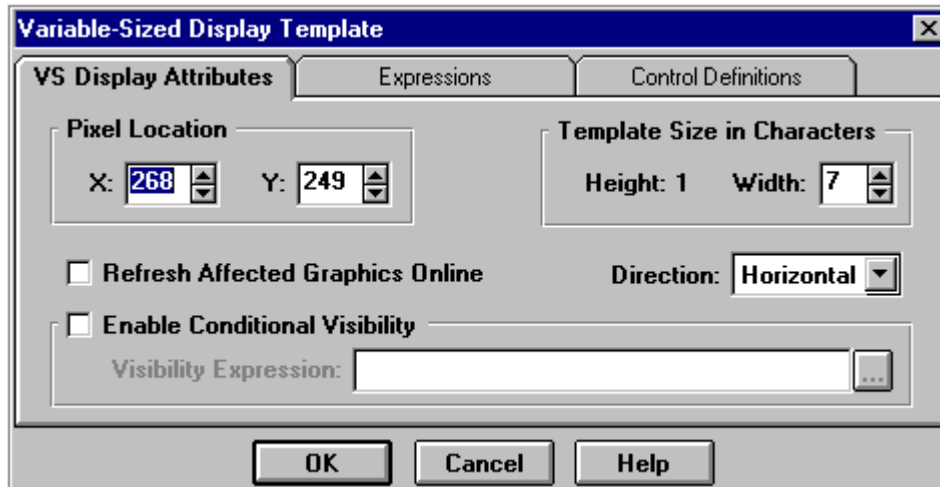
The actual creation of the message is done in the Message Library selected from the **Variable-Sized Display Template - Expressions Tab** dialog box.

The Variable-Sized Display Template consists of three tabbed dialog boxes that are listed below.

- Variable-Sized Display Template - VS Display Attributes Tab
- Variable-Sized Display Template - Expressions Tab
- Variable-Sized Display Template - Control Definitions Tab

## Variable-Sized Display Template – VS Display Attributes Tab

The Variable-Sized Display Template - VS Display Attributes Tab dialog box is shown below.



The fields in the Variable-Sized Display Template - VS Display Attributes Tab dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Display Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Display Template.

### Template Size In Characters

**Height:** Displays the height of the Variable-Sized Display Template as 1. This value cannot be changed.

**Width:** Allows you to enter the width of the Variable-Sized Display Template. Note that you can also re-size the width of the template by dragging the middle selection handle (square) on the right of the template.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the variable-sized template to be refreshed to properly reflect the layering of objects on the page whenever the template is updated.


**Direction:** Allows you to select the orientation in which the message is displayed. The selections are Horizontal (left-to-right) and Vertical (top-to-bottom).

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Display Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

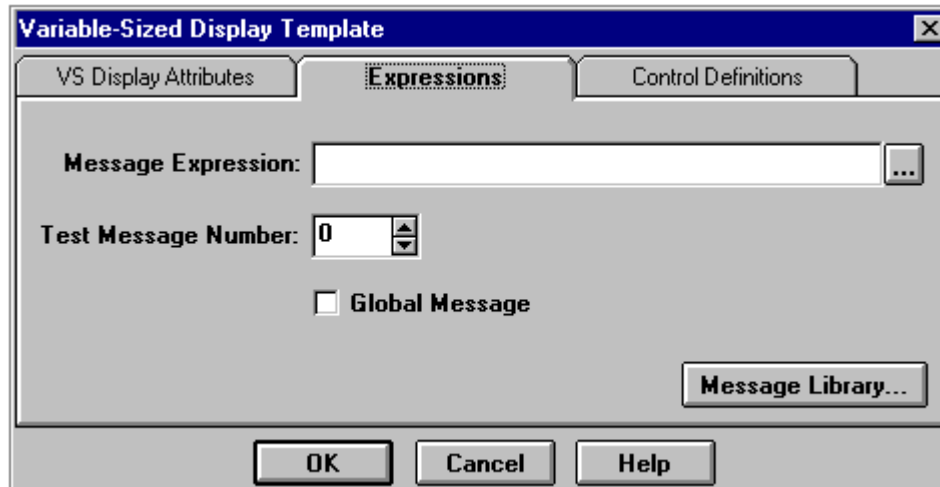
It is not recommended to use the Conditional Visibility feature with Variable-Sized Display Templates. If a message is updated due to a PLC reference change, it may display the message regardless of the Visibility Expression. An alternative method of achieving the same result would be to use the Message Expression multiplied by the Visibility Expression and then deselect the Enable Conditional Visibility field. For example, if the Message Expression is [40210] and the Visibility Expression is [10322], then the new Message Expression would be [40210]\*[10322] and Enable Conditional Visibility field would be deselected. When the Visibility Expression reference [10322] is false, the result would be to display the Message Number 0 which would display nothing.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.


## Variable-Sized Display Template – Expressions Tab

The **Variable-Sized Display Template - Expressions Tab** dialog box is shown below.



The fields in the **Variable-Sized Display Template - Expressions Tab** dialog box are described below.

**Message Expression:** Allows you to enter a message expression in the Variable-Sized Display Template. The result of the Message Expression represents the number of the message from the Message Library that will be displayed.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

If the Message Expression results in a number greater than the maximum number allowed in the Message Library or less than 0 when running online, the previously displayed message will be erased.

If the message expression results in an invalid equation (e.g., division by a value of zero, etc.), no message displays. If a message expression previously resulted in a valid value, but in a later scan results in an invalid equation, the previously displayed message will be erased.

To display a message based on a bit, multiply the bit reference times the message number to produce the message number. For example, to display message #25 when bit [127 14] is on, enter [127 14]\*25 in the Message Expression field.

The message expression can be as simple as a word reference (e.g., [253]) or a mathematical expression which solves to a value corresponding to a message number (e.g., [254]+12). The message expression can contain multiple PLC references. Note that the preceding examples are shown using a generic format. Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

When the Message Expression is true, embedded references are updated on the screen and not sent to the printer. Messages configured for BOTH or PRINTER are sent to the printer when the Message Expression changes and also when changing pages.

Note that when going to a new page that has non-global messages, messages set for PRINTER or BOTH will print once for each PLC reference in the message expression. Non-global messages on a page set for PRINTER or BOTH will print when returning from the Alarm Page, Screen Blanking, and when pressing the **Enable Fault Relay** control button, since these actions are treated as page changes.

When running online, if the message expression results in a value less than 0 or greater than permitted, then the previously displayed message will be erased.

Refer to the list of Conditional Expression Operators for more information.

The Variable-Sized Display Template also supports the display of ASCII strings from the PLC. To display ASCII strings, place the starting address of the ASCII characters within the Message Expression field, followed by the format specifier #ASC which then is followed by the number of characters to be displayed. When the PanelMate unit recognizes an ASCII format specifier (#ASC) in the message expression, the PanelMate unit will display the ASCII string from the PLC. Optionally, a byte-swap format specifier, #BSW, can be added to swap the order of character presentation on a word-by-word basis. The following table shows a block of generic PLC registers and the decimal, hex, and ASCII values for the registers.

Registers	Decimal Value	Hex Value	ASCII Value
100	16706	4142	AB
101	17220	4344	CD
102	17734	4546	EF
103	18248	4748	GH
104	18762	494A	IJ
105	19276	4B4C	KL
106	19790	4D4E	MN
107	20304	4F50	OP
108	20818	5152	QR
109	21332	5354	ST

If the following expressions are entered in the Message Expression field, the string will be displayed as shown below.

Message Expression	Displayed String
[100#ASC20]	ABCDEFGHIJKLMN OPQRS T
[100#BSW#ASC20]	BADCFE HGJILKN MPORQT S
[105#ASC7]	KLMNOPQ
[105#BSW#ASC7]	LKNMPOR

ASCII registers displayed in this manner will appear in normal font with white foreground and black background. These display attributes (font size, foreground color, and background color) may be changed by defining them in the first two words of the string.

The most significant byte of the first word must contain a 1. This will signal the PanelMate unit that the attributes are to be altered. The least significant byte of the first word must contain the font size key.

- 01 = Normal
- 02 = Graphic
- 03 = Double-High
- 04 = Quad

The most significant byte of the second word contains the foreground color, and the least significant byte contains the background color. The colors are numbered 1 through 255 and can be determined by using the Color Palette in the Configuration Software, counting left to right and top to bottom (e.g., black=1, blue=2, green=3, cyan=4, red=5, magenta=6, yellow=7, etc.). Refer to the examples below.

Examples:

If register 98 has a value of 260 (Hex 0104), and register 99 has a value of 1287 (hex 0507), then the message [98#ASC6] would display the string ABCDEF in Quad font with red characters on yellow background.

If the byte swap format is used, then the bytes of the first two words need to be swapped. Register 98 will have a value of 1025 (hex 0401) and register 99 will have a value of 1797 (Hex 0705). The message [98#BSW#ASC6] would then display the string BADCFE in Quad font with yellow characters on a red background.

**Test Message Number:** Allows you to enter a test message number. To view a message on the page during configuration, a message number may be entered into the Test Message field. The message corresponding to this number will be displayed at the Variable-Sized Display Template's origin. If there is not a message defined for that number, the template will be blank.

**Global Message:** Allows you to determine if the Variable-Sized Display Template will be a global message. To make a Variable-Sized Display Template global, select the Global Message box. The selection allows the PanelMate unit to monitor other Variable-Sized Display Templates not on the page being displayed in Run Mode. (Normally, the PanelMate unit only monitors the Variable-Sized Display Templates on the currently-visible page in Run Mode.) Templates on other pages are referred to as "global" templates.

Any Global Message triggered during online operation will be sent to the printer if they have destination settings of Printer or Both. Global Messages are not sent to the screen if the page where they were configured is not visible.

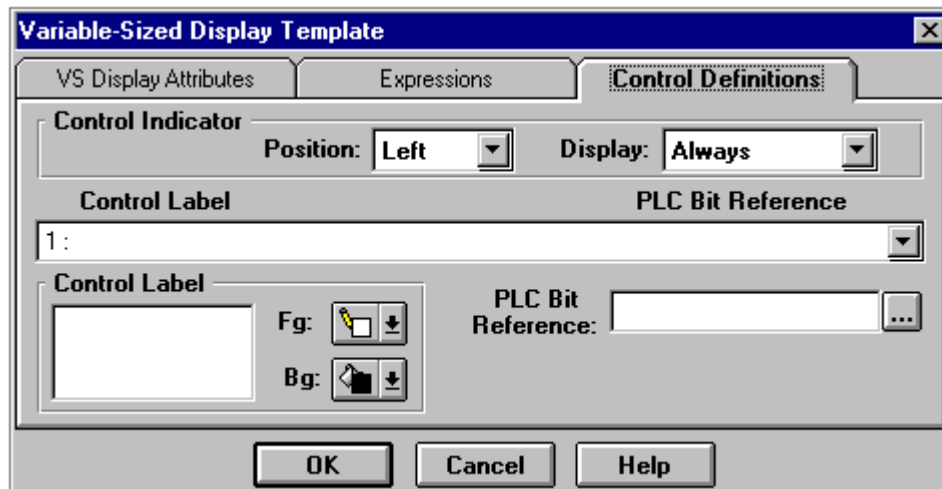
Global Messages only print when the Message Expression changes, not when the embedded references change. When you change to a page with Global messages, the Global Message will not print. If a hard-coded value (e.g. 100) is placed in the Message Expression, the Global Message will print only once at bootup.

**<Message Library>:** Opens the **Message Library** dialog box. Refer to the **Message Library** topic for more information.



## Variable-Sized Display Template – Control Definitions Tab

The Variable-Sized Display Template - Control Definitions Tab dialog box is shown below.



The Variable-Sized Display Template - Control Definitions Tab dialog box defines the control buttons on your PanelMate unit. If a control button is defined, a small arrow will display in the lower left corner of the template to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00] to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the Variable-Sized Display Template - Control Definitions Tab dialog box are described below.

### Control Indicator

**Position:** Allows you to select the position inside of the Variable-Sized Display Template for control indicator arrow. The selections are listed below.

- Left
- Below
- Right
- Above

**Display:** Allows you to determine if the arrow will always be visible or visible only when the template is selected. The selections are Always and On Selection.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

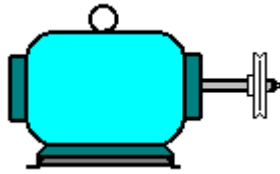
**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Graphic Template

Variable-Sized Graphic Templates are similar in function and purpose to Indicator Templates except that the Indicator Template uses a pre-defined graphic while the Variable-Sized Graphic Template uses user-defined symbols for status indication. For more information on creating symbols, refer to the **Make Symbol** topic.

Variable-Sized Graphic Templates can be used to indicate the status of a device and to control the device (e.g., by turning it ON or OFF). There are five lines to define the various states of the device. To tie a state to information in the PLC, a conditional expression may be entered which, when evaluated to true, displays the characteristics defined in the Pen and Fill fields for the Variable-Sized Graphic Template. The expression may be as simple as the condition of a single bit in the PLC (true = ON; false = OFF), a value comparison (register > constant), or a Boolean expression of up to 70 characters in length.



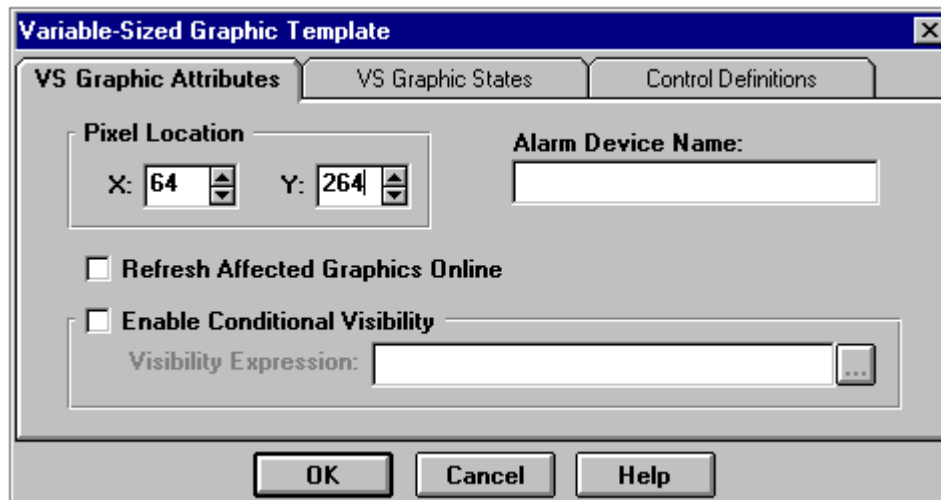
Note that when you select the Variable-Sized Graphic Template from the tool palette and click on the configuration page, the **Select Symbol** dialog box will appear. Select a symbol and click the **OK** button. The symbol you select is only a placeholder for the Variable-Sized Graphic Template you will configure.

The Variable-Sized Graphic Template consists of three tabbed dialog boxes that are listed below.

- Variable-Sized Graphic Template - VS Graphic Attributes Tab
- Variable-Sized Graphic Template - VS Graphic States Tab
- Variable-Sized Graphic Template - Control Definitions Tab

## Variable-Sized Graphic Template – VS Graphics Attributes Tab

The Variable-Sized Graphic Template - VS Graphics Attributes Tab dialog box is shown below.



The fields in the Variable-Sized Graphic Template - VS Graphics Attributes Tab dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Graphic Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Graphic Template.

**Alarm Device Name:** Allows you to enter a device name to be used as part of an alarm message. The Alarm Device Name field accepts normal-sized characters.


The name used in the Alarm Device Name field may be part of an alarm message. Be aware that only 25 characters for the Alarm Device Name will appear when the alarm message displays in Run Mode. The Alarm Device Name field allows you to enter more than 25 characters to allow for control key combinations for the redefined characters in the Font Editor. For more information on redefined characters, refer to the **Font Editor** topic.

**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of variable-sized template to be refreshed to properly reflect the layering of objects on the page whenever the variable-sized template is updated.

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Graphic Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

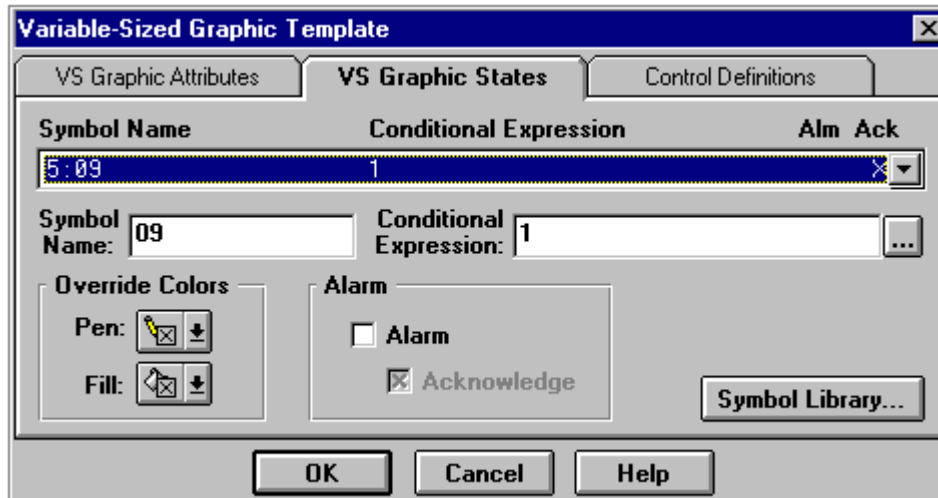
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Graphic Template – VS Graphic States Tab

The Variable-Sized Graphic Template - VS Graphic States Tab dialog box is shown below.



The fields in the Variable-Sized Graphic Template - VS Graphic States Tab dialog box are described below.

**Symbol Name/Conditional Expression/Alm/Ack:** Displays symbol names, conditional expressions, alarms, and alarm acknowledgments configured for the Variable-Sized Graphic Template. If the conditional expression evaluates to true, the associated symbol will be displayed in Run Mode. Each Variable-Sized Graphic Template can display up to five symbols, depending upon conditions you define. Each line in this list represents one of the symbols.

**Symbol:** Allows you to enter the name of the symbol to be displayed when the corresponding conditional expression becomes true.

**Conditional Expression:** Allows you to enter a conditional expression. The conditional expression can be a numerical, logical or relational expression that evaluates to true or false. When a numerical expression is evaluated if the result is even (least significant bit = 0), the value is false, and if the result is odd (least significant bit = 1), the value is true.

If you have an associated .csv file for tags, you can access your tag names and references by using the button. You can also access them by entering a left bracket ([]) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

In Run Mode, if an expression is satisfied (true or false), the characteristics defined for that line are used to display the template. If more than one expression is satisfied at the same time, the line with the highest priority displays. Line 1 has the highest priority and line 5 has the lowest.

When an expression results in an invalid equation (e.g., division by zero, etc.), no value or graphics are displayed.

If a true expression goes false in a later scan, the display for the true expression is erased.

Refer to the appropriate Communication Driver Manual for information regarding the format for specific PLC word references.

Refer to the list of Conditional Expression Operators for more information.

**Override Colors:** Allows you to select colors for a symbol that displays as a result of a conditional expression. These colors are used instead of the colors defined when the symbol was created. A symbol's objects for which the foreground or background is configured as None (transparent) are not affected by the Override Colors.

**Pen:** Allows you to select the foreground color or intensity for the symbol. The **Pen** button will display the standard Color Selection Palette.

**Fill:** Allows you to select the background color or intensity for the symbol. The **Fill** button will display the standard Color Selection Palette.

## Alarm

**Alarm:** Allows you to designate any line of the template definition as an alarm state. If the Alarm box is selected and the conditional expression evaluates to be true, an alarm message will be placed in the alarm list and sent to the printer if one is configured.

If the Alarm box is selected, the condition associated with the alarm will be monitored at all times, regardless of the page being displayed. Judicious use of the alarm state is recommended to maximize the response time of the PanelMate unit.

**Acknowledge:** Allows you to determine if the associated alarm must be acknowledged before the alarm is removed from the alarm list.

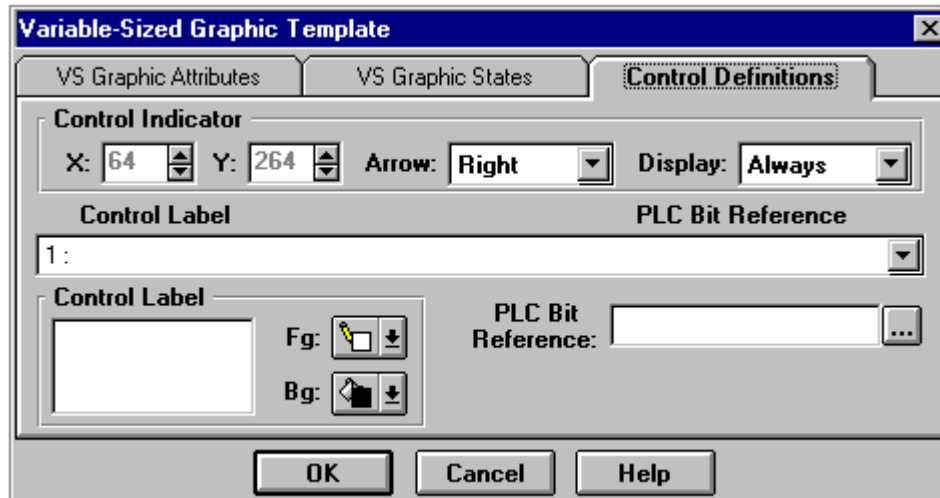
If the Acknowledge box is selected, the operator must acknowledge the corresponding alarm message before the alarm will be removed from the alarm list. If the Acknowledge box is not selected, the alarm message will be automatically removed from the list when the alarm condition clears.

Note that a cleared alarm message will be sent to the printer if one is configured.

**<Symbol Library>:** Opens the **Select Symbol** dialog box. Refer to the **Select Symbol** topic for more information.

## Variable-Sized Graphic Template – Control Definitions Tab

The **Variable-Sized Graphic Template - Control Definitions Tab** dialog box is shown below.



The **Variable-Sized Graphic Template - Control Definitions Tab** dialog box defines the control buttons on your PanelMate unit. If a control button is defined, a control arrow will display inside the symbol at its origin to indicate to the operator that a control function is available.

When a control button is pressed, the PanelMate unit sends a command to the PLC to set the referenced bit (e.g., [120 00]) to 1. When the button is released, a separate command is sent to set the bit to 0, thus providing a momentary input to the PLC. If a maintained input is desired, the bit may be latched in PLC logic.

The fields in the **Variable-Sized Graphic Template - Control Definitions Tab** dialog box are described below.

### Control Indicator

Since the default location of the control arrow for a Variable-Sized Graphic Template is placed inside the symbol at its origin, the control arrow may be overwritten even if the Control Indicator Display field is configured as Always. To avoid overwriting the control arrow, reposition the control arrow to the left of the symbol origin by eight pixels by configuring the Control Indicator Arrow X and Y fields.

**X:** Allows you to move the control indicator arrow in the Variable-Sized Graphic Template to the left or right. Note that this field is disabled until you configure the Control Label field or the Bit Reference field.

**Y:** Allows you to move the control indicator arrow in the Variable-Sized Graphic Template up or down. Note that this field is disabled until you configure the Control Label field or the Bit Reference field.



**Arrow:** Allows you to choose the position of the control indicator arrow. The selections are listed below.

- Right
- Left
- Up
- Down
- Right/Up
- Right/Dn
- Left/Up
- Left/Dn

**Display:** Determines if the arrow is always visible or visible only when the template is selected.

**Control Label/PLC Bit Reference:** Displays the control button labels and the associated PLC Bit Reference. Line 1 corresponds to the top control button; line 2 corresponds to the next control button down, etc. It is not necessary to use all control buttons. Simply leave a line blank if you do not want a control button at that location.


**Control Label:** Allows you to enter the control button label. The Control Label field accepts three lines of normal-size alphanumeric characters. Use spaces or a carriage return to move the text to the desired location. Note that on the configuration page, the text displayed in the control button will be truncated; but when in Run Mode, the text will automatically wrap to the next line. If the text wraps to the next line, you can eliminate a carriage return in some cases.

The Control Label field has an auto centering capability. If you wish to center the Control Label, check the Control Button Labels box in the Auto Centering field in the **Configuration Properties** dialog box.

**FG:** Allows you to select the foreground color or intensity for the control label. The **FG** button will display the standard Color Selection Palette.

**BG:** Allows you to select the background color or intensity for the control label. The **BG** button will display the standard Color Selection Palette.

**PLC Bit Reference:** Allows you to enter a PLC bit reference. The PLC Bit Reference field accepts alphanumeric characters that define the PLC bit to be set while an operator presses the corresponding control button. Expressions or conditional logic cannot be entered.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Control Button Template

The Variable-Sized Control Button is a one-touch button you can place anywhere a template or element can be placed. The Direct Select (Touchscreen Only) feature is intended for use on PanelMate touchscreen units and PanelMate NT units only. This template is intended for use with touchscreen units and should be used with the Direct Select feature in the **System Parameters - General Tab** dialog box. If the Direct Select feature is not enabled or if you use the Variable-Sized Control Button Template on a touchpanel unit, it becomes a two-step (select and execute) button.

The Variable-Sized Control Button Template is used to provide a momentary control to the PLC (e.g., start and stop machinery) or to issue a local page change command.



**⚠ CAUTION:** When placing a Variable-Sized Control Button on a page to issue a page change command, make sure there is not a Variable-Sized Control Button occupying the same location on the destination page. If multiple touches are attempted on the Variable-Sized Control Button, all touches after the first will be applied to the destination page. This will cause the Variable-Sized Control Button on the destination page to be executed, thus possibly resulting in unintended machinery operation or unintended page changes.

When using the Variable-Sized Control Button Template to start machinery or to perform page changes, make sure you label the template clearly so it can be easily recognized and make the template large enough to ensure easy one-touch operation. This button is not labeled the same as standard control buttons. You must supply the appropriate dynamics graphics, static graphics, and/or text for the button. Note that if you wish to use a dynamic graphic to label the Variable-Sized Control Button, you must follow the steps below.

- Configure the Lens Color field in the **Variable-Sized Control Button - VS Control Button Attribute Tab** dialog box as transparent by selecting None for the color.
- Place the dynamic graphic and/or text behind the Variable-Sized Control Button by selecting the button and choosing the Bring to Front selection in the Object Menu.

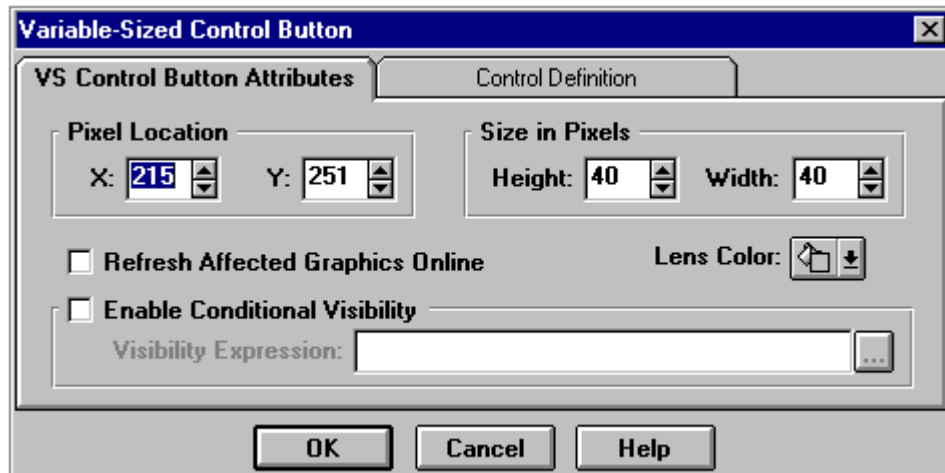
If these steps are not performed, the areas in the Variable-Sized Control Button covered by the dynamic graphic used in the label will not respond to the touch.

The Variable-Sized Control Button Template consists of two tabbed dialog boxes that are listed below.

- Variable-Sized Control Button Template - VS Control Button Attributes Tab
- Variable-Sized Control Button Template - Control Definitions Tab

## Variable-Sized Control Button Template – VS Control Button Attributes Tab

The Variable-Sized Control Button Template - VS Control Button Attributes Tab dialog box is shown below.



The fields in the Variable-Sized Control Button Template - VS Control Button Attributes Tab dialog box are described below.

### Pixel Location

**X:** Allows you to enter the X-location of the upper-left corner of the Variable-Sized Control Button Template.

**Y:** Allows you to enter the Y-location of the upper-left corner of the Variable-Sized Control Button Template.

### Size in Pixels

**Height:** Allows you to enter the height of the Variable-Sized Control Button Template in pixels.

**Width:** Allows you to enter the width of the Variable-Sized Control Button Template in pixels.


**Refresh Affected Graphics Online:** Allows all other templates, variable-sized templates, and graphics that lie within the area of the variable-sized control button to be refreshed to properly reflect the layering of objects on the page whenever the variable-sized control button is updated.

**Lens Color:** Allows you to select the color of the area inside the Variable-Sized Control Button. This button displays the standard Color Selection Palette.

**Enable Conditional Visibility:** Allows you to determine if the Variable-Sized Control Button Template will appear on a page based on the value of the Visibility Expression. If the Enable Conditional Visibility box is not checked, the template will always appear on the page.

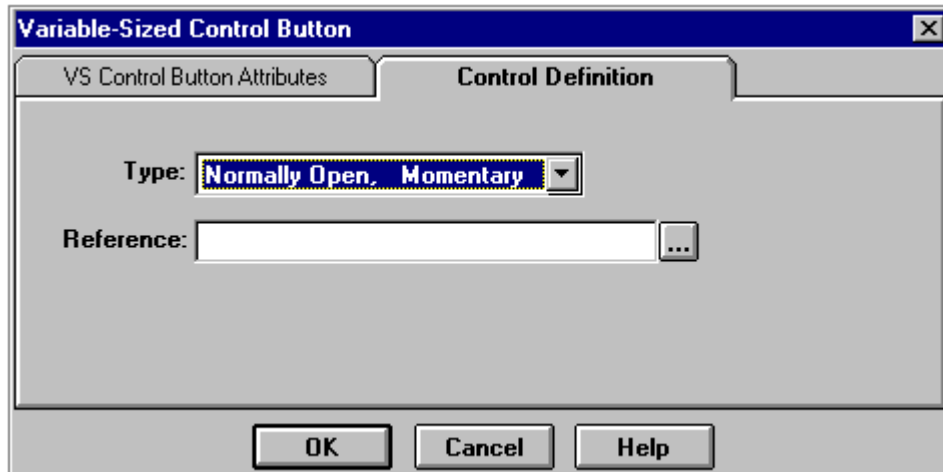
It is important to note that a template, which is invisible because the Visibility Expression evaluates to false, will still impose the same memory and polling response impact as when the template is visible. Therefore, the visibility feature should not be used to circumvent page number or capacity limitations.

**Visibility Expression:** Allows you to enter a conditional expression if the Enable Conditional Visibility box is checked. If the Visibility Expression evaluates to false (equal to zero), the template will be erased and all template updating will be deactivated when in Run Mode. If the Visibility Expression evaluates to true (not equal to zero), the template will appear and all template updating will be activated when in Run Mode.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to **Chapter 12: Using Tags**.

## Variable-Sized Control Button Template – Control Definitions Tab

The **Variable-Sized Control Button Template - Control Definitions Tab** dialog box is shown below.



The fields in the **Variable-Sized Control Button Template - Control Definitions Tab** dialog box are described below.

**Type:** Allows you to select the type of control definition. The selections are described below.

**Normally Open, Momentary:** Defines the PLC bit reference to be set to 1 when the corresponding control button is pressed. When the control button is released, the PLC bit reference will be set to 0.

**Normally Close, Momentary:** Defines the PLC bit reference to be set to 0 when the corresponding control button is pressed. When the control button is released, the PLC bit reference will be set to 1.

**Normally Open, Maintained:** Defines the PLC bit reference to be set to 1 when the corresponding control button is pressed. When the control button is released, there is no action.

**Normally Close, Maintained:** Defines the PLC bit reference to be set to 0 when the corresponding control button is pressed. When the control button is released, there is no action.

**Toggle:** Defines the PLC bit reference to be set to the inverse of the last setting when the corresponding control button is pressed.


**Page Change:** Determines the page to be displayed when the page number is calculated in the Expression field. Note that the Expression field appears on the **Variable-Sized Control Button Template – Control Definitions Tab** dialog box when Page Change is selected in the Type field.

**Reference or Expression:** Depending upon your selection in the Type field, this box will be labeled Reference or Expression. The Reference field will be displayed if you select Normally Opened Momentary, Normally Closed Momentary, Normally Opened Maintained, Normally Closed Maintained, or Toggle in the Type field. The Expression field will be displayed if you select Page Change in the Type field.

The selections are described below.

**Reference:** Allows you to enter the PLC bit to be set while an operator presses the corresponding control button. This field accepts alphanumeric characters. Expressions or conditional logic cannot be entered.

**Expression:** Allows you to determine the destination page when the corresponding control button is pressed. This field accepts numeric characters. Note that brackets are not required.

If you have an associated .csv file for tags, you can access your tag names and references by using the  button. You can also access them by entering a left bracket ([) or by entering a comma (,) after entering the PLC device name. For more information on tags, refer to Chapter 12: Using Tags.

# Using Tags

## 12

*In this chapter, you will learn:*

- *Advantages of Using Tags*
- *About Tag Database Files*
- *How Configuration Software Processes Tag References*
- *How to Access Your Tags*
- *How to Construct Expressions Using Tags*
- *How to Edit Tags*
- *How to Create a .CSV File*
- *How the I/O Limit in a PanelMate Pro LT 1100 works*

## Tag Usage Overview

Tags are used as a convenient method of referencing the I/O address in a PLC reference. A tag “name” can be directly associated with a specific PLC I/O address, ie: GATE OPEN = [B450/104]. There are several advantages for using tags in your PanelMate configuration:

- After defining a tag, the tag can be reused anywhere in your PanelMate configuration. Instead of retyping the I/O address, you simply type in the tag name or select it from a pull down list or dialog box.
- You can quickly change multiple, identical I/O addresses in your configuration by just editing the PLC address associated with the tag.
- You can reuse tags in other PanelMate configurations. After you have developed a tag database, you can reuse the database in future PanelMate configurations.
- You can adapt tag databases developed for other applications/products (ie: your PLC) for use with your PanelMate application., without defining the relationship between tags and addresses twice.
- You can reduce development time and typing errors by selecting tags from pull down lists and dialog boxes instead of typing them.

## Tag Database Files

Tags are stored in a tag database. There are many third-party software packages that can be used for creating and editing tag databases, including Microsoft Excel. Depending on the intended application for the tag database, the database may contain a variety of data related to each tag. For your PanelMate application, the Configuration software only requires two types of information:

The Tag Name

The PLC I/O address reference

The Configuration software reads the tag name and I/O address information from a comma separated variable (.csv) file. Most third-party software packages will allow you to create a .csv file from your tag database.

**Note:** **The .csv file is the only place where tag information can be stored. The file can be located anywhere accessible to the PanelMate Configuration software, but it can not be edited by the Configuration software. It is the user's responsibility to maintain the content of the .csv file.**

### **.CSV File Format Parameters**

- 1 The following parameters must be followed when creating the tag name .csv file:
- 2 A column ending is delimited by a comma character (0x2c).
- 3 A row is delimited by a lline feed character (0x0a) and a carriage return character (0x0d).
- 4 A row must contain 2 or more columns. One of the columns must be the **Tag Name** and another column must be the **PLC I/O Address** reference.
- 5 Blank rows are permitted.
- 6 A comma after the last column of a row is optional.



## How Configuration Software Processes Tag References

Tag name information is processed exclusively by the Configuration software. When a configuration is exported for downloading to a PanelMate online unit, the .pps file contains only the I/O address information. The tag name is not retained in the .pps file.

The Configuration software processes tag references in four situations:

- Entering tag information when configuring a template
- Saving a configuration
- Reference-to-tag replacement operations (tag refresh)
- Exporting a configuration

### Entering Tag Information

If a device in a configuration has an associated .csv file, when a reference is entered into the template's Control Definition PLC Bit Reference field or Conditional Expression field (see Chapter 10), the reference is validated. The Configuration software searches the tag name field of the .csv file for the tag name that was referenced. If the tag name is found, the I/O address corresponding with the tag name is validated. If the tag name is not found in the .csv file, the configuration software assumes the tag name to be an I/O address and validates it.

**Note:** When the Configuration software searches for a tag name in a .csv file, the search is case insensitive.

### Saving A Configuration

When a configuration is saved, the Configuration software will save the .csv file location and format information into the PLC Name and Port Table in the PanelMate database. When the configuration is opened, the configuration software will automatically open the associated .csv file.

**Note:** When opening a configuration, if the .csv file specified in the PLC Name and Port Table can not be found, the tags in the .csv file will not be loaded and a warning message will appear.

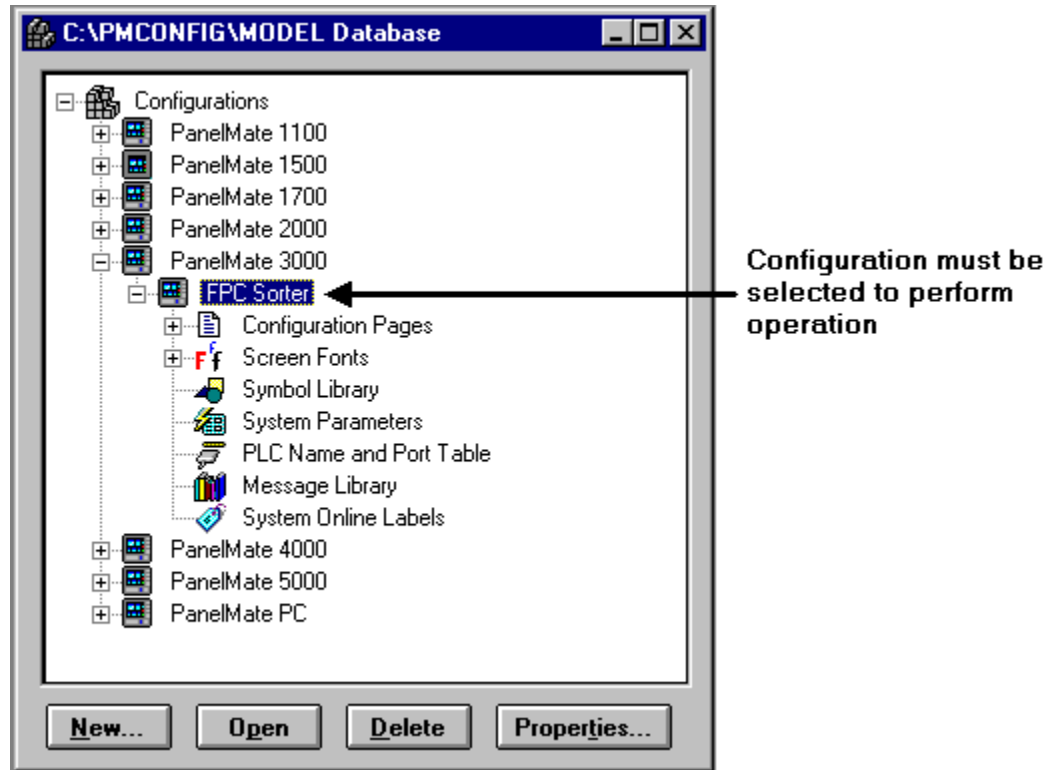
### Reference-To-Tag Replacement Operations

A reference-to-tag replacement operation is performed when a user wants to replace an existing I/O address with a tag name. This operation is especially useful when importing a .pps file into the PanelMate database. Because .pps files do not contain tag references, the imported configuration will only contain I/O references. By associating a .csv file with the imported configuration, the user can replace all of the I/O references with the corresponding tag names.

When performing a reference-to-tag replacement operation, the Configuration software searches the I/O Address Field of the .csv file. If the I/O address is found in the I/O Address Field, the corresponding tag name will replace the I/O address throughout the configuration. If the I/O address is not found in the .csv file, the Tag Name Column is searched to verify that the tag exists in the .csv file. Tags that are not found in either the I/O Address Field or the Tag Name Column are listed in pop-up dialog box, allowing you to resolve the status of the unknown I/O address.

**CAUTION:** Prior to performing a reference-to-tag operation, confirm that your .csv file does not contain any duplicate tag name (same tag name, different I/O address). Duplicate tag names WILL NOT be replaced during reference-to-tag operations.

- Note: When the Configuration software searches for an I/O address in a .csv file, the search is case insensitive. If there is more than one tag name associated with the same I/O address, then the first one found in the .csv file is used.
- Note: To perform a reference-to-tag operation, you must select the configuration in your Treeview. If you have a page selected, or any of the sub-categories (such as configuration pages, screen fonts, etc.) the Reference-To-Tag selection will not be accessible. Once the name of the configuration is selected, select the file pull-down menu in the configuration software and the References>Tags selection will be enabled. Click the References>Tags selection to complete the process.

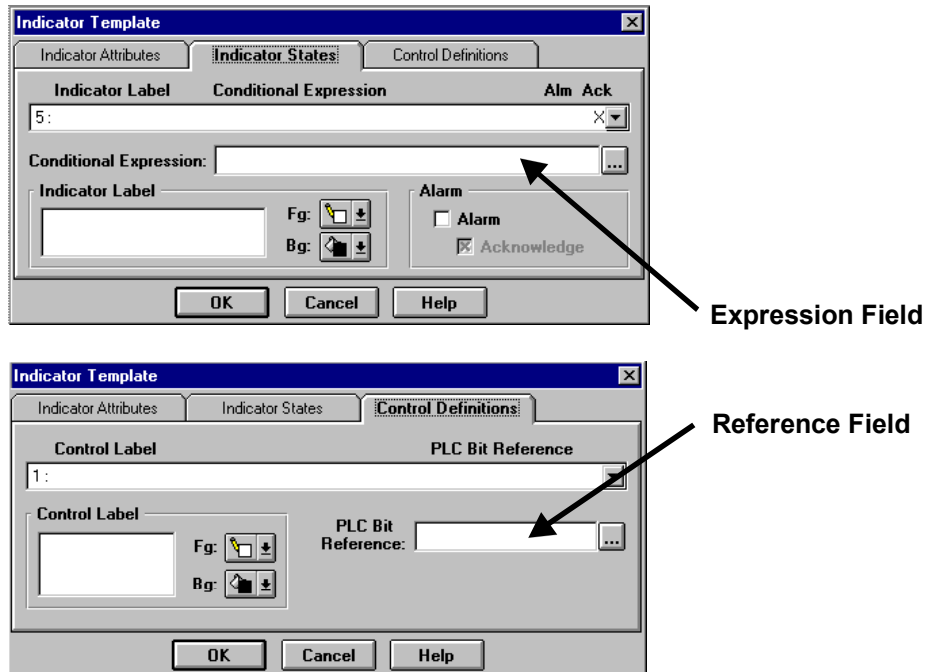


### Exporting A Configuration


When a configuration is exported and a .pps file is created, the Configuration software validates the information contained in the configuration. When a reference is validated, the configuration software searches the tag name field of the .csv file for the tag name that was referenced. If the tag name is found, the I/O address associated with the tag name is validated. If the tag name is not found in the .csv file, the configuration software assumes the tag name to be an I/O address and validates it.

## Accessing Tags

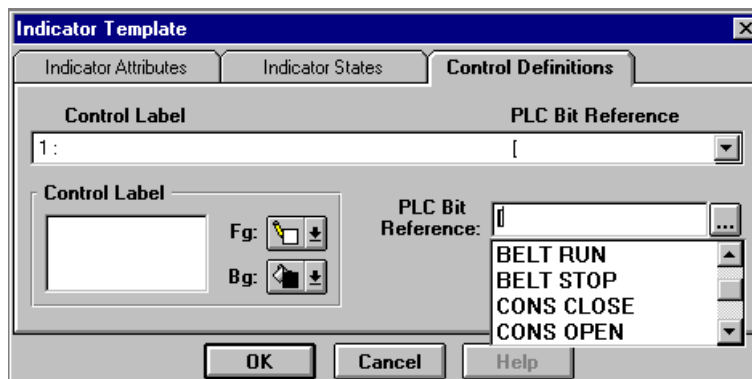
When building a PanelMate application, you may enter a tag name into any expression or reference field. An example of an expression and reference field is shown below.




You can access your tag names and references by doing any of the following:

- Enter a left bracket ( [ )
- Enter a comma ( , ) after entering the PLC device name.
- Click on the  button.

If you enter a left bracket ( [ ) or the PLC device name and a comma ( , ), a drop down list will appear, shown below. You can enter the tag information to the expression or reference field by double clicking on the desired tag in the list. Or you can manually enter the tag, if desired.



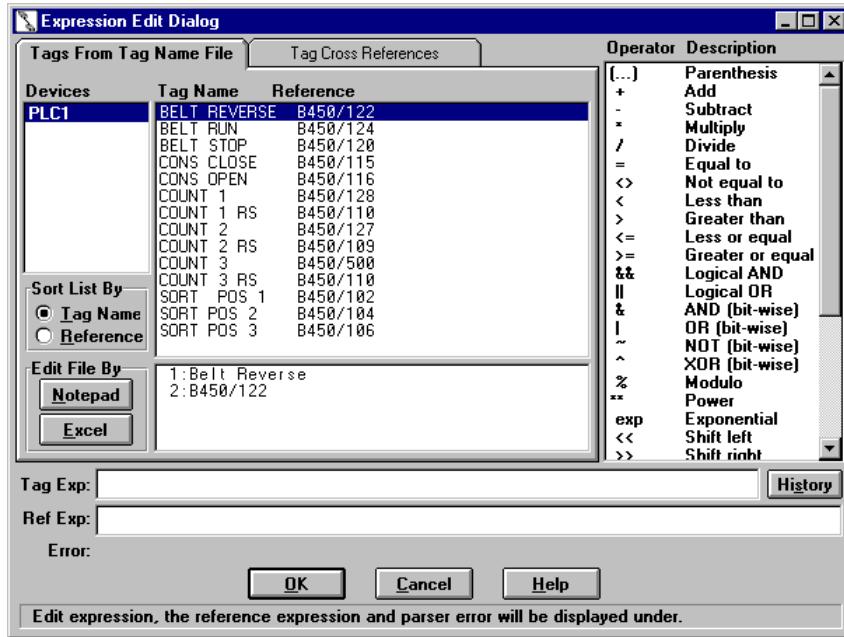
When you double click the  button associated with any reference or expression field, the **Expression Edit** dialog box will appear.

The **Expression Edit** dialog box allows you to:

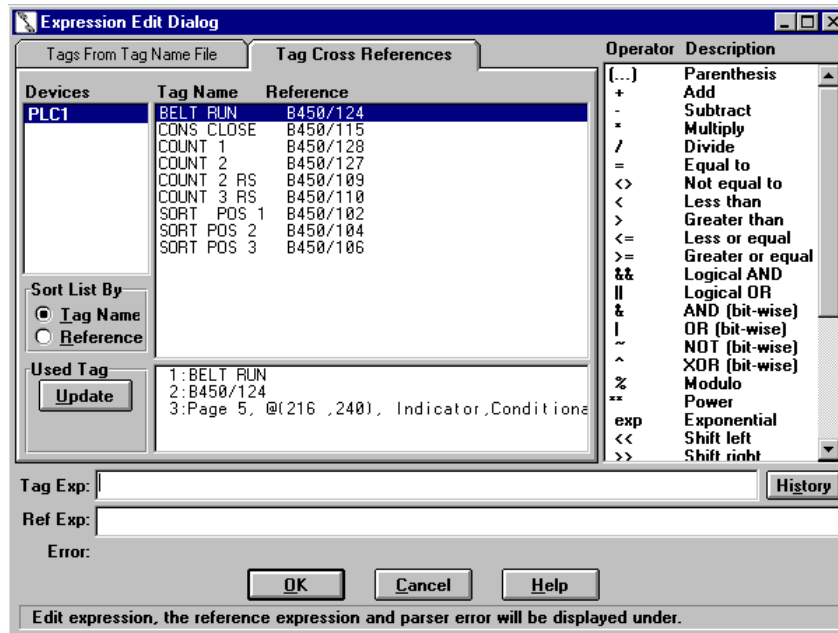
- Select tags
- Construct expressions
- See where tags are used in your configuration

The Expression Edit dialog box can be used in two views:

**Tags From Tag Name File** view - displays all tags in tag file



**Tag Cross Reference** view – only displays tags used in the configuration



The fields in the **Expression Edit** dialog box are described below:

**Devices Field:** Displays the device associated with the tag (.csv) file.

**Tag Name and Reference Field – Tags From Tag Name File Tab:** The upper field displays the Tag Name and Reference. The lower field displays the Tag Name and Reference column information. Double clicking on a Tag Name and Reference in the upper field and pressing the OK button will select the tag and close the Expression Edit dialog box.

**Tag Name and Reference Field – Tag Cross Reference Tab:** The upper field displays the Tag Name and References used in the configuration. When a Tag Name/Reference is highlighted, the lower field displays the specific “where used” information.

**Sort List By:** Determines the order of information displayed in the Tag Name and Reference field.

**Tag Exp:** This field displays the tag names and operators used in the Tag Expression. For more information, refer to **Constructing Expressions Using Tags**.

**Ref Exp:** This field displays the tag references and operators used in the Tag Expression. For more information, refer to **Constructing Expressions Using Tags**.

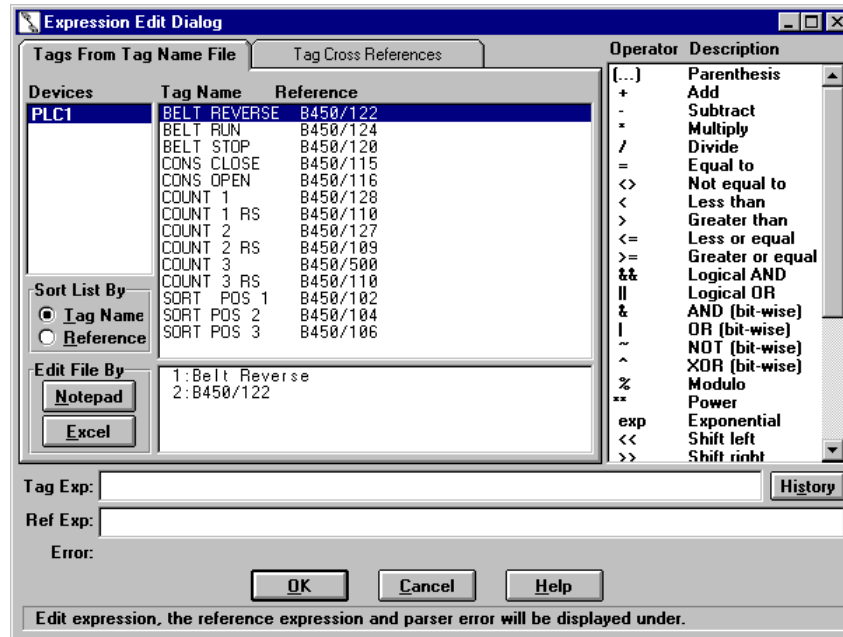
**Operator Description Field:** Displays the operators and descriptions commonly used in constructing expressions. Double clicking on an operator will add that operator to the expressions in the **Tag Exp** and **Ref Exp** fields.

**Edit File By:** (Tags From Tag Name File view only) Launches Microsoft Notepad or Excel. For more information, refer to **Editing Tags**.


**Used Tag Update:** (Tag Cross Reference view only) This button refreshes the list of used tags displayed in the Tag Name and Reference field.

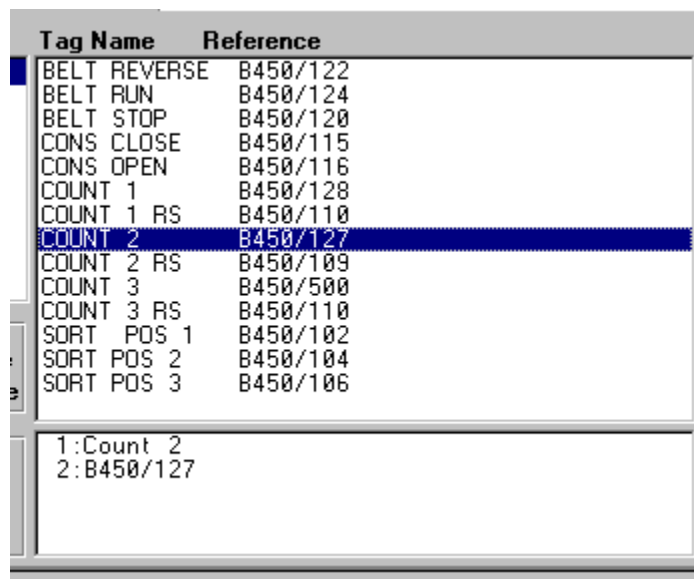
## Constructing Expressions Using Tags

The **Expression Edit** dialog box provides an easy, powerful method of constructing expressions incorporating tag names and references.



The following steps describe a typical expression construction process:

1. Click on the  button associated with any reference or expression field to open the Expression Edit dialog box.
2. Double click on the first Tag Name/Reference needed for the expression.



3. The Tag Name and Reference will appear in the Tag Exp and Ref Exp fields.

Tag Exp: [COUNT 2] History

Ref Exp: [B450/127]

Error:

4. Double click on the Operator needed for the expression.

Operator	Description
(...)	Parenthesis
+	Add
-	Subtract
*	Multiply
/	Divide
=	Equal to
<>	Not equal to
<	Less than
>	Greater than
<=	Less or equal
>=	Greater or equal
&&	Logical AND
	Logical OR
&	AND (bit-wise)
	OR (bit-wise)
~	NOT (bit-wise)
^	XOR (bit-wise)
%	Modulo
**	Power
exp	Exponential
<<	Shift left
>>	Shift right

5. The Operator will appear in the Tag Exp and Ref Exp fields.

Tag Exp: [COUNT 2] >= History

Ref Exp: [B450/127] >=

Error:

6. Continue repeating Steps 2-4 until the expression is completed. Press the OK button to close the Expression Edit dialog box

For more information on constructing expressions, refer to **Appendix A: Conditional Expression Operators**.

## Editing Tags


Your Configuration Editor can not edit a .csv file. You must use a third party software package such as Microsoft Excel or Notepad if you need to make changes to your .csv file. For convenience, you can launch Excel or Notepad from your Configuration Editor. Two launch points are available:

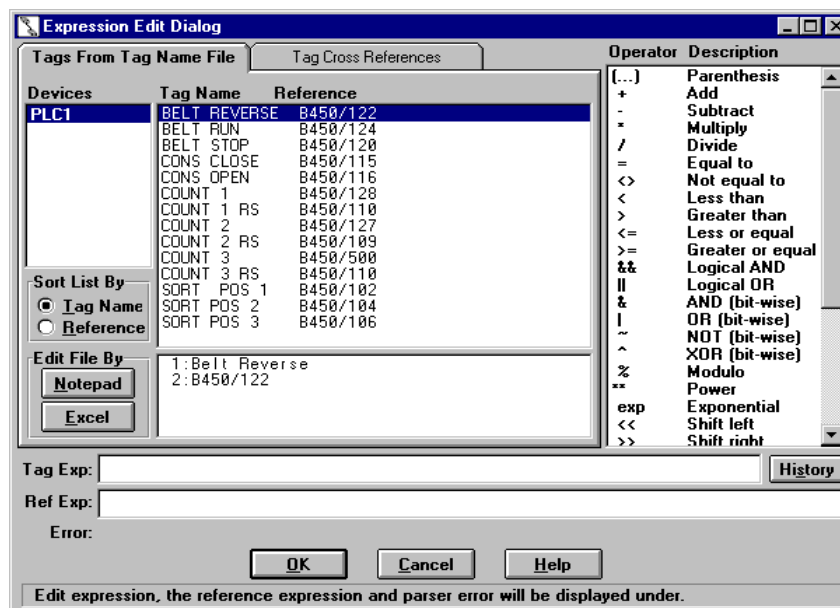
### Tag Name File dialog box

This dialog box is accessed from the **PLC Name and Port Table** dialog box. Click on the **Tag Name** button to activate the **Tag Name File** dialog box. Select the Excel or Notepad radio buttons and then press the **Edit...** button. This launches the selected program. When you exit the program, you will return to the Tag Name File dialog box.



### Expression Edit dialog box

This dialog box is accessed by clicking on the  button from any dialog box containing PLC references fields. In the Expression Edit dialog box, click on either the **Excel** or **Notepad** button to launch the desired program. When you exit the program, you will return to the Expression Edit dialog box.

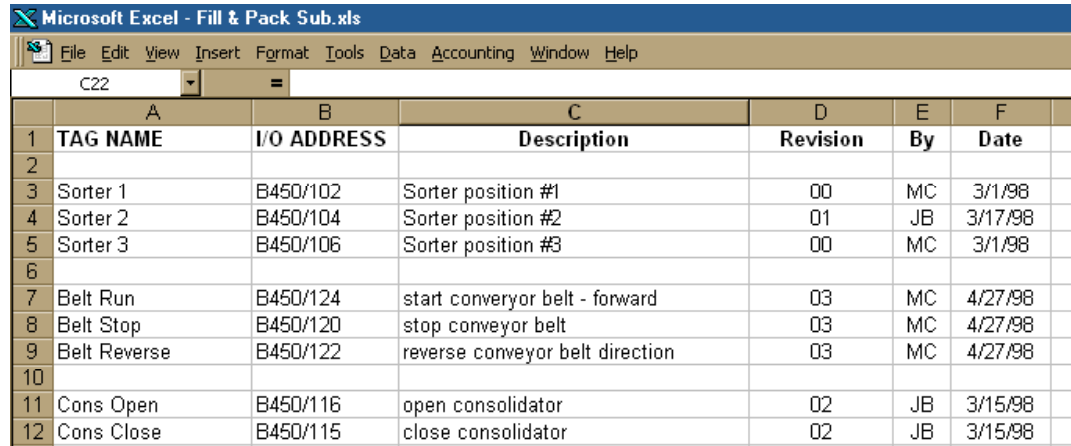




## Creating a .CSV File in Microsoft Excel

If you would like to use tags in your PanelMate application but do not have an existing tag database, you can develop one using Microsoft Excel spreadsheet software. If you are not familiar with Microsoft Excel, you may wish to read the Microsoft Excel software user's manual prior to starting your tag database.

The Configuration software only requires two types of information: the **Tag Name** and the **PLC I/O Address** reference. In your Excel spreadsheet, designate one column as the tag name and a second column as the I/O address. You may wish to use additional columns to add notes or other information, however these columns will not be recognized or used by the Configuration software. They will, however, be displayed in the Excel spreadsheet. An example is shown below.



	A	B	C	D	E	F
1	TAG NAME	I/O ADDRESS	Description	Revision	By	Date
2						
3	Sorter 1	B450/102	Sorter position #1	00	MC	3/1/98
4	Sorter 2	B450/104	Sorter position #2	01	JB	3/17/98
5	Sorter 3	B450/106	Sorter position #3	00	MC	3/1/98
6						
7	Belt Run	B450/124	start conveyor belt - forward	03	MC	4/27/98
8	Belt Stop	B450/120	stop conveyor belt	03	MC	4/27/98
9	Belt Reverse	B450/122	reverse conveyor belt direction	03	MC	4/27/98
10						
11	Cons Open	B450/116	open consolidator	02	JB	3/15/98
12	Cons Close	B450/115	close consolidator	02	JB	3/15/98

↑  
Column 1  
contains the  
**Tag Name**

↑  
Column 2  
contains the  
**I/O Address**

↑ ↑ ↑ ↑  
Columns 3,4,5,& 6 contain additional  
data that is not recognized or used by  
the PanelMate Configuration software

When you have finished entering all of your tag names and associated I/O address references, you must save the file as a .csv file. For easier future modifications, you should also consider saving the file as an Excel spreadsheet (.xls)

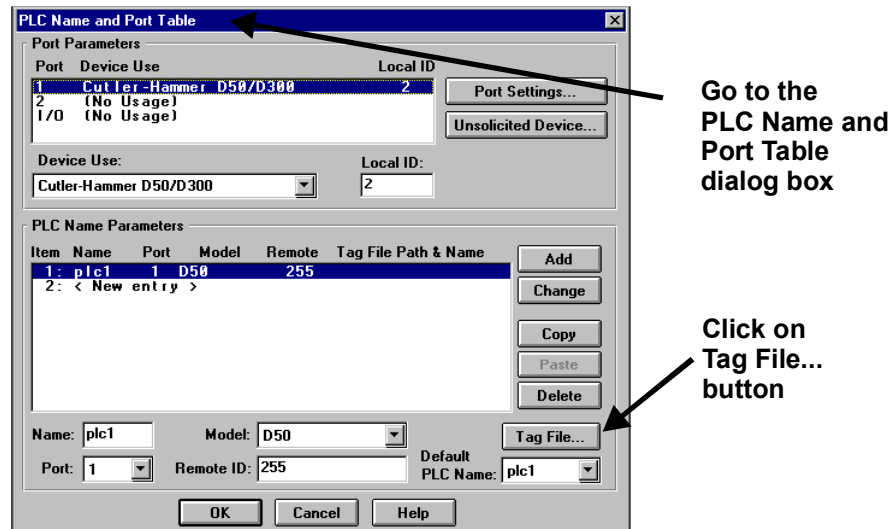
After saving as a .csv file, you can associate the .csv file with your PanelMate configuration using the PLC Name and Port Table (see Chapter 7).

## Creating a .CSV File From Your PanelMate Configuration

If you have a PanelMate configuration that was developed without tags, you can export your references to a .csv file using the PLC Name and Port dialog box. Once created, you can associate the .csv file with a device in your source configuration or any other PanelMate configuration. To create a .csv file, use the following procedure:

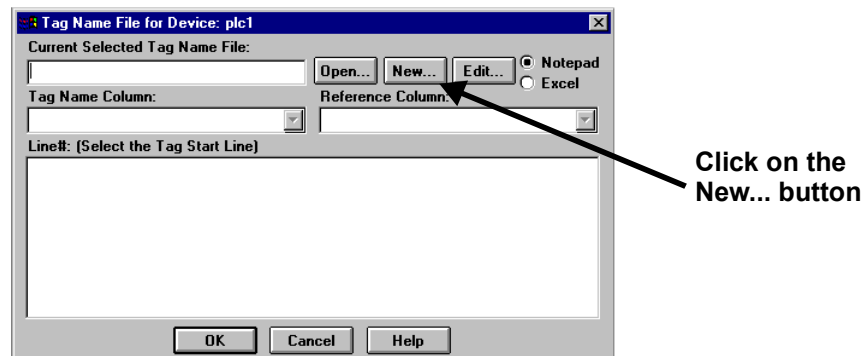
### Step 1

Open the **PLC name and Port Table** and click on the **Tag File...** button



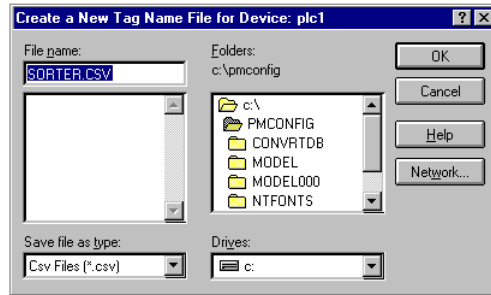
### Step 2

Click on the **NEW...** button in the **Tag Name File** dialog box



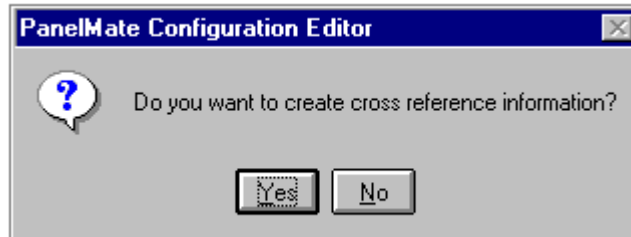
### Step 3

Choose a file name and path for the .csv file in the **Create a New Tag Name** dialog box.



### Step 4

A Message box will appear asking if you want to create cross reference information. Both a “NO” or “YES” response will produce a .csv file.



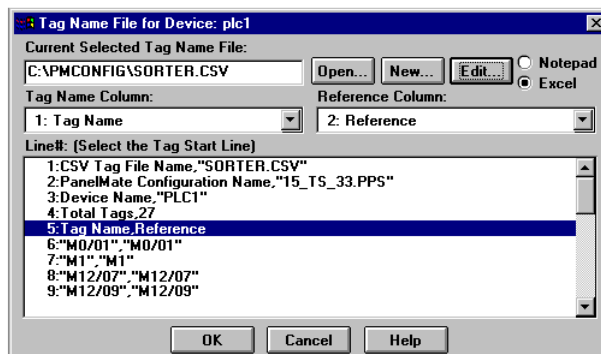
A “NO” response will produce a simple Tag Name file with two columns of information: the Tag Name and the Tag Reference.

A “YES” response will produce a Tag Name file with additional columns of data containing PLC cross reference information.

Samples of both types of .csv files are shown in **Step 6**.

### Step 5

After selecting “NO” or “YES”, the .csv file is automatically generated and associated with the device in your configuration. The Tag Name File dialog box will reappear, displaying the reference data.



Although the .csv file is now associated with your device and configuration, it only contains tag reference data. The reference data is displayed in both the **Tag Name Column** and the **Reference Column**. To make the .csv useful, you will need to assign tag names to the references.

## Step 6

To assign tag names to the references, select the **Excel** radio button and then click on the **Edit...** button. This will launch Excel and display your .csv file data in a spreadsheet format for easy editing.

If you chose a “NO” response in **Step 4**, your tag name and reference data will appear in the first two columns of the Excel spreadsheet as shown below:

	A	B	C	D	E
1	CSV Tag File Name	SORTER2.CSV			
2	PanelMate Configuration	15_TS_33.PPS			
3	Device Name	PLC1			
4	Total Tags	27			
5					
6	<b>Tag Name</b>	<b>Reference</b>			
7	M0/01	M0/01			
8	M1	M1			
9	M12/07	M12/07			
10	M12/09	M12/09			
11	M13/00	M13/00			
12	M13/01	M13/01			
13	M13/05	M13/05			
14	M13/06	M13/06			

**Column 1 contains Tag Names**

**Column 2 contains References**

Note: Since your configuration did not contain any tag names, the PLC reference information is placed in both the Tag Name column and the Reference column. You will need to assign actual tag names, as described in Step 7.

If you chose a “YES” response in **Step 4**, your tag name and reference data will appear in the first two columns, and your PLC reference data will appear in columns 3, 4, etc. Although data in columns 3 and beyond are not used by the Configuration software, the data does provide an overall summary of your configuration. An example is shown below:

	A	B	C	D	E	F	G
1	CSV Tag File Name	SORTER.CSV					
2	PanelMate Configuration	15_TS_33.PPS					
3	Device Name	PLC1					
4	Total Tags	27					
5							
6	<b>Tag Name</b>	<b>Reference</b>	<b>Expression</b>	<b>Page #</b>	<b>Position</b>	<b>Element Type</b>	<b>Expression Type</b>
7	M13/06	M13/06	[m13/06]	1	(543 ,161)	Variable-Sized Control Button	PLC bit reference
8	M13/05	M13/05	[m13/05]	1	(415 ,161)	Variable-Sized Control Button	PLC bit reference
9	M4/00	M4/00	[M4/00]	1	(420 ,102)	Variable-Sized Graphic	Conditional 4 expression
10	M15/00	M15/00	[M15/00]	1	(414 ,97)	Variable-Sized Control Button	PLC bit reference
11	M4/01	M4/01	[M4/01]	1	(493 ,102)	Variable-Sized Graphic	Conditional 4 expression
12	M4/02	M4/02	[M4/02]	1	(566 ,102)	Variable-Sized Graphic	Conditional 4 expression
13	M2/04	M2/04	[m2/04]	1	(504 ,174)	Variable-Sized Graphic	Conditional 4 expression
14	M15/01	M15/01	[M15/01]	1	(487 ,97)	Variable-Sized Control Button	PLC bit reference

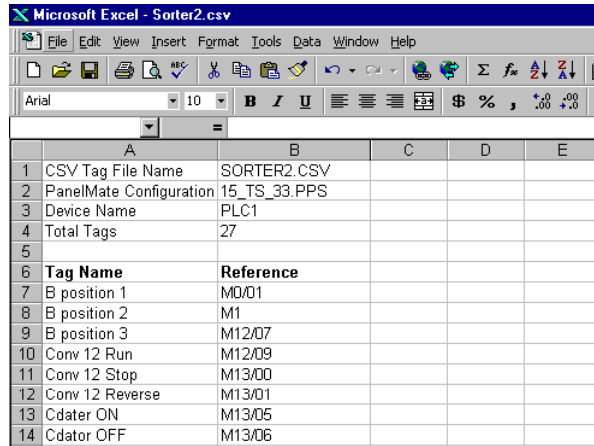
**Column 1 contains Tag Names**

**Column 2 contains References**

**Columns 3 and beyond contain PLC cross reference information**

## Step 7

The final step is to replace the duplicate references in the Tag Name Column with actual tag names. After tag names have been assigned to the references, your edits are saved and the .csv file can now be used to convert your configuration's references to tags. See “**References to Tag Replacement Operations**” for more information.



	A	B	C	D	E
1	CSV Tag File Name	SORTER2.CSV			
2	PanelMate Configuration	15_TS_33.PPS			
3	Device Name	PLC1			
4	Total Tags	27			
5					
6	<b>Tag Name</b>	<b>Reference</b>			
7	B position 1	M0/01			
8	B position 2	M1			
9	B position 3	M12/07			
10	Conv 12 Run	M12/09			
11	Conv 12 Stop	M13/00			
12	Conv 12 Reverse	M13/01			
13	Cdator ON	M13/05			
14	Cdator OFF	M13/06			

↑  
**Convert duplicate references  
to Tag Names**

## Tags and I/O References in the PanelMate Pro LT 1100

When building a PanelMate application for the PanelMate Pro LT 1100, there is an I/O reference count limit that applies to the application. The number of I/O references that are allowed in a PanelMate Pro LT 1100 application depends on the number of I/O expansion options that have been applied to the 1100. The default limit is 64 I/O references. Expansion options are available in 64 reference blocks, up to a maximum total of 512 I/O references.

**CAUTION:** Once a tag upgrade is loaded onto a PanelMate Pro LT 1100, it is there permanently. It cannot be removed or relocated to another unit or back to the tag key. Careful planning in determining the number of actual tag references that are to be used should be exercised before loading a tag upgrade.

An I/O reference is **any unique I/O address used by the configuration, including scratchpad references** (internal references created by the user but local to the PanelMate). An individual I/O reference may be used as many times as needed by the configuration, and will only count as a single I/O reference. Each additional different reference counts as another I/O reference against the total I/O count limit.

When using Tags in the configuration, the PanelMate Power Pro software resolves the Tag names into I/O references at the time of Export. Each unique tag name that references a different I/O address counts as an I/O reference against the total I/O count limit. Multiple tag names that reference the same I/O address will only count as a single I/O reference against the total. Unused tag names do not count against the total I/O count.

A list of tag names and I/O references used by an application are given below as an example:

BELT REVERSE	B450/122
BELT RUN	B450/124
BELT STOP	B450/120
COUNT 1 RS	B450/110
COUNT 2 RS	B450/112
COUNT 1 CV	B450/110
(No tagname)	B450/124

In the list shown above, there are 7 tags and I/O references. Of the 7 tags and references, there are only 5 **unique** I/O references. This list would count for 5 I/O references against the total I/O count limit.

A quick way of calculating the number of unique tags and I/O references used by a configuration is to use the Create New Tag File feature in the PLC Name and Port Table (refer to **Chapter 7: PLC Name and Port Table**). To create a new tag file for a communication device, use the following procedure:

1. Open the PLC Name and Port Table
2. Select a communication device from the PLC Name Parameters section
3. Click on the **Tag File...** button
4. In the Tag File dialog box, click on the **New...** button
5. Enter a name for the .CSV file to be created, and click **OK**

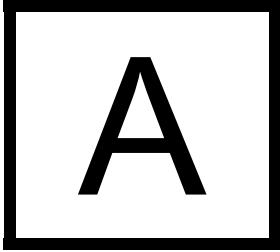
On file creation, the Configuration Editor displays the new file's contents. The fourth line of the file will display the number of unique tags for the selected device, plus one for the input expression operator ([?]). By repeating the above process for each communication device in the PLC Name Parameters section, the total unique I/O reference count can be obtained, excluding internal scratchpad references. Note that if an existing tag file is used for editing, **Cancel** the new tag file creation, and not save the newly created tag file.

An additional method for calculating the number of unique tags and I/O references used by a configuration is to use the Tag Cross Reference feature of the Expression Edit Dialog box, and

manually count the listed references. See the previous section, **Accessing Tags**, for more information on using the Tag Cross Reference feature.

The final calculation of the total number of I/O references used in an application is made by the PanelMate Pro LT 1100. If the I/O reference count exceeds the allowable count for the 1100, the unit displays an error message showing the number of references exceeding the limit when loading the application. After displaying the error message, the 1100 resets to the offline menu. Refer to the **PanelMate Power Pro Online Operation User's Guide** for more information.

# Conditional Expression Operators



*In this chapter, you will learn:*

- *About the Conditional Expression Operators*



## Conditional Expression Operators

The operators are listed in order of precedence. Level 1 has the highest precedence and level 14 has the lowest precedence. All operators on the same level are evaluated left to right. You can use parentheses to change the order of operation. For more information on the conditional expressions, refer to the **Conditional Expression Examples** topic.

No.	Operator	Description	No.	Operator	Description
1	<b>sqr()</b>	Square root	1	<b>abs()</b>	Absolute value
1	<b>log()</b>	Base 10 log	1	<b>nlog()</b>	Natural log
1	<b>sin()</b>	Sine	1	<b>cos()</b>	Cosine
1	<b>tan()</b>	Tangent	1	<b>asin()</b>	Arcsine
1	<b>acos()</b>	Arccosine	1	<b>atan()</b>	Arctangent
2	<b>~</b>	NOT (bit-wise)	3	<b>exp</b>	Exponential
4	<b>**</b>	Power	5	<b>*</b>	Multiply
5	<b>/</b>	Divide	5	<b>%</b>	Modulo
6	<b>-</b>	Subtract	6	<b>+</b>	Add
7	<b>&gt;&gt;</b>	Shift right	7	<b>&lt;&lt;</b>	Shift left
8	<b>&lt;</b>	Less than	8	<b>&lt;=</b>	Less than or equal to
8	<b>&gt;</b>	Greater than	8	<b>&gt;=</b>	Greater than or equal to
9	<b>=</b>	Equal to	9	<b>&lt;&gt;</b>	Not equal to
10	<b>&amp;</b>	AND (bit-wise)	11	<b>^</b>	XOR (bit-wise)
12	<b> </b>	OR (bit-wise)	13	<b>&amp;&amp;</b>	Logical AND
14	<b>  </b>	Logical OR			

Note the following items:

- All operators must be lower case when entered in a conditional expression.
- The results of all trigonometric functions are in radians.
- A space is required before and after the exp operator. For example: 2 exp 5.

## Conditional Expression Examples

The following conditional expression examples are grouped into categories. Refer to the sections below.

Note that spaces are not required between references.

### General Examples

The following general examples are shown using a generic format. See the appropriate Communication Driver Manual sent with your PanelMate software for more specific information.

[204 06]

A conditional expression can be as simple as a single bit reference that resolves to true if the bit is on.

[204 03] && [204 04] && [205 07]

This conditional expression resolves to true if bit 3 of word 204, bit 4 of word 204, and bit 7 of word 205 are all on.

[35] >500

This conditional expression resolves to true if the value of word 35 is greater than 500.

[?]\*([?]>=0)\*([?]<=100)+([?]<0)\*[123]+([?]>100)\*[123]

This conditional expression limits entries between 0 and 100 to the PLC register. Any value outside this range has no effect on the value in the register.

### Trigonometry Function Examples

sin([1]) will return the sine of the contents of register 1.

abs([1]) will return the absolute value of the contents of register 1.

### Bit-wise Function Examples (using 8 bits)

Bit-wise functions produce numerical answers based on the numerical values of the operands and the operation being performed. Assume [1] contains the value 5 (0000 0101 binary) and [1] contains the value 6 (0000 0110 binary).

$$\sim[1] = \sim(0000\ 0101) = 1111\ 1010$$

$$\begin{array}{rcl}
 [1] \& [2] & = \\
 & \& & \begin{array}{r} 0000\ 0101 \\ 0000\ 0110 \\ \hline 0000\ 0100 = 4 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 [1] | [2] & = & \begin{array}{r} 0000\ 0101 \\ | \quad 0000\ 0110 \\ \hline 0000\ 0111 \end{array}
 \end{array}$$

$$\begin{array}{rcl}
 [1] \wedge [2] & = & \begin{array}{r} 0000\ 0101 \\ \wedge \quad 0000\ 0110 \\ \hline 0000\ 0011 \end{array}
 \end{array}$$

$$[1] \gg 2 = 0000\ 0101 \gg 2 = 0000\ 0001 = 1.$$

$$[1] \ll 3 = 0000\ 0101 \ll 3 = 0010\ 1000 = 40.$$

### Logical Function Examples

Logical functions produce answers that are either TRUE (1) or FALSE (0) by performing operations on their operands using either their numerical value for comparisons or their logical value such that FALSE = 0 and TRUE = anything but 0 (zero). Assume that the address [1] contains the value 5, the address [1] contains the value 6, and the address [3] contains the value 0.

$$[1] > [2] = 5 > 6 = \text{false} = 0.$$

$$[1] < [2] = 5 < 6 = \text{true} = 1.$$

$$[1] || [2] = 5 || 6 = \text{true} || \text{true} = \text{true} = 1.$$

$$[2] \&\& [3] = 6 \&\& 0 = \text{true} \&\& \text{false} = \text{false} = 0.$$

Note that =, <>, >=, and <= work similarly.

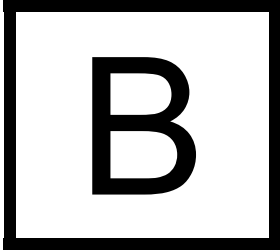
### Exponential Function Examples

Assume that the address [1] contains the value 5 and the address [2] contains the value 6.

$$[1] ** [2] = 5 ** 6 = 5 \text{ raised to the } 6^{\text{th}} \text{ power.}$$

$$[1] \text{ exp } [2] = 5 \text{ exp } 6 = 5 \text{ times } 10 \text{ raised to the } 6^{\text{th}} \text{ power.}$$

# Word and Bit References



*In this chapter, you will learn:*

- *About the Word and Bit References*

## Word and Bit References

This topic describes the word and bit formats used by the PanelMate unit for reading and writing data to/from the PLC.

### PLC Word References

All of the editors use the same format for referencing PLC words. To refer to a specific word in any expression, use the following format ...

[plcname,word#format]

The fields plcname and #format are optional. If no information is entered in these fields, default values are used.

#### PLC Word Format Fields

<b>plcname,</b>	<p>The six character (or less) name of the designated PLC followed by a comma. The PLC name is defined in the <b>PLC Name and Port Table</b> dialog box. See the <b>PLC Name and Port Table</b> topic for more information about this name.</p> <p>If plcname is omitted, the default PLC (defined in the <b>PLC Name and Port Table</b> dialog box) is used.</p> <p>This field is optional.</p>
<b>word</b>	<p>The actual PLC reference number of the word to be read or written, using the addressing nomenclature of the PLC defined by plcname.</p> <p>See the specific PLC section for more information about word reference numbers.</p>
<b>#format</b>	<p>A three-character or four-character code preceded by a number sign (#). This code specifies the format of all PLC data read or written.</p> <p>If #format is omitted, the default formats will be used as noted in the Communication Driver Manuals.</p>

The PanelMate unit recognizes the following formats ...

<b>#S16</b>	Signed, 16 bit integer between -32768 and 32767 inclusive. The sign is defined by the high order bit.
<b>#U16</b>	Unsigned, 16 bit integer between 0 and 65535 inclusive.
<b>#S32*</b>	Signed, 32 bit integer between -2,147,483,648 and 2,147,483,647 inclusive. The sign is defined by the high order bit.
<b>#U32*</b>	Unsigned, 32 bit integer between 0 and 4,294,967,295 inclusive.
<b>#BCD3</b>	Three-digit binary coded decimal number between 0 and 999.
<b>#BCD4</b>	Four-digit binary coded decimal number between 0 and 9,999.
<b>#BCD6*</b>	Six-digit binary coded decimal number between 0 and 999,999. The number is stored in two contiguous registers, three digits per register.
<b>#BCD8*</b>	Eight-digit binary coded decimal number between 0 and 99,999,999. The number is stored in two contiguous registers, four digits per register.
<b>#BIN3</b>	Three-digit decimal number between 0 and 999.
<b>#BIN4</b>	Four-digit decimal number between 0 and 9,999.
<b>#BIN6*</b>	Six-digit decimal number between 0 and 999,999. The number is stored in two contiguous registers, three digits per register.
<b>#BIN8*</b>	Eight-digit decimal number between 0 and 99,999,999. The number is stored in two contiguous registers, four digits per register.

\* **When specifying these data formats, the address specified for word defines the first of the two registers (the one with the lower reference). This register will contain the most significant portion of the number.**

**#FP** 32-bit floating point number between  $\pm 1.20 \times 10^{-38}$  and  $3.40 \times 10^{38}$  using the IEEE format. The 32 bits contain three fields:

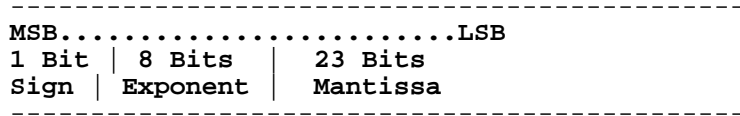
- 1 sign bit
- Eight-bit biased exponent
- 23-bit mantissa with a 24<sup>th</sup> implicit normalized bit.

The **normalized bit** is always 1 for non-zero numbers. The bit is recognized implicitly and not stored. The decimal point is placed immediately to the right of the implicit normalized bit.

The **exponent** has a bias of 7F HEX (127 decimal).

The **mantissa** is precise to seven decimal places.

The PanelMate unit does not convert the bits in the PLC to any other data type, but reads the bits as they are stored in the PLC. The PLC stores the bits as shown below ...



*When the number of significant digits in a value exceeds the number of digits for the display, the value is displayed in exponential notation provided the length of the value field is equal to or greater than ...*

- five for positive numbers
- six for negative numbers

*The exponential format is ...*

- [-]n.nnnE-nn for negative exponents
- [-]n.nnnE nn for positive exponents

Note that seven significant digits (not including the sign and decimal point) are valid. If the field is longer than seven significant digits, the additional information may be erroneous.

When you send data to the PLC, the PanelMate unit deletes any high order bits above the range allowed.

BCD and BIN formats do not support negative values. Expressions can be used to scale values in the PanelMate unit so the operator enters and reads negative numbers, but positive numbers are written to or read from the PLC.

Note: For PMPC/ePro configurations, set up to communicate through an OPC server. Refer to the appropriate help documentation for details on configuring the floating point format type.

## PLC Bit References

All of the editors use the same format for referencing PLC bits. To refer to a specific bit in any expression, use the following format ...

[plcname,bit]

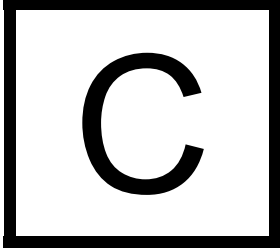
The field plcname is optional. If no information is entered in this field, default values are used.

### PLC Bit Format Fields

- plcname,** The six character (or less) name of the designated PLC followed by a comma. The PLC name is defined in the **PLC Name and Port Table** dialog box. See the **PLC Name and Port Table** topic for more information about this name.
- If plcname is omitted, the default PLC (defined in the **PLC Name and Port Table** dialog box) is used.
- This field is optional.
- bit** The actual PLC reference number of the bit to be read or written, using the addressing nomenclature of the PLC defined by plcname.
- See the specific PLC section for more information about word reference numbers.



# Using Graphics from other Software



*In this chapter, you will learn:*

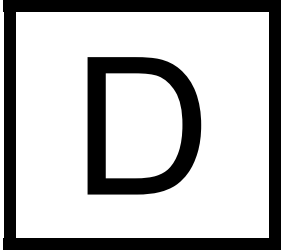
- *About using graphics from other software*

## Using Graphics from other Software

You can cut and copy graphics from other window-based packages (such as CorelDraw and AutoCad) and paste the graphics into the Configuration Software using the Windows clipboard. The graphic will be converted to a bitmap or PowerGraphic. Once the graphic has been inserted, you can make it a symbol.

The other application must be able to output to the Windows clipboard in a Windows bitmap or metafile format.

# Editing Graphics



*In this chapter, you will learn:*

- *About editing graphics*

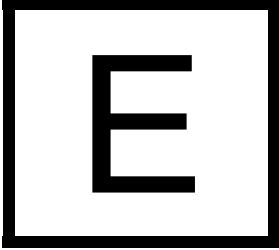
## Editing Graphics

You can use the keyboard keys to move, resize, or select objects. The following lists some suggestions for using the keyboard keys.

- The **Arrow** keys will move the selected object(s) one pixel.
- The **SHIFT** key with the **Arrow** keys will move the selected object(s) five pixels.
- The **CTRL** key with the **Arrow** keys will re-size the selected object(s) one pixel.
- The **TAB** key will select the next object that was created on a page.
- The **SHIFT** and **TAB** keys will select the previous object that was created on a page.
- The **F2** key will open the **Object Properties** dialog box when the object is selected.

Keyboard keys used to select, resize, move, select next, or select previous objects will not function on a configuration page when another window has been selected. For example, if an object is selected and the cursor is placed inside of the color selection palette and the **Arrow** keys are used to select different colors on the palette, the **Arrow** keys cannot be used to move the selected object unless the configuration page and the object are re-selected. This also applies when an object is selected and the cursor is placed inside of the Select Font box or the Pen Width box on the toolbar.

# Configuration Editor Problems



*In this chapter, you will learn:*

- *Solutions to some common Configuration Editor problems*

## Configuration Editor Problems

Some common configuration editor problems and solutions are listed below.

For information on online or transfer problems, refer to the Online Operation User's Guide or the Transfer Utility User's Guide.

Problem	Possible Cause	Corrective Action
Configuration Editor could not open the database.	<ol style="list-style-type: none"> <li>1. Share.exe is not loaded.</li> <li>2. The NetNamePath in the win.ini file under [Paradox Engine] is not pointing to a valid pathname.</li> <li>3. pmconfig.db is not found in the specified directory.</li> <li>4. The database path in pmconfig.ini (in Windows directory) does not point to a valid database.</li> <li>5. The database resides on a shared drive on a network and is currently open by another user.</li> <li>6. The Configuration Editor terminated abnormally through a General Protection Fault or hardware power failure and left the database in a "locked" state.</li> </ol>	<ol style="list-style-type: none"> <li>1. Load share.</li> <li>2. Change the path to the correct database directory.</li> <li>3. Ensure the path points to a valid database directory.</li> <li>4. Ensure the database path points to a valid database. Note that this is updated automatically when the database path is changed within the Configuration Editor.</li> <li>5. Once the other user closes the database, you will be able to open it.</li> <li>6. If you are <b>absolutely sure</b> the database is not open on your system, or another system from a network connection: delete the two lockfiles in the database, paradox.lck and pdoxusr.lck. Then, re-open the database.</li> </ol>
The pull down menu font selection does not display all options when a large font video driver is used.		Use the arrow keys to view all font selections.

Problem	Possible Cause	Corrective Action
The error “General Protection Fault” occurs during an export of a configuration containing bitmaps.	Incompatibility with the video driver.	Replace the video driver with a standard Windows (VGA) driver and re-export.
The error “File exception occurred while reading database” appears in the Configuration Software while trying to export a configuration.	Insufficient disk space.	Ensure there is sufficient disk space where the Temp directory or folder is located.
Colors or blinks shown in the editor do not match those shown in the online unit.	<ol style="list-style-type: none"> <li>1. Switching between Windows applications that use different color palettes.</li> <li>2. The video driver selected in the Windows Control Panel is not a 256-color driver.</li> <li>3. The selected video driver has a bug.</li> </ol>	<ol style="list-style-type: none"> <li>1. Try switching out of the editor and back again or close the editor and re-open it. If these actions correct the problem, then the video driver has a bug. Proceed to corrective action 3.</li> <li>2. Select a 256-color driver from the video driver list in the Windows Control Panel.</li> <li>3. Contact the video card manufacturer for an updated version that corrects this driver bug.</li> </ol>
PanelMate Series 1500 unit has sluggish performance when layered symbols are used and the Conditional Visibility feature is enabled.		Install the Dynamic Graphics option and use Variable-Sized Graphic objects instead of layered symbols.

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## PanelMate Power Pro Configuration Editor User's Guide 01-00490-01

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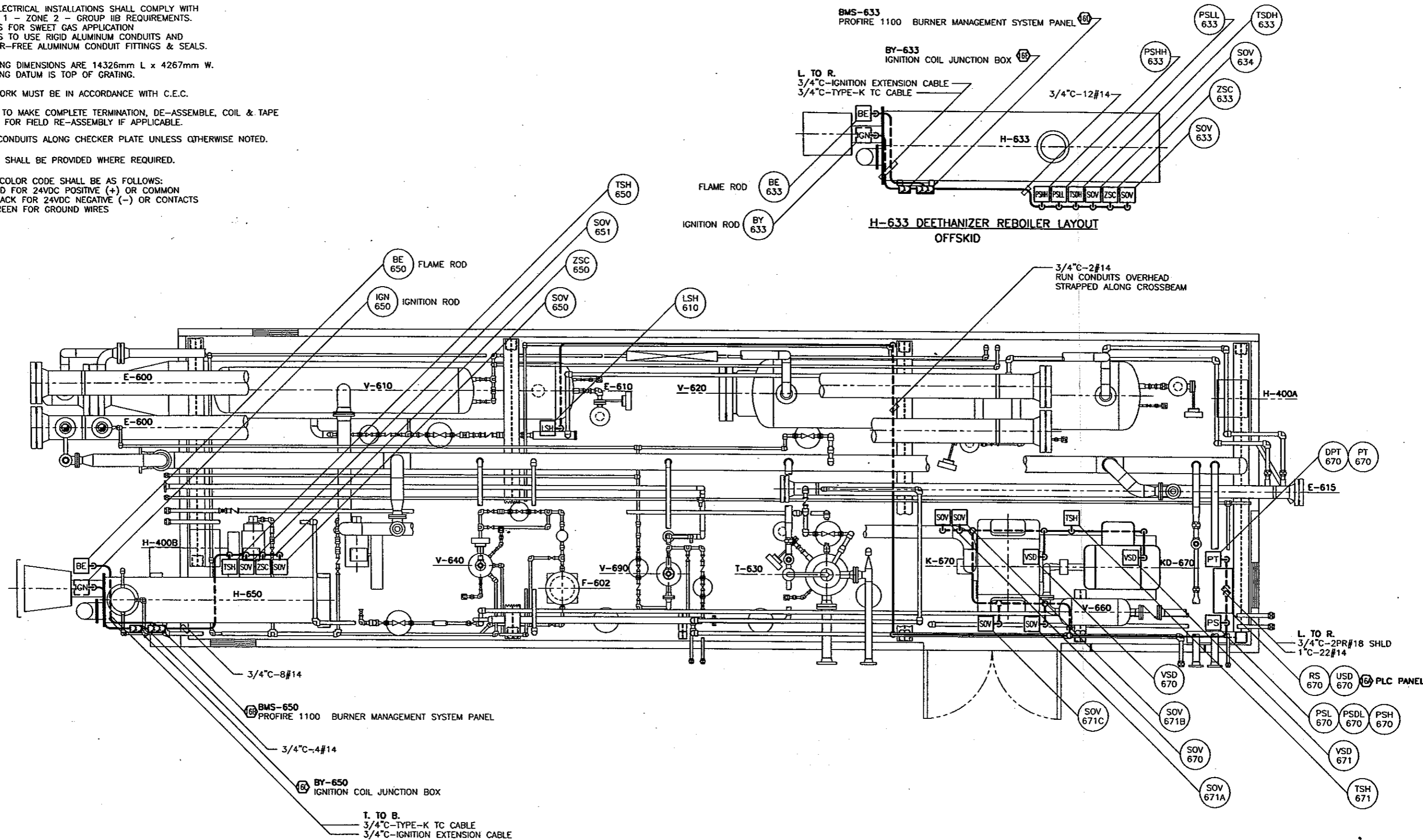
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**NOTES:**

- ALL ELECTRICAL INSTALLATIONS SHALL COMPLY WITH CLASS 1 - ZONE 2 - GROUP IIB REQUIREMENTS. UNIT IS FOR SWEET GAS APPLICATION. UNIT IS TO USE RIGID ALUMINUM CONDUITS AND COPPER-FREE ALUMINUM CONDUIT FITTINGS & SEALS.
- BUILDING DIMENSIONS ARE 14326mm L x 4267mm W. BUILDING DATUM IS TOP OF GRATING.
- ALL WORK MUST BE IN ACCORDANCE WITH C.E.C.
- SHOP TO MAKE COMPLETE TERMINATION, DE-ASSEMBLE, COIL & TAPE WIRES FOR FIELD RE-ASSEMBLY IF APPLICABLE.
- RUN CONDUITS ALONG CHECKER PLATE UNLESS OTHERWISE NOTED.
- SEALS SHALL BE PROVIDED WHERE REQUIRED.
- WIRE COLOR CODE SHALL BE AS FOLLOWS:
  - RED FOR 24VDC POSITIVE (+) OR COMMON
  - BLACK FOR 24VDC NEGATIVE (-) OR CONTACTS
  - GREEN FOR GROUND WIRES



No.	REVISION	BY	DATE	CKD	ENG
3	SHOP AS BUILT	M.L.L.	30/SEP/05	MLL	V.L.
2	UNIT SOLD AND CHANGED ALTRONIC PANEL TO PLC PANEL	X.W.	22/AUG/05	MLL	V.
1	ISSUED FOR CONSTRUCTION	X.W.	23/MAR/05	MLL	AC

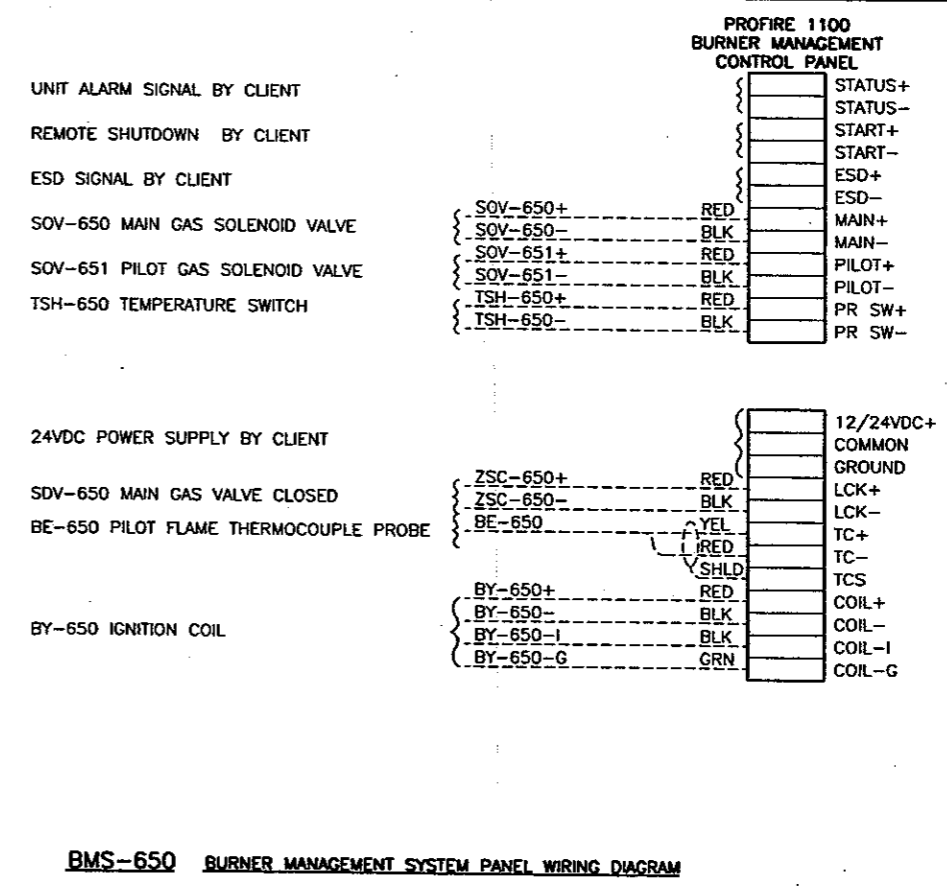
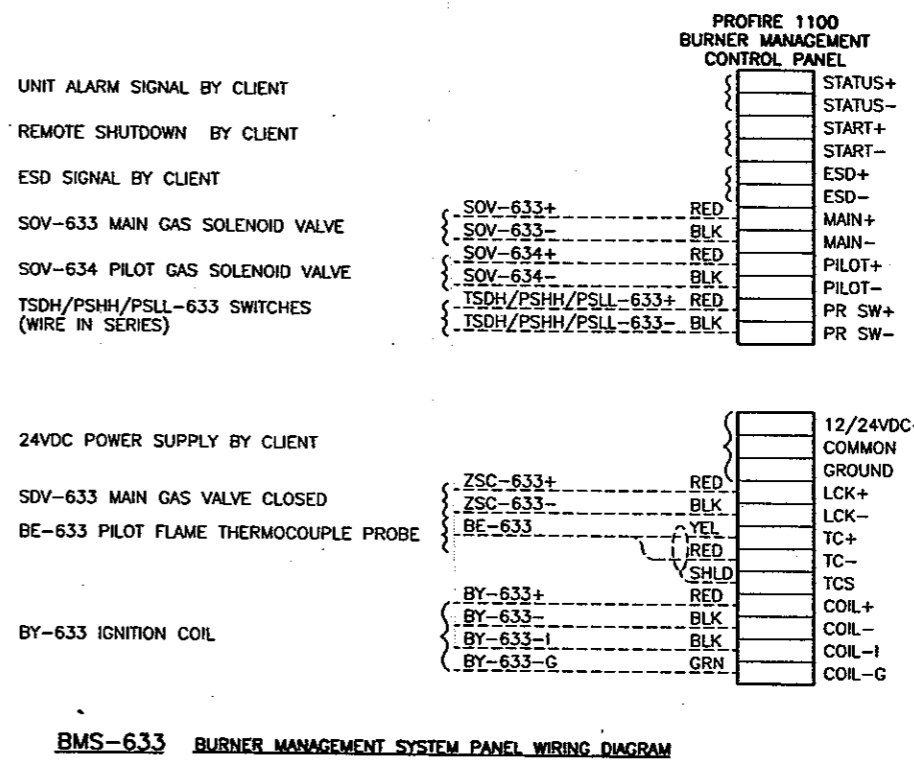
APPROVED		DRAWN	
MECH/STRUCT.	BY	X.WANG	DATE
DATE	DATE	23/MAR/05	
ELECTRICAL	A.C.E.J.	CHECKED	
DATE	25/MAR/05	BY	M.LUCERO
PROJECT	DATE	25/MAR/05	
DATE		SCALE	1:25

FORT ENERGY CORP	
REFRIGERATION PLANT - REF 8B	
ELECTRICAL	
REFRIGERATION BUILDING LAYOUT	
DWG. No.: D-ELO-054468-156	SHEET 11 REV. 3

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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BILL OF MATERIALS				
ITEM	QTY	DESCRIPTION	CATALOG # AND MANUFACTURER	VISION #
1A	90 FT	CONDUIT: 3/4" x 10' RIGID ALUMINUM	-	525418
1B	20	CONDUIT: 3/4" RIGID STEEL CONDUIT 2-PIECE STRAP	THOMAS & BETTS 701-113PGC	525487
1C	6	CONDUIT: 3/4" x 1/2" REDUCING BUSHING ALUMINUM	CROUSE-HINDS RE21SA	527030
1D	3M	CONDUIT: 1/2" LIQUIDTIGHT FLEXIBLE	THOMAS & BETTS CSA050	525476
1E	2	CONDUIT: 1/2" CLOSE NIPPLE ALUMINUM	-	525149
1F	2	CONDUIT: 1-1/2" x 3/4" REDUCING BUSHING RIGID GALVANIZED STEEL	-	525280
1G	1	MISC: 1-3/4" OZ TUBE THREAD LUBRICANT	CROUSE-HINDS STL-2	507009
1H	2	MISC: ELECTRICAL STRUT 1-5/8" WIDE x 1-5/8" DEEP x 10' PCS, GALVANIZED STEEL	UNISTRUT AT20010PGC	507003
2A	6	CONDUIT: 3/4" MARK 9 TYPE LB ELBOW COPPER-FREE ALUMINUM	CROUSE-HINDS LB29SX77	527491
2B	3	CONDUIT: 3/4" MARK 9 TYPE T TEE COPPER-FREE ALUMINUM	CROUSE-HINDS T29SX77	527499
2C	1	CONDUIT: 3/4" MARK 9 TYPE LL ELBOW COPPER-FREE ALUMINUM	CROUSE-HINDS LL29SX77	527497
2D	1	CONDUIT: 3/4" MARK 9 TYPE LR ELBOW COPPER-FREE ALUMINUM	CROUSE-HINDS LR29SX77	527498
2E	11	CONDUIT: 3/4" MARK 9 COVER COPPER-FREE ALUMINUM	CROUSE-HINDS 290	527090
2F	11	CONDUIT: 3/4" MARK 9 GASKET	CROUSE-HINDS GASK1942	527105
2G	4	CONDUIT: 3/4" HUB GROUNDING COPPER-FREE ALUMINUM	THOMAS & BETTS H075GRCA-CRHSTAG2	525111
2H	2	CONDUIT: 1/2" 90 DEGREE LIQUID TIGHT FLEX CONNECTOR COPPER-FREE ALUMINUM	THOMAS & BETTS 5252AL	525128
2I	4	CONDUIT: 1/2" STRAIGHT LIQUID TIGHT FLEX CONNECTOR ALUMINUM	THOMAS & BETTS 5232AL	525134
3A	50M	ELECT WIRE: #16 PURPLE STRANDED TINNED TEW	-	572007
3B	50M	ELECT WIRE: #16 YELLOW STRANDED TINNED TEW	-	572010
3C	3M	ELECT WIRE: #14 GREEN/YELLOW STRIPE STRANDED RW90	-	572001
P 16A	1	PLC COMPRESSOR CONTROL PANEL	PROPAK	-
P 16B	1	BMS-650 BURNER MANAGEMENT SYSTEM PANEL, PROFIRE SERIES 1100	PROFIRE 780021	-
P 16C	1	BY-650 IGNITION COIL JUNCTION BOX	PROFIRE 780034	-
P 16D	1	BMS-633 BURNER MANAGEMENT SYSTEM PANEL, PROFIRE SERIES 1100	PROFIRE 780021	-
P 16E	1	BY-633 IGNITION COIL JUNCTION BOX	PROFIRE 780034	-

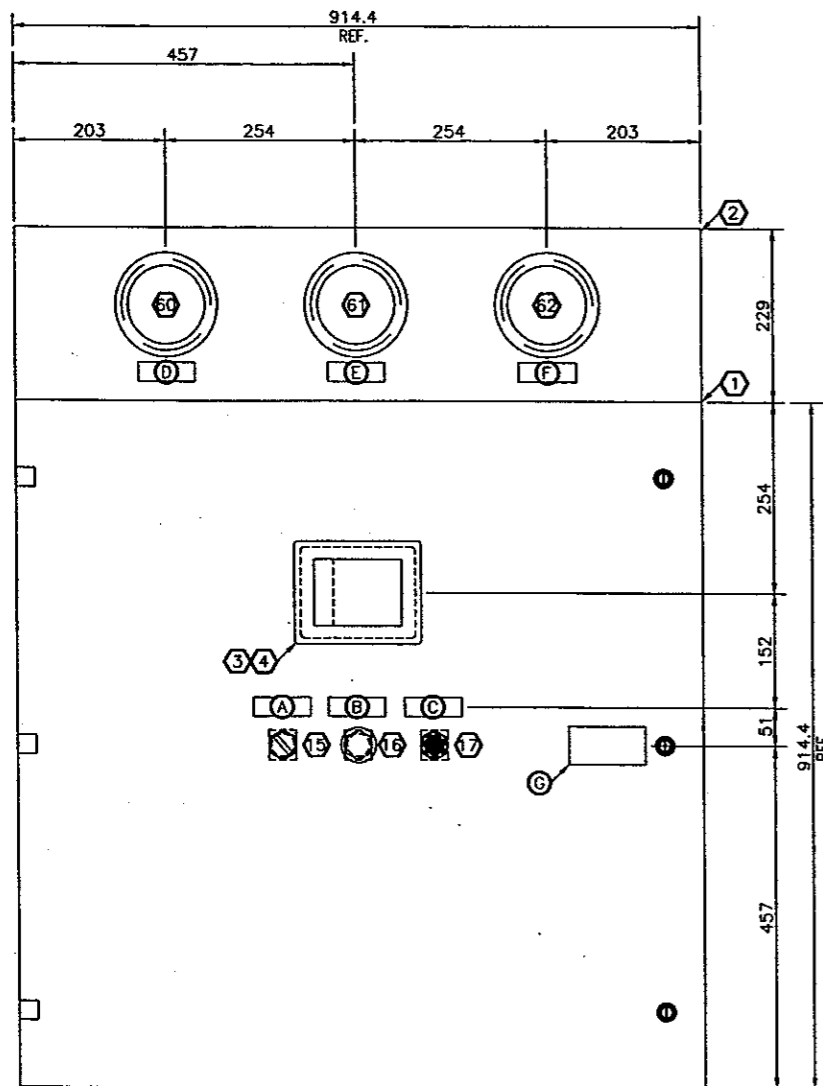


GENERAL NOTES		GENERAL NOTES	
3	SHOP AS BUILT	M.L.L.	30/SEP/05
2	UNIT SOLD AND CHANGED ALTRONIC PANEL TO PLC PANEL	XW	22/MG/05
1	ISSUED FOR CONSTRUCTION	XW	23/MAR/05

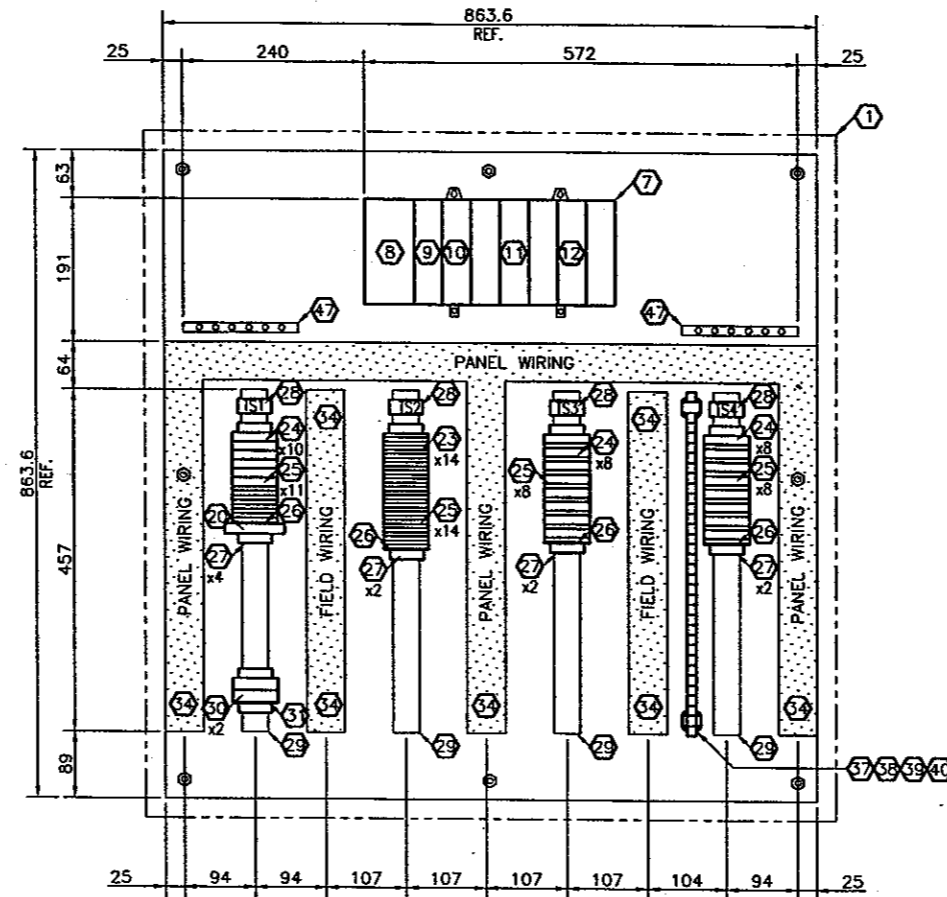
APPROVED	DRAWN	FORT ENERGY CORP.	
MECH/STRUCT.	BY X.WANG	REFRIGERATION PLANT - REF 88	
DATE	DATE 23/MAR/05	ELECTRICAL	
ELECTRICAL	A.CEJ	ELECTRICAL	
DATE	DATE 25/MAR/05	BILL OF MATERIAL	
PROJECT	BY M.LUCERO	DWG. No.: D-ELO-054468-156	
DATE	DATE 25/MAR/05	SHEET 2	
SCALE	NONE	REV. 3	

PROPAK  
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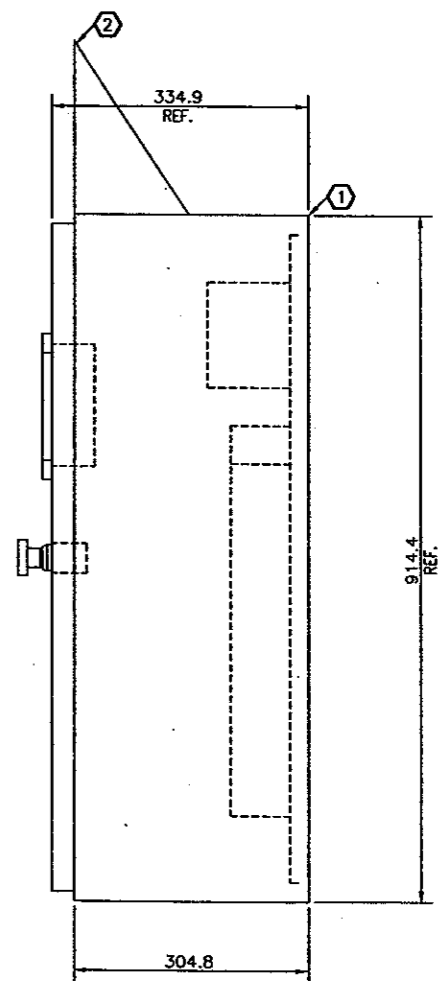
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PANEL DOOR EQUIPMENT LAYOUT



PANEL BACK-PAN EQUIPMENT LAYOUT



PANEL SECTION

GENERAL NOTES		GENERAL NOTES	
No.	2	1	2
	SHOP AS BUILT		ISSUED FOR CONSTRUCTION

BY	DATE	CHKD	ENG
MLL	30/SEP/05		
XW	22/AUG/05	MLL	VI

APPROVED		DRAWN	
MECH/STRUCT.	BY X.WANG	DATE	02/AUG/05
DATE	22/AUG/05	CHECKED	
ELECTRICAL	BY M.LUCERO	DATE	22/AUG/05
PROJECT		SCALE	1:5

<b>FORT ENERGY CORP.</b> REFRIGERATION PLANT - REF 88 ELECTRICAL PLC PANEL LAYOUT		SHEET 1 REV. 2
--	--	----------------

**PROPAK**  
 440 East Lake Road,  
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 Airdrie, Alberta  
 Canada T4B 2C3

TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAC.

BILL OF MATERIALS				
ITEM	QTY	DESCRIPTION	CATALOG NUMBER & MANUFACTURER	VISION #
1	1	STEEL ENCLOSURE, 914.4mmH x 914.4mmW x 304.8mmD, NEMA-4 c/w BACK-PANEL & MOUNTING FEET	EUROBEX 5412ES363612	535529
2	1	CUSTOM PLATE, 229mmH x 914mmW x 152mmD c/w 3 x 127mm CUT-OUTS	ACE MANUFACTURING	506065
3	1	TOUCH SCREEN, 8" PANELMATE POWER PRO DISPLAY, 24VDC, CL. I-DIV. 2	CUTLER HAMMER 1775T-PMPS-1700	510053
4	1	INTERFACE CABLE, TOUCH SCREEN TO PLC	HMI-CAB ACC CABLES	520392
5				
6				
7	1	PLC RACK, 7 SLOT CHASSIS	ALLEN-BRADLEY 1746-A7	510029
8	1	PLC POWER SUPPLY, 24VDC, CL. I-ZONE 2	ALLEN-BRADLEY 1746-P3	510003
9	1	PLC PROCESSOR, SLC 5/03	ALLEN-BRADLEY 1747-531	510034
10	1	PLC DISCRETE INPUT CARD, 16 POINTS, 24VDC, CL. I-ZONE 2	ALLEN-BRADLEY 1746-IB16	510006
11	1	PLC DISCRETE OUTPUT CARD, 8 POINTS, 24VDC, CL. I-ZONE 2	ALLEN-BRADLEY 1746-0X8	510038
12	1	PLC ANALOG INPUT CARD, 8 CHANNELS, 24VDC, CL. I-ZONE 2	ALLEN-BRADLEY 1746-NIB	510004
13				
14				
15	1	2-POSITION SELECTOR SWITCH, 1-NO CONTACT, HERMETICALLY SEALED, CL. I-ZONE 2	CUTLER-HAMMER 10250T722BK	509070
16	1	PUSHBUTTON, PUSH/PULL, MUSHROOM, ILLUMINATED RED, 1-NO/1-NC CONTACT, HERMETICALLY SEALED, CL. I-ZONE 2	CUTLER-HAMMER 10250T849ED	509063
17	1	PUSHBUTTON, EXTENDED HEAD, ILLUMINATED GREEN, 1-NO/1-NC CONTACT, HERMETICALLY SEALED, CL. I-ZONE 2	CUTLER-HAMMER 10250T818GD	509071
18				
19				
20	1	RELAY, 2 POLE, 6 AMP, HERMETICALLY SEALED CONTACTS, CL. I-ZONE 2, 24VDC, TYPE PLC-RSC-24VDC/21-21/AEX	PHOENIX CONTACT 5603678	540034
21				
22				
23	14	TERMINAL BLOCKS, DISCONNECT, TYPE WTR 2.5	WEIDMULLER 101120	501034
24	26	TERMINAL BLOCKS, FUSED, 24VDC c/w LED, TYPE WSI-6/2	WEIDMULLER 101420	501035
25	41	TERMINAL BLOCKS, FEED-THRU, TYPE WDU 4	WEIDMULLER 102010	501070
26	4	W SERIES TERMINAL BLOCK END PLATES FOR WDU 4, TYPE WAP	WEIDMULLER 105000	501019
27	10	W SERIES TERMINAL BLOCK END BRACKETS, TYPE EW 35	WEIDMULLER 38356	501032
28	4	GROUP TAG CARRIERS, TYPE SchT 5	WEIDMULLER 29246	501016
29	2	TERMINAL BLOCK MOUNTING RAILS 79" LENGTH, TYPE TS 35 x 7.5	WEIDMULLER 051450	501074
30	2	TERMINAL BLOCK, FEED-THRU, TYPE WDU 35	WEIDMULLER 102050	501037
31	1	W SERIES TERMINAL BLOCK END PLATES FOR WDU 35, TYPE WAP	WEIDMULLER 105010	501077
32				
33				
34	2	WIRING DUCT, 50mmW x 75mmD, GREY W/ COVER	WEILAND DNG100050G	545308
35				
36				
37	1	ISOLATED GROUND BUSBAR, TYPE ESch c/w INSULATION	WEIDMULLER 28030	501045
38	40	ISOLATED GROUND BUSBAR PRESSURE CLAMP, TYPE DS	WEIDMULLER 28010	501046
39	40	ISOLATED GROUND BUSBAR CLAMPING SCREW, TYPE BS	WEIDMULLER 29670	501047
40	3	ISOLATED GROUND BUSBAR SUPPORT BLOCK, TYPE SH1PA	WEIDMULLER 29986	501048
41				
42				
43	3	1-50 TERMINAL BLOCK MARKER, 6.0mm, TYPE DEK 6.0	WEIDMULLER 468760001	501039
44	1	51-100 TERMINAL BLOCK MARKER, 6.0mm, TYPE DEK 6.0	WEIDMULLER 468760051	501040
45				
46				
47	2	GROUND BAR, COPPER w/ SCREWS, #14-#16 AWG	ILSCO N174	505061
48				
49				
50	4	DIODES	IN4004	504000
51				
52				
53	1	15A FAST ACTING CERAMIC FUSES, 1/4" x 1-1/4"	GOULD SHAWMUT GAB15	538054
54	3	8A FAST ACTING CERAMIC FUSES, 1/4" x 1-1/4"	GOULD SHAWMUT GAB8	538012
55	3	5A FAST ACTING CERAMIC FUSES, 1/4" x 1-1/4"	GOULD SHAWMUT GAB5	538010
56	3	3A FAST ACTING CERAMIC FUSES, 1/4" x 1-1/4"	GOULD SHAWMUT GAB3	538008
57	16	1A FAST ACTING CERAMIC FUSES, 1/4" x 1-1/4"	GOULD SHAWMUT GAB1	538006
58				
59				
P 60	1	PI-670, PRESSURE INDICATOR, 114mm DIAL, 304SS BOURDON TUBE, 0-400kPA RANGE	HYDRPOISE 902M	432025
P 61	1	PI-671, PRESSURE INDICATOR, 114mm DIAL, 304SS BOURDON TUBE, 0-2800kPA RANGE	HYDRPOISE 902M	432025
P 62	1	PI-672, PRESSURE INDICATOR, 114mm DIAL, 304SS BOURDON TUBE, 0-2800kPA RANGE	HYDRPOISE 902M	432025
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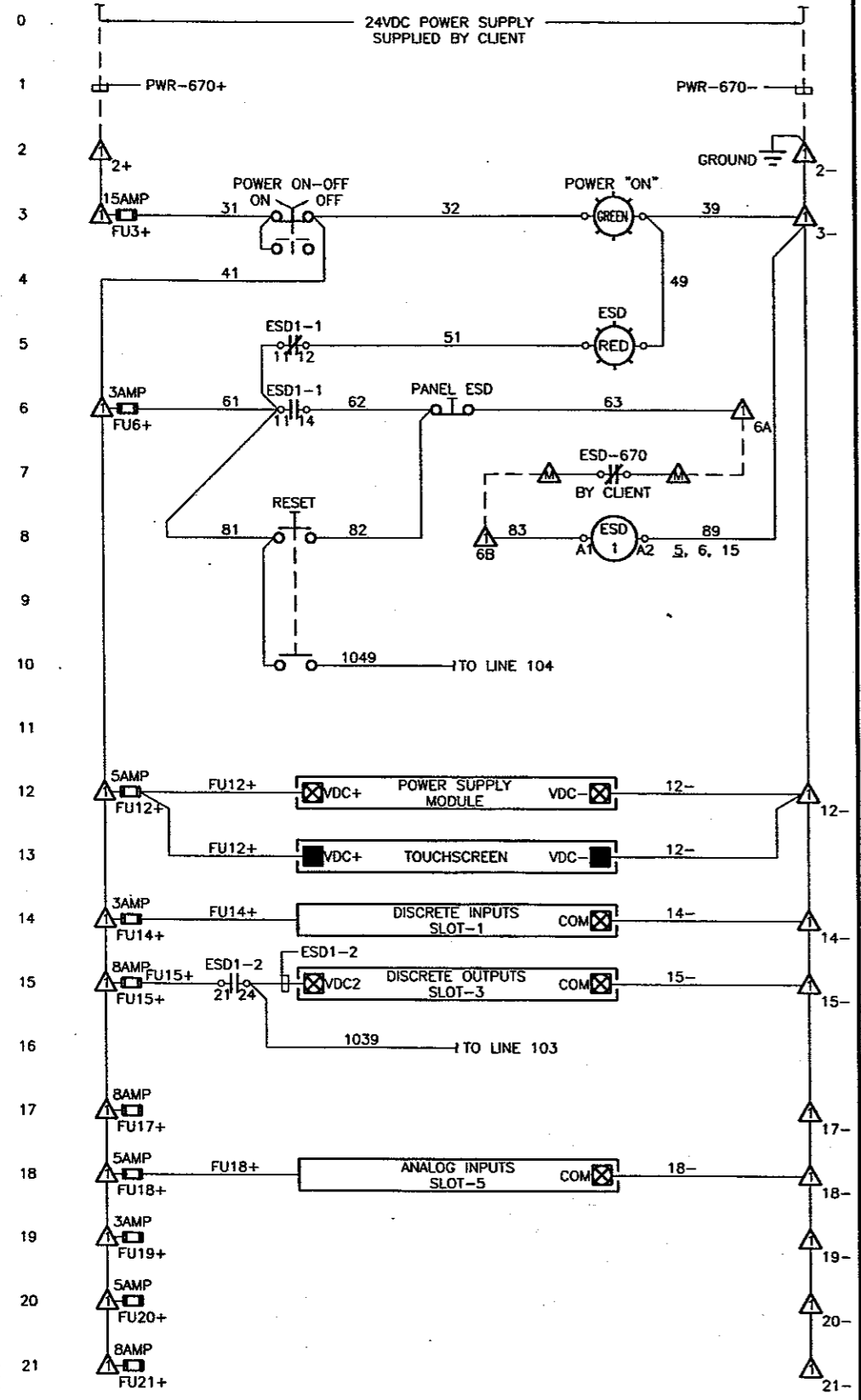
METALLIC NAMEPLATE SCHEDULE							
ITEM	NAMEPLATE ENGRAVING DESCRIPTION ( 4mm LETTERING )			NAMEPLATE SIZE(mm)	COLOUR		VISION #
	LINE - 1	LINE - 2	LINE - 3		LETTERING	BACKGROUND	
A	PANEL	POWER	OFF/ON	25 x 76	BLACK	WHITE	
B		ESD		25 x 76	WHITE	RED	
C	POWER ON	RESET		25 x 76	BLACK	WHITE	
D	SUCTION	PRESSURE					
E	OIL	PRESSURE					
F	DISCHARGE	PRESSURE					
G	WARNING: DO NOT OPEN UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS	DISCONNECT POWER BEFORE OPENING  CHANGE FUSES ONLY WITH THE SAME TYPE & RATING	PANEL MAY CONTAIN MORE THAN ONE SOURCE	100 x 100	WHITE	RED	

**NOTES:**

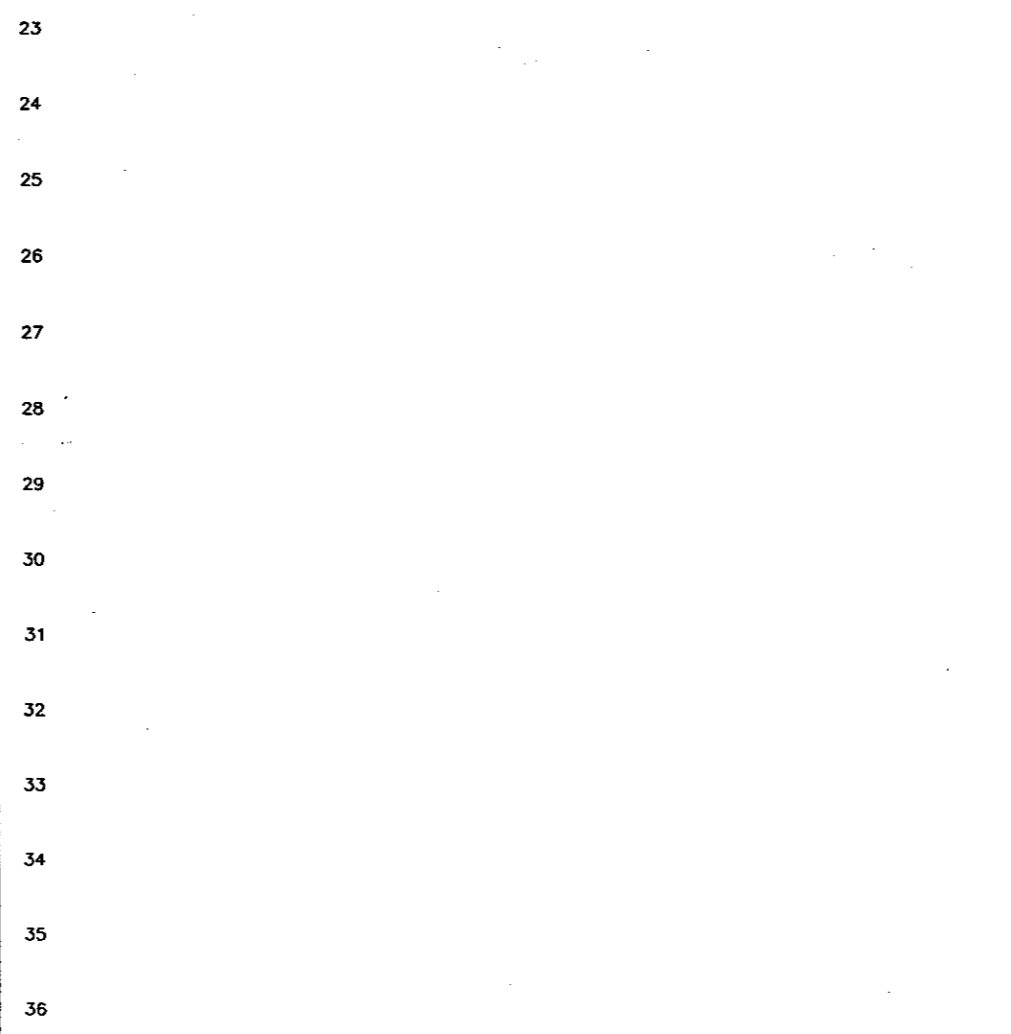
- THIS IS A CLASS I - ZONE 2 - GROUP B RATED PANEL. ALL COMPONENTS AND FINAL ASSEMBLY MUST BE SUITABLE FOR THIS AREA CLASSIFICATION. **NO PURCHASING SUBSTITUTES**
- TS-1 TERMINAL STRIP IS FOR 24VDC POWER DISTRIBUTION AND ESD RELAYS.
- TS-2 TERMINAL STRIP IS FOR DISCRETE INPUTS.
- TS-3 TERMINAL STRIP IS FOR DISCRETE OUTPUTS.
- TS-4 TERMINAL STRIP IS FOR ANALOG INPUTS & OUTPUTS.
- WIRE COLOR CODE SHALL BE AS FOLLOWS:
  - A) 24VDC POSITIVE(+) SHALL BE RED.
  - B) 24VDC NEGATIVE(-) SHALL BE YELLOW.
  - C) 24VDC LOGIC SHALL BE ORANGE.
  - D) 4-20ma SIGNAL PAIR (+/-) SHALL BE WHITE/BLACK.
  - E) 4-20ma SIGNAL TRIAD (+/-/SIG) SHALL BE WHITE/BLACK/RED.
  - F) GROUND WIRES SHALL BE GREEN.

<p><b>GENERAL NOTES</b></p> <p>2 SHOP AS BUILT</p> <p>1 ISSUED FOR CONSTRUCTION</p>		<p><b>REVISION</b></p> <p>No. 2</p>		<p>BY DATE CKD ENG</p> <p>MLL 30/SEP/05 [Signature] VI</p> <p>XW 22/AUG/05 MLL VI</p>		<p><b>APPROVED</b></p> <p>MECH/STRUCT. BY DATE</p> <p>ELECTRICAL V.L.P. DATE 22/AUG/05</p> <p>PROJECT DATE</p>		<p><b>DRAWN</b></p> <p>BY DATE</p> <p>CHECKED M.LUCERO DATE 22/AUG/05</p>		<p><b>FORT ENERGY CORP.</b></p> <p>REFRIGERATION PLANT - REF 88</p> <p>ELECTRICAL</p> <p>PLC PANEL BILL OF MATERIAL</p>		<p><b>PROPAC</b></p> <p>440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3</p>	
<p>DATE: 2005/09/29 03:57 PM J:\JOBS05\054468\20-DRAWINGS\ELC\FAB\0-PNL-054468-113-02.DWG monnyl</p>				<p>SCALE NONE</p>		<p>DWG. No.: D-PNL-054468-113</p>		<p>SHEET 2 REV. 2</p>					

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COMPRESSOR CONTROL PANEL POWER DISTRIBUTION & ESD SCHEMATICS



- TERMINAL LEGEND:**
- = TS-1 PLC PANEL POWER DISTRIBUTION & ESD TERMINALS.
  - = TS-2 PLC PANEL DISCRETE INPUT TERMINALS.
  - = TS-3 PLC PANEL DISCRETE OUTPUT TERMINALS.
  - = TS-4 PLC PANEL ANALOG INPUT & OUTPUT TERMINALS.
  - = CLIENT MASTER PLC PANEL TERMINALS
  - = FEED-THRU TERMINAL BLOCKS
  - = DISCONNECT TERMINAL BLOCKS
  - = FUSED TERMINAL BLOCKS
  - = TOUCHSCREEN TERMINALS
  - = PLC TERMINALS
  - = CLIENT MCC TERMINALS

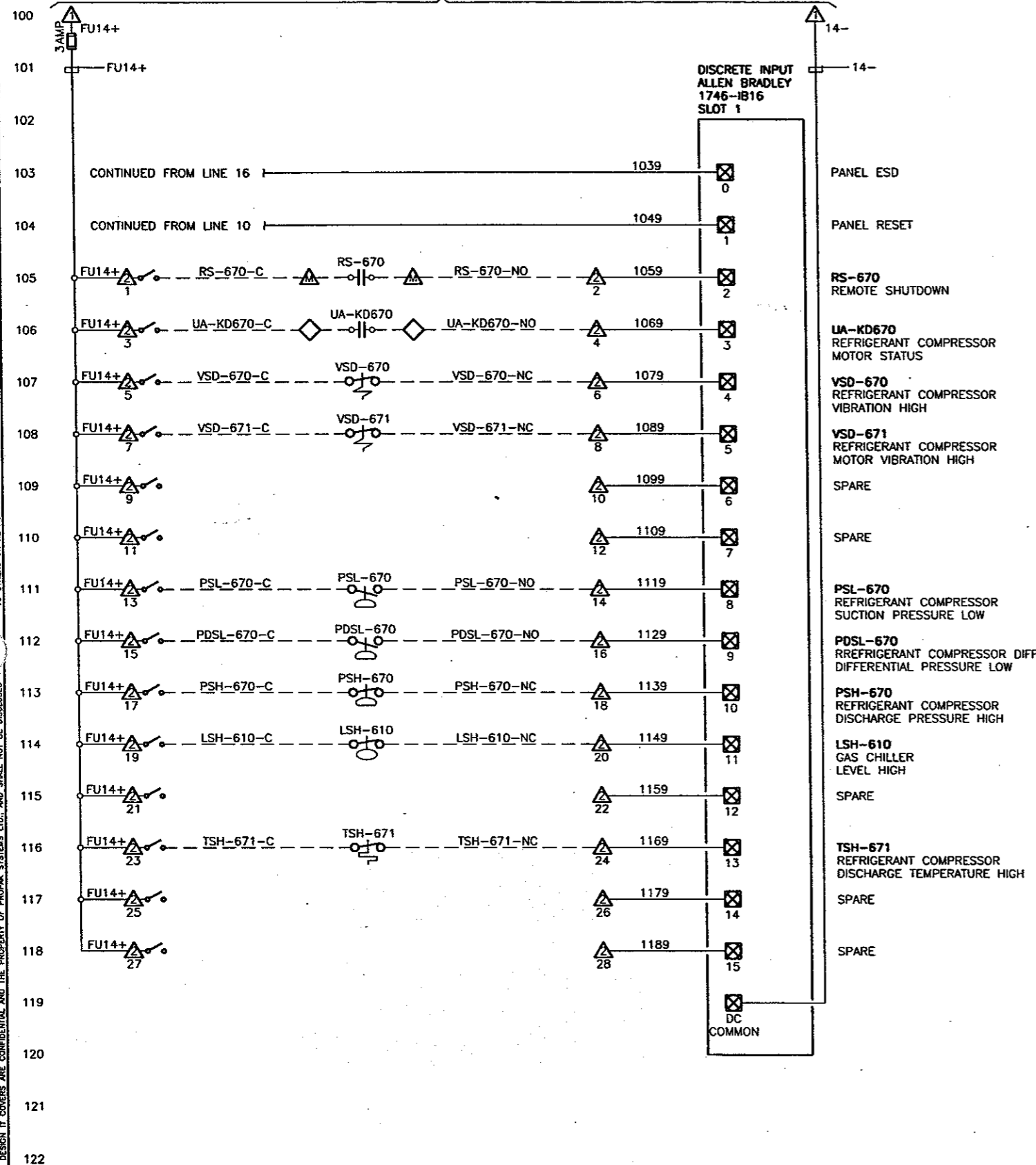
ALLEN BRADLEY 1746 A7 7-SLOT I/O CHASSIS						
CPU SLOT	SLOT-1	SLOT-2	SLOT-3	SLOT-4	SLOT-5	SLOT-6
ALLEN BRADLEY 1746-P3 POWER SUPPLY MODULE	ALLEN BRADLEY 1747-L531 CPU PROCESSOR MODULE	ALLEN BRADLEY 1746-IB16 DISCRETE INPUT MODULE	SPACE	ALLEN BRADLEY 1746-OB8 DISCRETE OUTPUT MODULE	SPACE	ALLEN BRADLEY 1746-N18 ANALOG INPUT MODULE
<input type="checkbox"/> DH-485						
<input type="checkbox"/> RS232						

COMPRESSOR CONTROL PANEL PLC RACK CONFIGURATION



24VDC POWER SUPPLY  
SEE SHEET 3

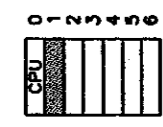
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- 1039 0 PANEL ESD
- 1049 1 PANEL RESET
- 1059 2 RS-670 REMOTE SHUTDOWN
- 1069 3 UA-KD670 REFRIGERANT COMPRESSOR MOTOR STATUS
- 1079 4 VSD-670 REFRIGERANT COMPRESSOR VIBRATION HIGH
- 1089 5 VSD-671 REFRIGERANT COMPRESSOR MOTOR VIBRATION HIGH
- 1099 6 SPARE
- 1109 7 SPARE
- 1119 8 PSL-670 REFRIGERANT COMPRESSOR SUCTION PRESSURE LOW
- 1129 9 PDSL-670 REFRIGERANT COMPRESSOR DIFF DIFFERENTIAL PRESSURE LOW
- 1139 10 PSH-670 REFRIGERANT COMPRESSOR DISCHARGE PRESSURE HIGH
- 1149 11 LSH-610 GAS CHILLER LEVEL HIGH
- 1159 12 SPARE
- 1169 13 TSH-671 REFRIGERANT COMPRESSOR DISCHARGE TEMPERATURE HIGH
- 1179 14 SPARE
- 1189 15 SPARE
- DC COMMON

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SLOT 2  
SPACE

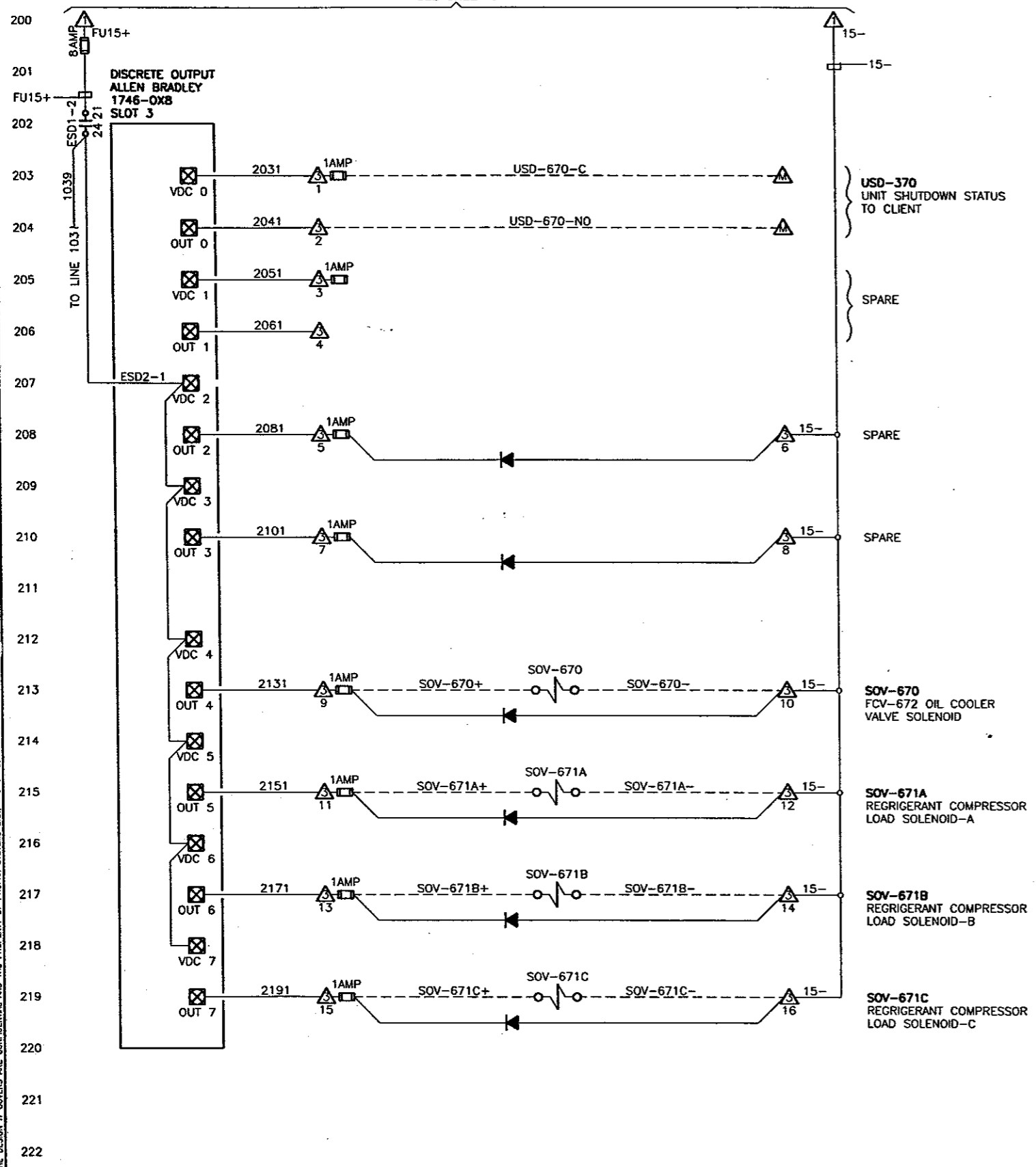


GENERAL NOTES		GENERAL NOTES		REVISION		APPROVED		DRAWN		FORT ENERGY CORP.	
2 SHOP AS BUILT		1 ISSUED FOR CONSTRUCTION		MLL 30/SEP/05		XW 22/AUG/05		BY X.WANG		DATE 02/AUG/05	
DATE: 2005/09/29 04:00 PM. J:\JOBS05\054468\20-DRAWINGS\ELC\FAB\D-PNL-054468-113-04.DWG mannyl		No.		BY DATE CKD ENG		DATE 22/AUG/05		BY M.LUCERO		DATE 22/AUG/05	
								SCALE NONE		DWG. No.: D-PNL-054468-113 SHEET 4 REV. 2	

**PROPAK**  
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Airdrie, Alberta  
Canada T4B 2C3

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24VDC POWER SUPPLY  
SEE SHEET 3

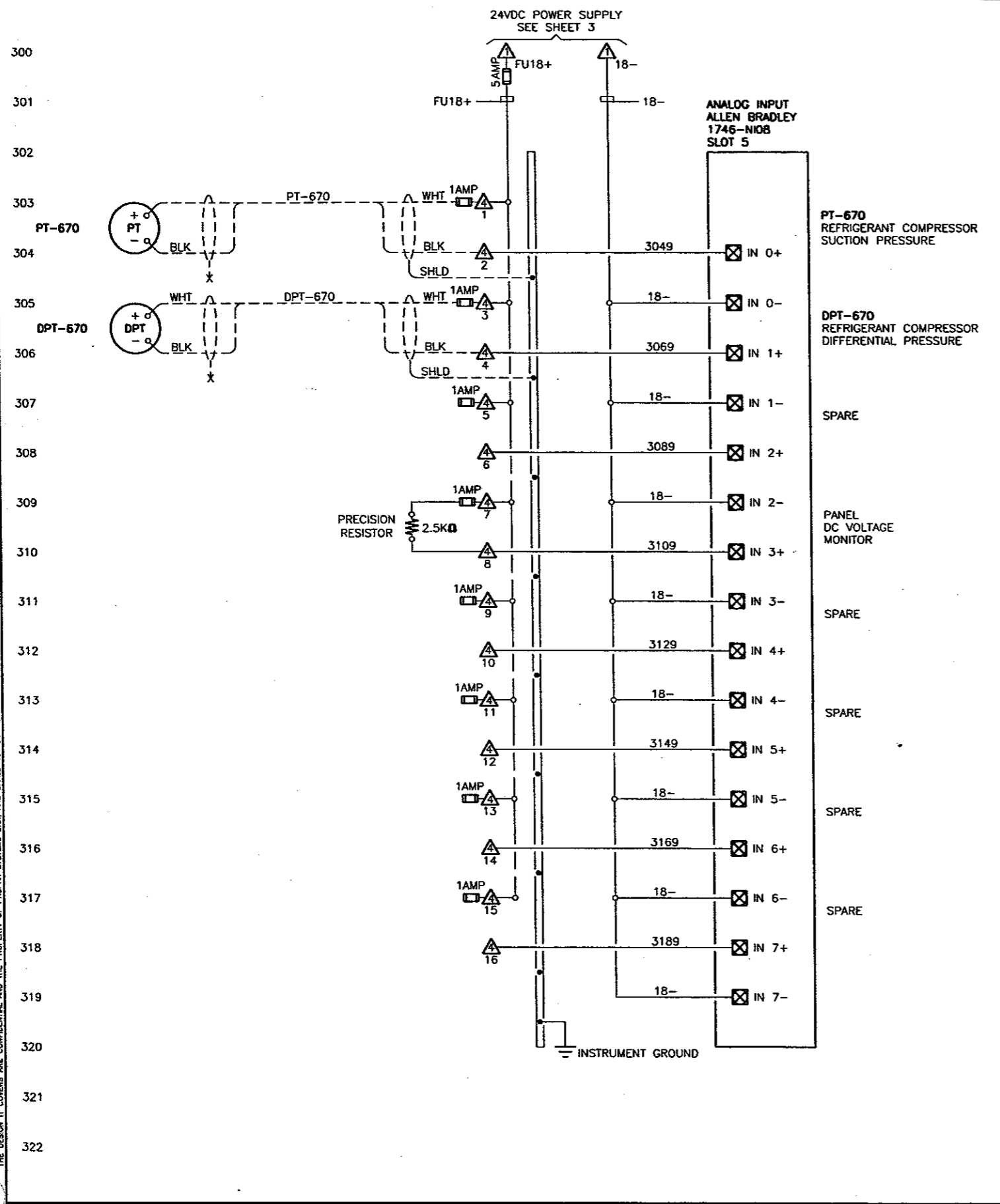


SLOT 4  
SPACE



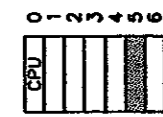
DATE: 2005/09/29 04:03 PM J:\JOBS05\054468\20-DRAWINGS\ELC\FAB\D-PNL-054468-113-05.DWG mannyl		No.		REVISION		BY		DATE		CKD		ENG		APPROVED		DRAWN		FORT ENERGY CORP.		440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
GENERAL NOTES		2		SHOP AS BUILT		MLL		30/SEP/05		MLL		VI		BY		X.WANG		REFRIGERATION PLANT - REF 88		No.:	
GENERAL NOTES		1		ISSUED FOR CONSTRUCTION		XW		22/AUG/05		MLL		VI		DATE		02/AUG/05		ELECTRICAL		SHEET 5	
														DATE		22/AUG/05		PLC PANEL I/O SCHEMATICS		REV. 2	
														SCALE		NONE		D-PNL-054468-113		REV. 2	

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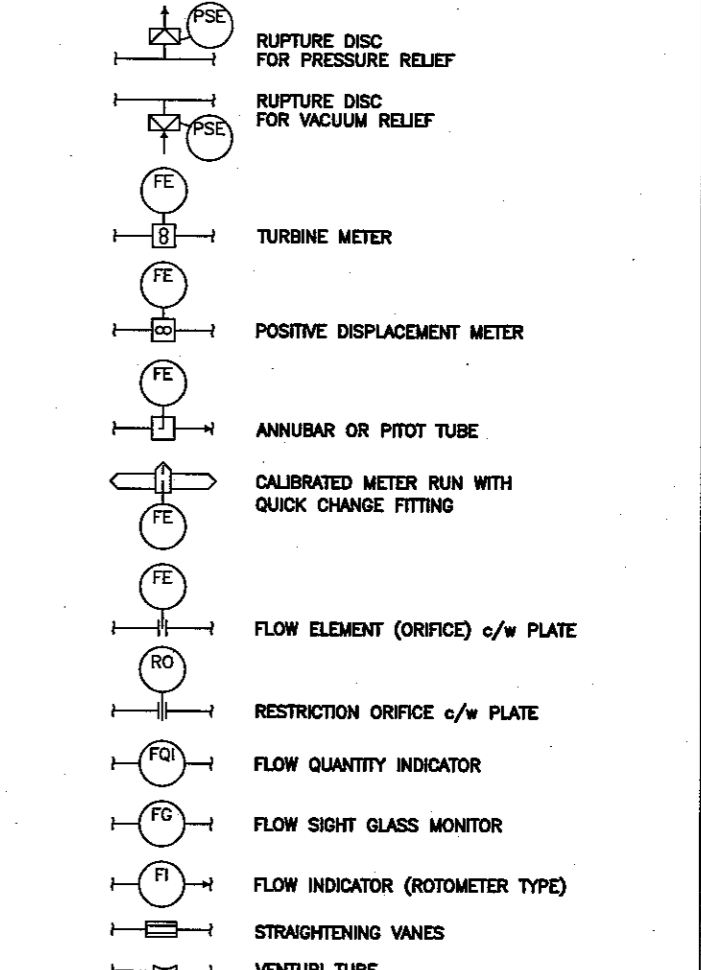
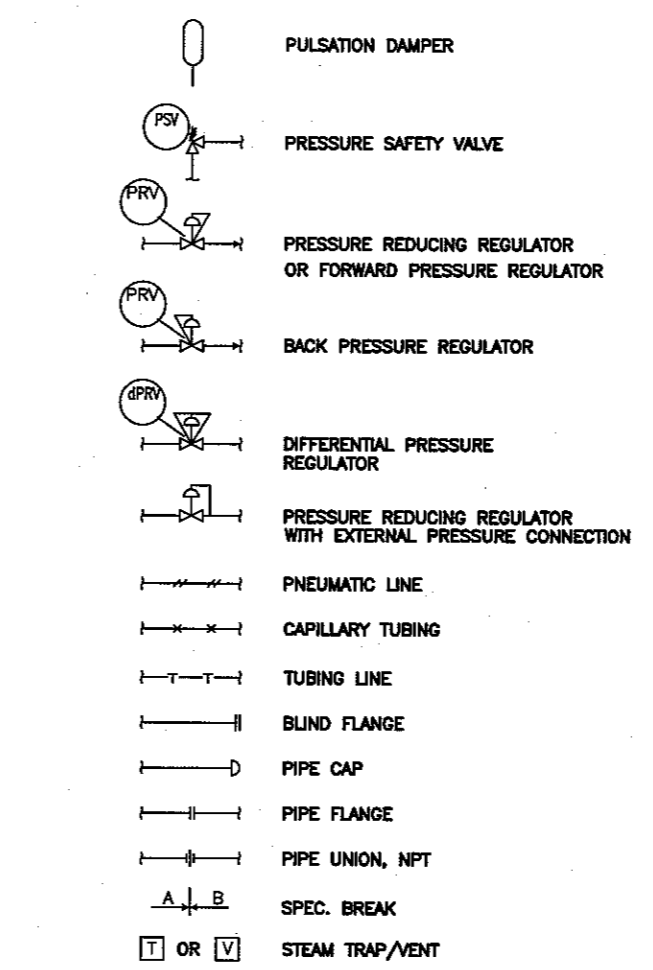
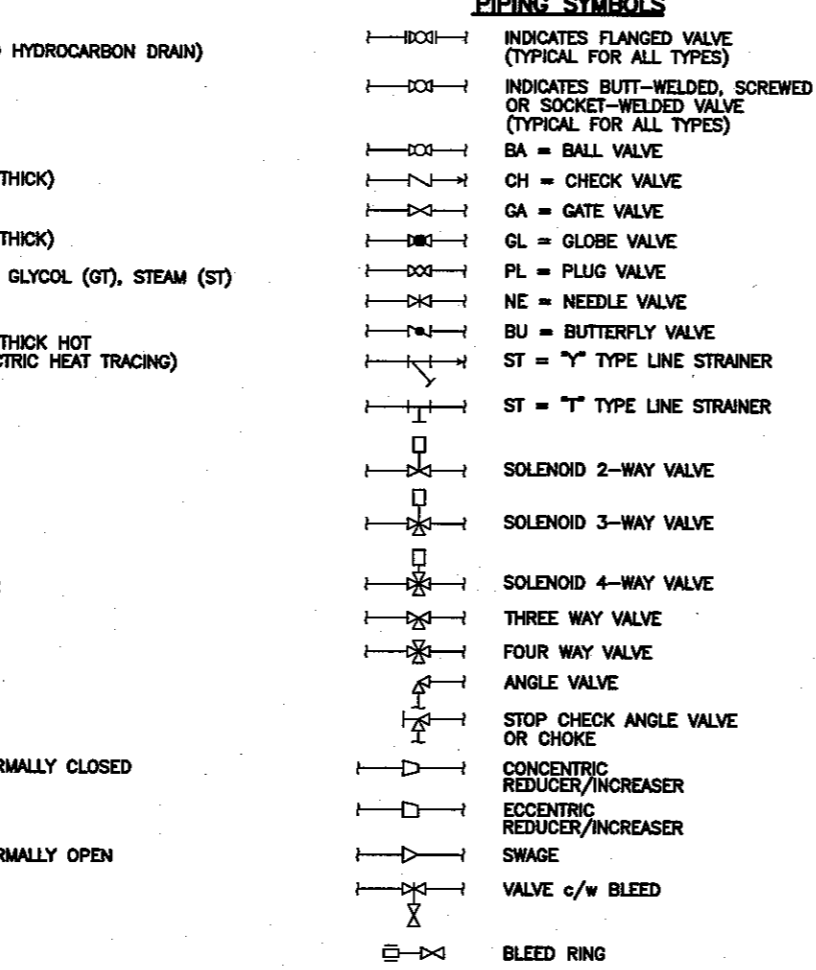
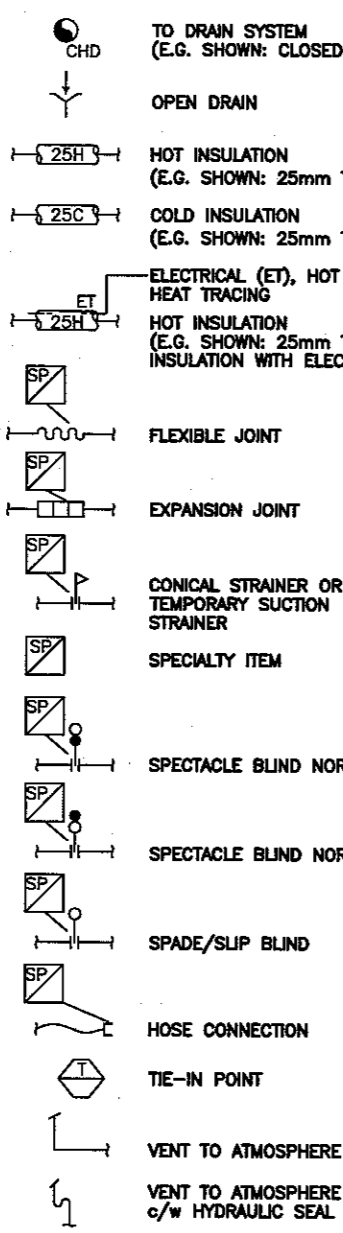
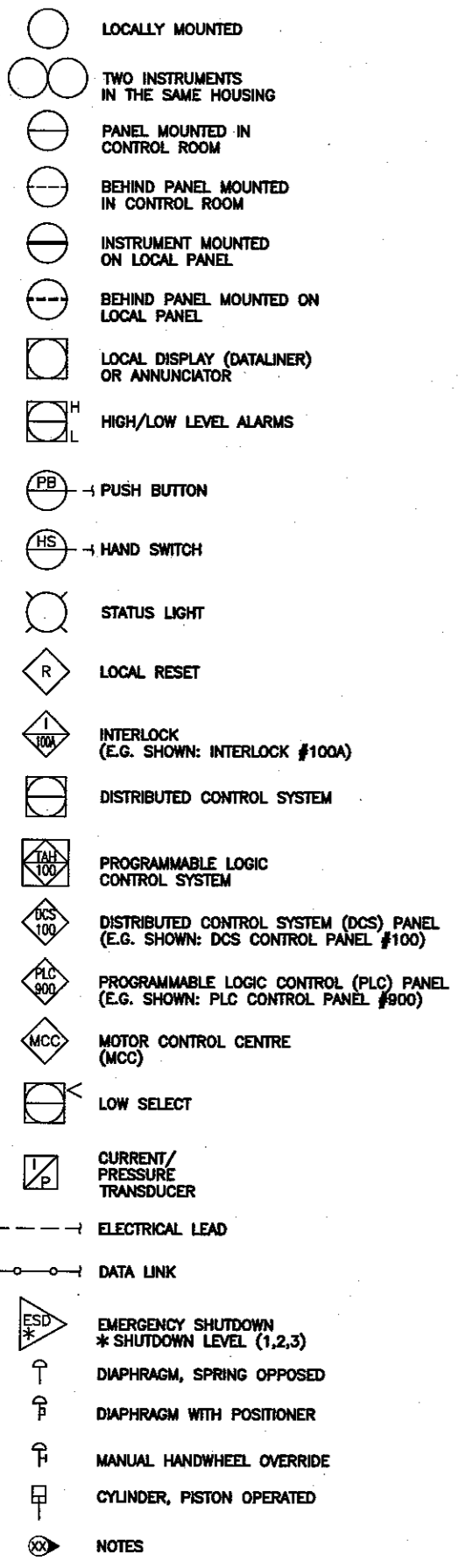
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SLOT 6  
SPACE



DATE: 2005/09/29 04:04 PM J:\JOBS05\054468\20-DRAWINGS\ELC\FAB\0-PNL-054468-113-06.DWG mannyl		No.		REVISION		BY		DATE		CKD		ENG		APPROVED		DRAWN		FORT ENERGY CORP.		440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
GENERAL NOTES		2		SHOP AS BUILT		MLL		30/SEP/05		VLC				MECH/STRUCT.		BY		REF 8B			
		1		ISSUED FOR CONSTRUCTION		XW		22/AUG/05		ML		VI		ELECTRICAL		DATE		ELECTRICAL			
														PROJECT		DATE		PLC PANEL I/O SCHEMATICS			
														DATE		SCALE		SHEET 6		REV. 2	
																NONE		D-PNL-054468-113			

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	A	AH	AHL	AL	C	CV	DR	DV	E	FIC	G	GM	I	IC	IS	IT	K	L	Q	R	RC	RR	S	SC	SD	SDH	SDL	SE	SH	SL	SLL	SM	SO	SV	T	V	W	Y	
A ANALYSIS		AAH	AHL	AAL	AC	ACV	ADR		AE				AI	AIC		AIT					AR	ARC	ARR	AS			ASDH	ASDL		ASH	ASL		ASM			AT		AY	
BJ BURNER FAILURE	BJA																						BS		BSD														
C CONDUCTIVITY		CAH	CHL	CAL	CC	CCV	CCR		CE				CI	CIC	CIS	CIT				CR	CRC	CRR	CS			CSDH	CSDL		CSH	CSL		CSM				CT		CY	
D DENSITY		DAH	DAHL	DAL	DC	DCV	DDR		DE		DG		DI	DIC	DIS	DIT	DK	DL		DR	DRC	DRR	DS			DSDH	DSDL	DSE	DSH	DSL		DSM				DT		DY	
dP DIFFERENTIAL PRESSURE	dPA	dPAH	dPAHL	dPAL	dPC	dPCV	dPR						dPI	dPIC	dPIS	dPIT	dPL			dPRC		dPS			dPSDH	dPSDL		dPSH	dPSL						dPT		dPY		
E EMERGENCY																										ESD											ESDV		EY
F FLOW		FAH	FAHL	FAL	FC	FCV	FDR		FE	FFIC	FG		FI	FIC	FIS	FIT	FK	FL	FQ	FR	FRC	FRR	FS			FSDH	FSDL		FSH	FSL		FSM		FSV	FT		FY		
G GAS DETECTION		GAH							GE																	GSDH			GSH								HV	HY	
H HAND (MANUAL)					HC	HCV								HRC									HS																
J POWER														JIC																									
K TIME	KA				KC	KCV	KDR											KL	KQ				KS													JT	KV	KY	
L LEVEL		LAH	LAHL	LAL	LC	LCV	LDR		LE		LG	LGM	LI	LIC	LIS	LIT		LL		LR	LRC	LRR	LS		LSD				LSH	LSL	LSSL	LSM			LT		LY		
M MOISTURE		MAH	MAHL	MAL	MC	MCV	MDR		ME				MI	MIC	MIS	MIT		ML		MR	MRC	MRR	MS		MSDH	MSDL		MSH	MSL		MSM				MT		MY		
P PRESSURE		PAH	PAHL	PAL	PC	PCV	PDR		PE				PI	PIC	PIS	PIT	PK	PL		PR	PRC	PRR	PS			PSDH	PSDL	PSE	PSH	PSL		PSM		PSV	PT		PY		
R REMOTE																																					RSDV		RY
S SPEED		SAH	SAHL	SAL	SC	SCV	SDR		SE				SI	SIC	SIS	SIT	SK	SL		SR	SRC	SRR	SS			SSDH	SSDL		SSH	SSL		SSM			ST		SY		
T TEMPERATURE		TAH	TAHL	TAL	TC	TCV	TDR		TE				TI	TIC	TIS	TIT	TK	TL		TR	TRC	TRR	TS			TSDH	TSDL	TSE	TSH	TSL		TSM			TT		TW	TY	
U UNIT	UA							UDV									UL																						
V VIBRATION		VAH			VC				VE				VI							VR			VS			VSDH			VSH							VT			
VI VISCOSITY		VIAH	VIAHL	VIAL	VIC	VICV	VIDR		VIE				VII	VIIIC	VIIIS	VIIIT		VIL		VIR	VIRC	VIRR	VIS		VISD				VISH	VISL		VISM			VIT		VW		
X FIRE DETECTION	XA								XE																														
Z LIMIT OR POSITION		ZAH	ZAHL	ZAL					ZE						ZIS	ZIT		ZL						ZSC		ZSDH	ZSDL		ZSH	ZSL		ZSM	ZSO		ZT		ZY		

**GENERAL NOTES**

2 AS BUILT

1 ISSUED FOR CONSTRUCTION

No. REVISION

**APPROVED**

MECH/STRUCT. BY DATE

ELECTRICAL BY DATE

PROJECT R. TURSKI DATE JUN. 29/05

DATE JUN. 29/05

**DRAWN**

PSC JUN. 29/05

CHECKED R. TURSKI

DATE JUN. 29/05

SCALE

**FORT ENERGY CORP.**

REFRIGERATION UNIT - REF88

LEGEND

MECHANICAL FLOWSHEET

DWG. No.: D-MFS-054468-100 SHT. 1 OF 6 REV. 2

**PROPAK**

440 East Lake Road,

Postal Bag #2

Airdrie, Alberta

Canada T4B 2C3

THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAC SYSTEMS LTD., AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAC.

**GENERAL SPECIFICATIONS**

CLASS	TYPICAL SERVICE	TEMP. RANGE (°C)	PRESS. RATING (ANSI)
A	SWEET HYDROCARBON, PROPANE REFRIGERANT, FUEL GAS AND FLARE GAS	-28.8°C TO 260°C	150 # RF
B	SWEET HYDROCARBON, PROPANE REFRIGERANT, FUEL GAS AND FLARE GAS	-28.8°C TO 260°C	300 # RF
C	SWEET HYDROCARBON, PROPANE REFRIGERANT, FUEL GAS AND FLARE GAS	-28.8°C TO 260°C	600 # RF
H	COMPRESSED AIR AND UTILITY WATER	0°C TO 38°C	150 # RF
J	DRAIN SYSTEM PIPING	5°C TO 95°C	150 # RF
K	GLYCOL	1.21 MPa @ 177°C	150 # RF TO 1500 # RF
AS	SOUR HYDROCARBON, RICH AMINE AND SOUR WATER	-28.8°C TO 260°C	150 # RF
BS	SOUR HYDROCARBON, RICH AMINE AND SOUR WATER	-28.8°C TO 260°C	300 # RF
CS	SOUR HYDROCARBON, RICH AMINE AND SOUR WATER	-28.8°C TO 260°C	600 # RF
AL	SWEET HYDROCARBON, PROPANE REFRIGERANT	-45.5°C TO 66°C	150 # RF
BL	SWEET HYDROCARBON, PROPANE REFRIGERANT	-45.5°C TO 66°C	300 # RF
CL	SWEET HYDROCARBON, PROPANE REFRIGERANT	-45.5°C TO 66°C	600 # RF
AC	SWEET HYDROCARBON	-184°C TO 66°C	150 # RF
BC	SWEET HYDROCARBON	-184°C TO 66°C	300 # RF
CC	SWEET HYDROCARBON	-184°C TO 66°C	600 # RF

**GENERAL NOTES (ABBREVIATIONS)**

- AC - AIR CLOSURES
- AD - AIR OPENS
- AVT - AUTOVENT TRAP
- BD - BLOWDOWN
- BF - BLIND FLANGE
- CBD - CONTINUOUS BD
- CD - CLOSED DRAIN
- CO - CHAIN OPERATED
- CSC - CAR SEAL CLOSED
- CSO - CAR SEAL OPEN
- DC - DRAIN CONNECTION
- EBD - EMERGENCY BD
- ESD - EMERGENCY SHUTDOWN
- ET - ELECTRICAL HEAT TRACE
- FO - FAIL OPEN
- FC - FAIL CLOSED
- FP - FULL PORT
- GT - GLYCOL HEAT TRACE
- HH - HAND HOLE
- HC - HOSE CONNECTION
- L - LOW
- LC - LOCK CLOSED
- LO - LOCK OPEN
- ML - MANUAL LOADING
- MW - MANWAY
- NC - NORMALLY CLOSED
- NE - NORMALLY ENERGIZED UNDER OPER. COND.
- NO - NORMALLY OPEN
- ND - NORMALLY DE-ENERGIZED UNDER OPER. COND.
- PC - PISTON CHECK VALVE
- PO - PUMPOUT
- PP - PERSONNEL PROTECTION
- QO - QUICK OPENING
- SC - SAMPLE CONNECTION
- SO - STEAM OUT
- SP - SET POINT
- ST - STEAM HEAT TRACE
- UG - UNDERGROUND
- VB - VACUUM BREAKER
- VFD - VARIABLE FREQUENCY DRIVE
- WC - WATER COLUMN

**COMMODITY (ABBREVIATIONS)**

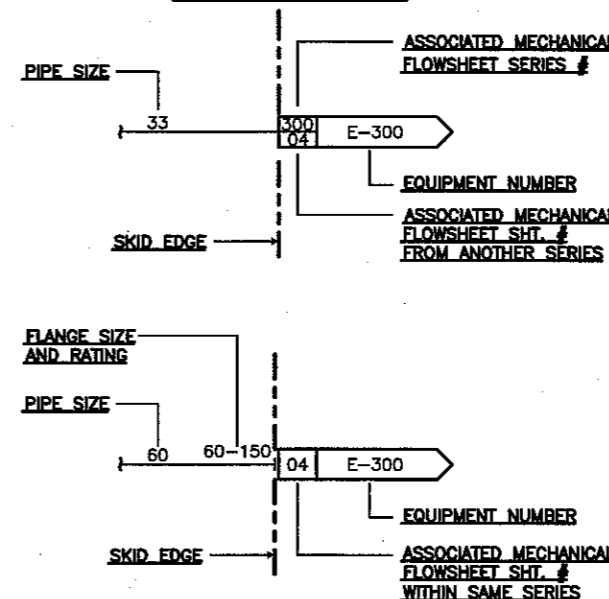
- AG - ACID GAS
- AGF - ACID GAS FLARE
- AMD - AMINE DRAIN
- AV - ATMOSPHERIC VENTS
- BD - BLOWDOWN
- C - CAUSTIC
- CCD - CLOSED CRYOGENIC DRAIN
- CHD - CLOSED HYDROCARBON DRAIN
- CSD - CLOSED SOUR DRAIN
- CV - CRYOGENIC VENT
- CWD - CLOSED WATER DRAIN
- DR - DRAIN (ATMOSPHERIC)
- EQL - EQUALIZING
- FG - FUEL GAS
- FL - FLARE
- FO - FUEL OIL
- FW - FIRE WATER
- GD - GLYCOL DRAIN
- GL - GLYCOL
- HC - HIGH PRESSURE STEAM CONDENSATE
- HCL - HYDROCARBON LIQUIDS
- HCV - HYDROCARBON VAPOUR
- HM - HEAT MEDIUM
- HPF - HIGH PRESSURE FLARE
- HS - HIGH PRESSURE STEAM
- I/A - INSTRUMENT AIR
- I/G - INSTRUMENT GAS
- IS - INSTRUMENT SUPPLY
- JW - JACKET WATER
- K - CHEMICALS
- LAM - LEAN AMINE
- LC - LOW PRESSURE STEAM CONDENSATE
- LO - LUBE OIL
- LOD - LUBE OIL DRAIN
- LPF - LOW PRESSURE FLARE
- LPG - LOW PRESSURE GAS
- LS - LOW PRESSURE STEAM
- MC - MEDIUM PRESSURE STEAM CONDENSATE
- MS - MEDIUM PRESSURE STEAM
- P - PROCESS GAS/LIQUID
- PDW - PRODUCED WATER
- POD - PACKING OIL DRAIN/VENT
- POW - POTABLE WATER
- PS - SOUR PROCESS GAS
- PSW - SOUR PROCESS WATER
- PW - PROCESS WATER
- RAM - RICH AMINE
- RLRV - REFRIG. LIQUID, REFRIG. VAPOUR
- ROD - REFRIG. OIL DRAIN
- SO - SEAL OIL
- SOD - SEAL OIL DRAIN
- UW - UTILITY WATER

**TUBING SIZES**

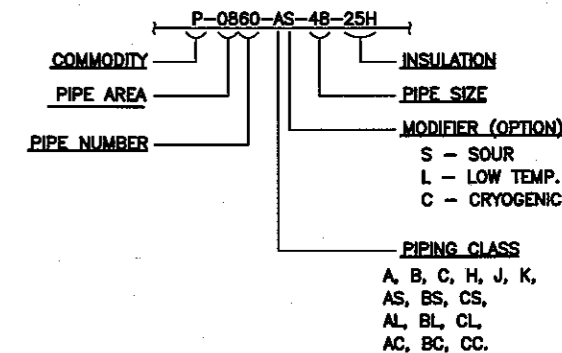
METRIC O.D. (mm)	IMP. O.D. (INCH.)	IMP. NPS (INCH.)	METRIC O.D. (mm)	METRIC DIN (mm)
3	1/8"	1/4"	14	8
6	1/4"	3/8"	17	10
9	3/8"	1/2"	21	15
13	1/2"	3/4"	27	20
19	3/4"	1"	33	25
25	1"	1-1/2"	48	40
		2"	60	50
		3"	89	80
		4"	114	100
		6"	168	150
		8"	219	200
		10"	273	250
		12"	324	300
		14"	356	350
		16"	406	400
		18"	457	450
		20"	508	500
		24"	610	600
		36"	914	900
		42"	1067	1050

NOTES:  
NPS - NOMINAL PIPE SIZE

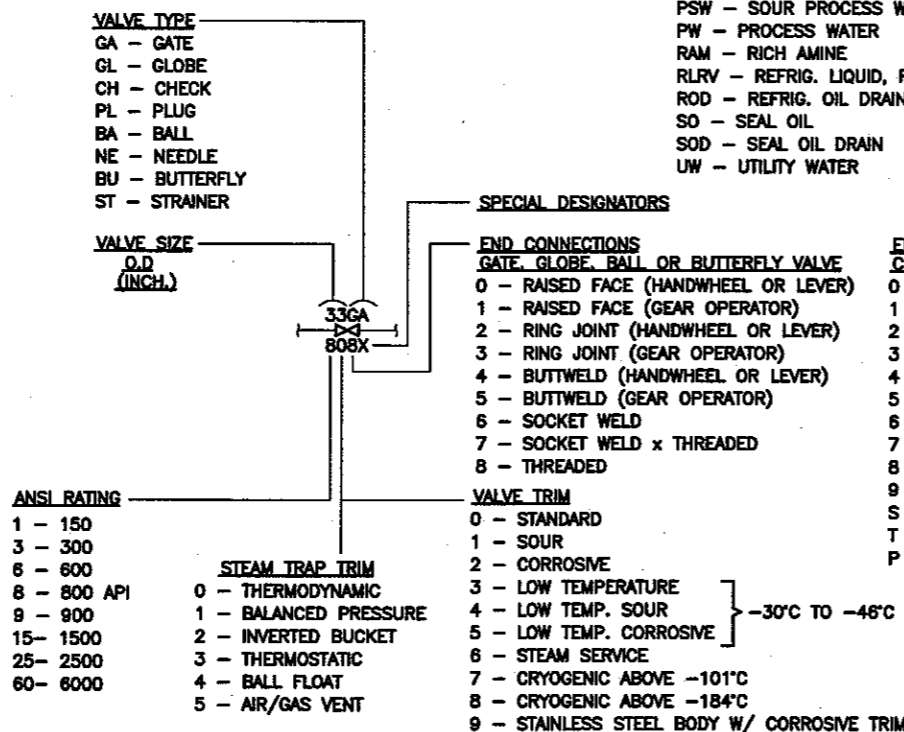
**TYPICAL PIPE FLAGS**



**TYPICAL PIPE IDENTIFICATION**



**TYPICAL VALVE IDENTIFICATION**



**TYPICAL EQUIPMENT IDENTIFICATION**

TAG No: T-820  
 DESCRIPTION: DEETHANIZER  
 MAKE AND MODEL: ...  
 DIMENSIONS: ...mm O.D. x ...mm S/S  
 DESIGN PRESSURE @ DESIGN TEMP., CORROS. ALLOWANCE: ... kPa @ ... °C, ...mm C.A.  
 GAS FLOW RATES: ... m3/d  
 LIQUID FLOW RATES: ... m3/h  
 DUTIES: ... kW  
 MOTOR POWER: ... kW @ V/φ/Hz  
 STRESS RELIEVING AND X-RAY: S.R.: YES/NO, X-RAY: FULL/100%/SPOT

THE DRAWING AND

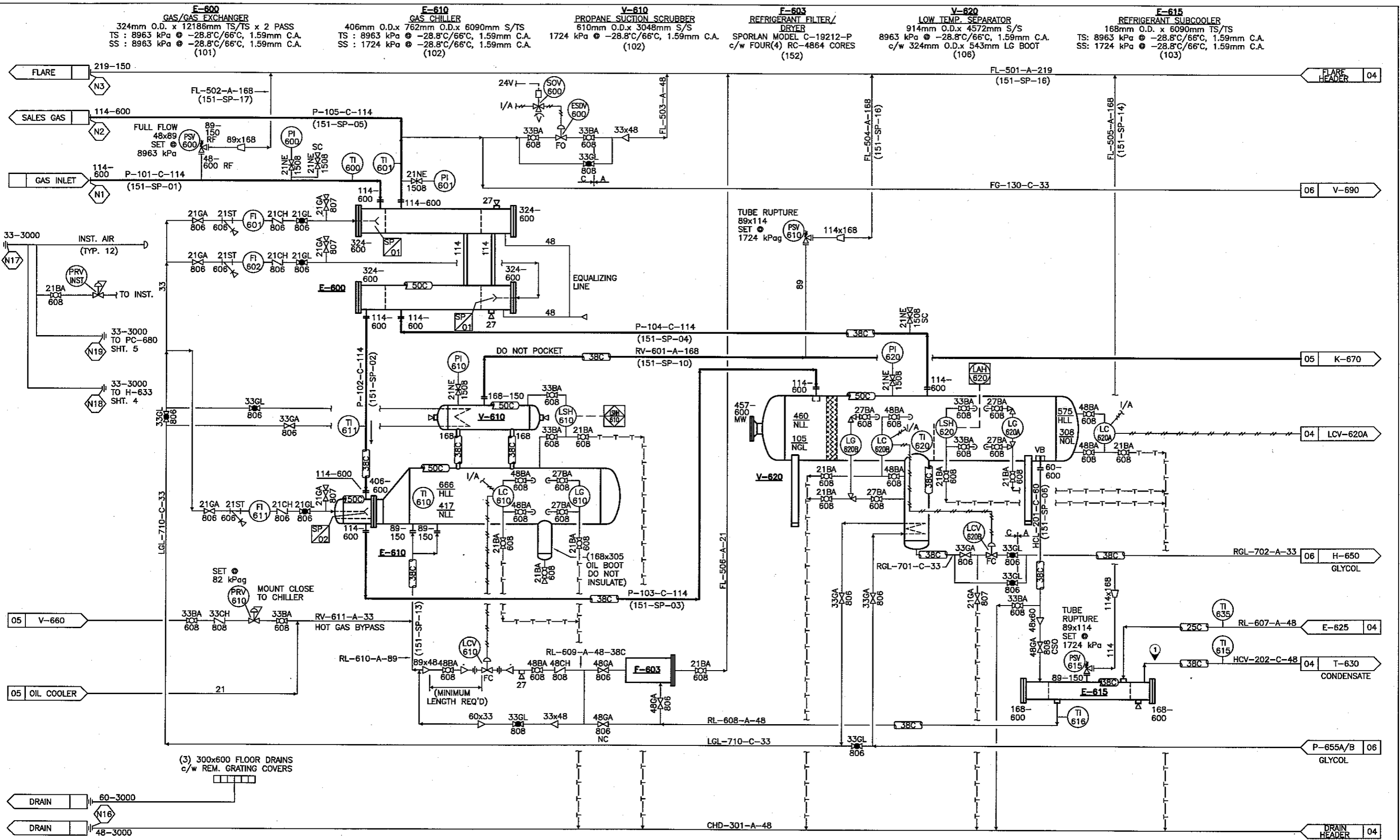
GENERAL NOTES	REVISION	BY	DATE	CHK	ENG
2 AS BUILT		P. YU	05/08/18		
1 ISSUED FOR CONSTRUCTION		H. NENG	05/07/18	ROD	ROD

APPROVED	DRAWN
MECH/STRUCT. DATE	BY PSC DATE JUN. 29/05
ELECTRICAL DATE	CHECKED BY R. TURSKI DATE JUN. 29/05
PROJECT R. TURSKI DATE JUN. 29/05	SCALE

FORT ENERGY CORP.	
REFRIGERATION UNIT - REF88	
LEGEND	
MECHANICAL FLOWSHEET	
DWG. No.: D-MFS-054468-100	SHT. 2 OF 6

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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(3) 300x600 FLOOR DRAINS c/w REM. GRATING COVERS

1. TOP TS OUTLET ON E-615 REQUIRED.

GENERAL NOTES		GENERAL NOTES	
1	ISSUED FOR CONSTRUCTION	3	AS BUILT
2		3	LSH-610 CONTROL CHANGE

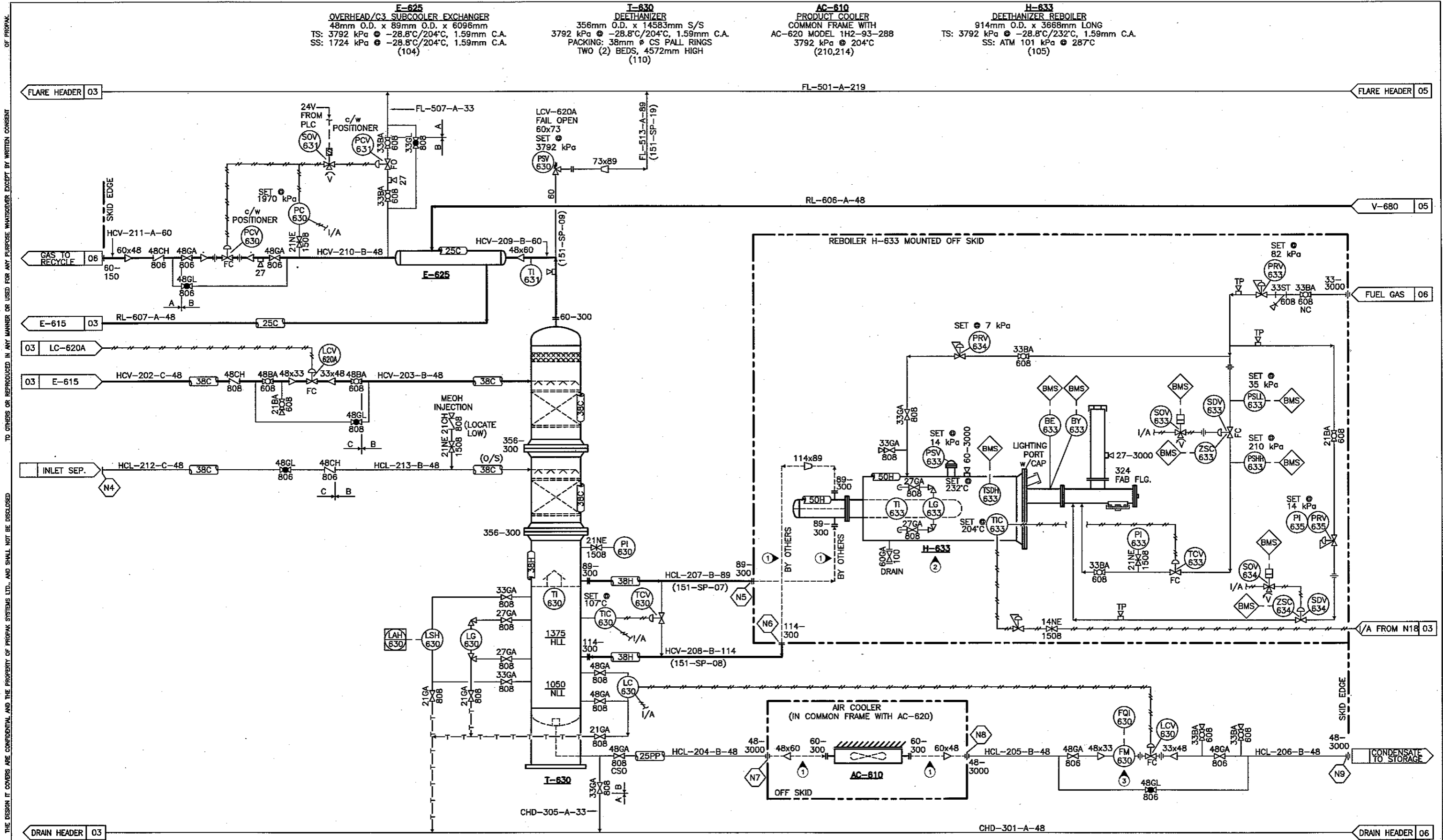
No.	REVISION	BY	DATE	CKD	ENG
1	ISSUED FOR CONSTRUCTION	H. MENG	05/07/19	RDD	RDD
2		F. DEL	05/08/11	RDD	RDD
3	AS BUILT	P. YU	05/09/16	RDD	RDD

APPROVED		DRAWN	
MECH./STRUCT.	BY	PSC	DATE
ELECTRICAL	BY	CHECKED	DATE
PROJECT	R. TURSKI	DATE	JUN. 29/05
DATE	JUN. 29/05	SCALE	

FORT ENERGY CORP.	
REFRIGERATION UNIT -- REFBB	
MYCOM 8B REFRIGERATION PLANT	
MECHANICAL FLOWSHEET	
DWG. No.: D-MFS-054468-100	SHT. 3 OF 6 REV. 3

**PROPAC**  
 440 East Lake Road,  
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 Airdrie, Alberta  
 Canada T4B 2C3

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1. ON SKID SPOOLING BY PROPAG.  
OFF SKID SPOOLING BY OTHERS.
2. LOCATE REBOILER H-633 NEAR SKID.
3. ALLOW 10 PIPE DIA. UP AND DOWNSTREAM OF FM-630

GENERAL NOTES		GENERAL NOTES	
No.	REVISION	No.	REVISION
3	AS BUILT	3	AS BUILT
2	GENERAL REVISIONS	2	GENERAL REVISIONS
1	ISSUED FOR CONSTRUCTION	1	ISSUED FOR CONSTRUCTION

BY	DATE	CHKD	ENG
P. YU	06/09/16	MZ	MZ
H. MENG	06/09/06	MZ	MZ
H. MENG	06/07/19	RDD	RDD

APPROVED		DRAWN	
MECH/STRUCT.	BY	PSC	
DATE	DATE	JUN. 29/05	
ELECTRICAL	CHECKED		
DATE	BY	R. TURSKI	
PROJECT	DATE	JUN. 29/05	
DATE	SCALE		

**FORT ENERGY CORP.**  
 REFRIGERATION UNIT - REF8B  
 MYCOM 8B REFRIGERATION PLANT  
 MECHANICAL FLOWSHEET

**PROPAG**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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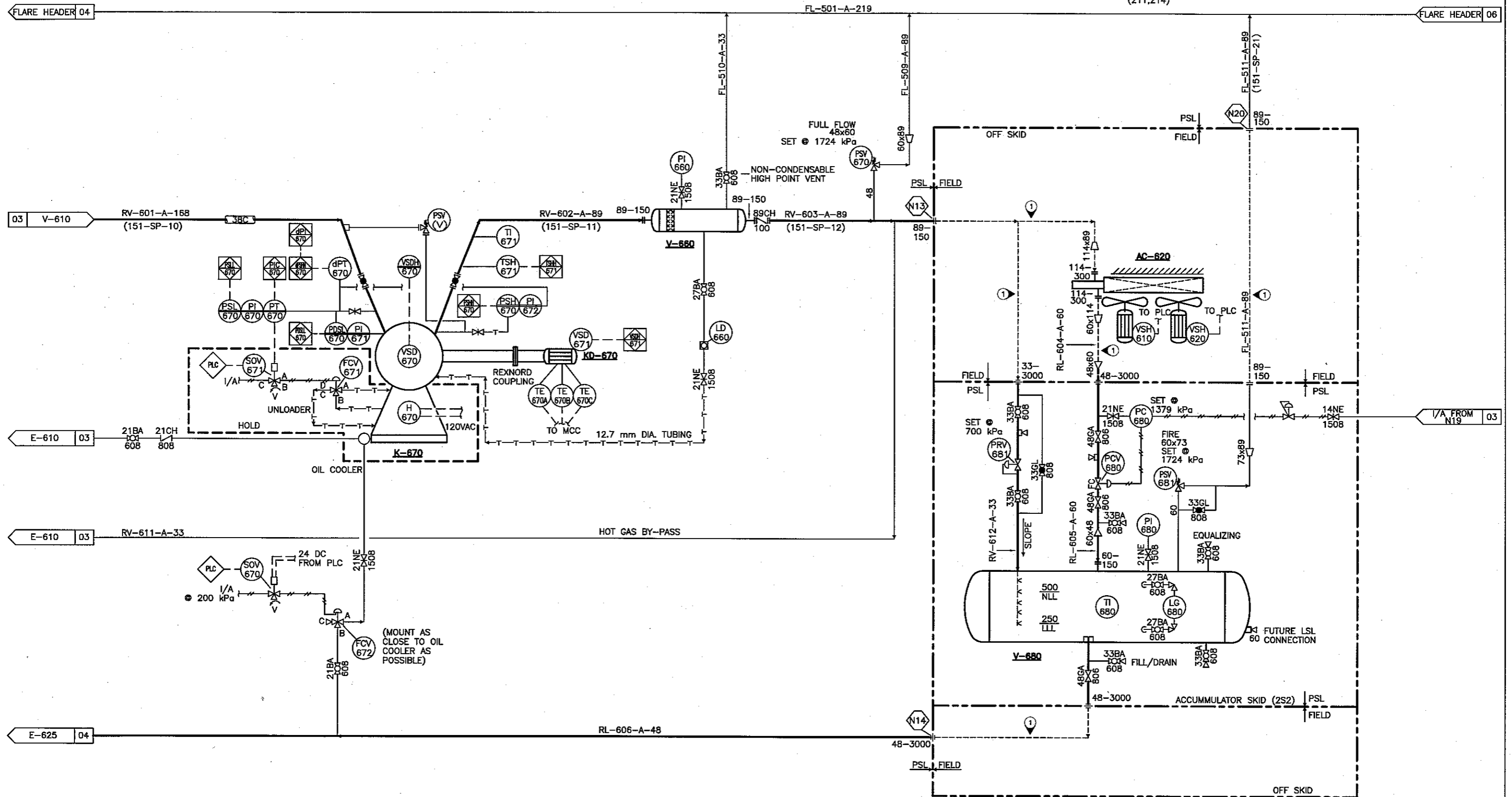
**K-670**  
REFRIGERANT COMPRESSOR  
MYCOM MODEL P8WB  
38 USTR @ 109 HP, 1200 RPM  
-26°C EVAP., 43°C COND.  
(150)

**KD-670**  
COMPRESSOR DRIVER  
150 HP 460/3/60  
xP 1200 RPM  
DIRECT DRIVE  
(149)

**V-660**  
DISCHARGE OIL SCRUBBER  
356mm O.D.x 610mm S/S  
1724 kPa @ -28.8°C/93°C, 1.59mm C.A.  
(109)

**V-680**  
REFRIGERANT ACCUMULATOR  
762mm O.D.x 3048mm S/S  
1724 kPa @ -28.8°C/66°C, 1.59mm C.A.  
(201)

**AC-620**  
REFRIG. CONDENSER  
MODEL 1H2-93-286  
FAN DRIVER (2) 15 HP TEFC  
1800 RPM, 480/3/60  
DUTY: 291 kW  
INTEGRAL WITH AC-610  
2068 kPa @ 93°C  
(211,214)



1. ON SKID SPOOLING BY PROPAK, OFF SKID SPOOLING BY OTHERS.

**GENERAL NOTES**

**GENERAL NOTES**

DATE: 2005/09/16 03:25 PM J:\JOBS05\054468\20-DRAWINGS\FLW\MFS-054468-100-05.DWG pyu

No.	REVISION	BY	DATE	CKD	ENG
4	AS BUILT	P. YU	05/09/16	MZ	MZ
3	COMPRESSOR CONTROLS CHANGE	F. DEL	05/08/11	RDD	RDD
2	ADDED TRANSMITTERS	E. JIA	05/08/05	RDD	RDD
1	ISSUED FOR CONSTRUCTION	H. MENG	05/07/19	RDD	RDD

APPROVED		DRAWN	
MECH/STRUCT.	BY	PSC	
DATE	DATE	JUN. 29/05	
ELECTRICAL	CHECKED		
DATE	DATE	JUN. 29/05	
PROJECT	BY	R. TURSKI	
DATE	DATE	JUN. 29/05	
SCALE			

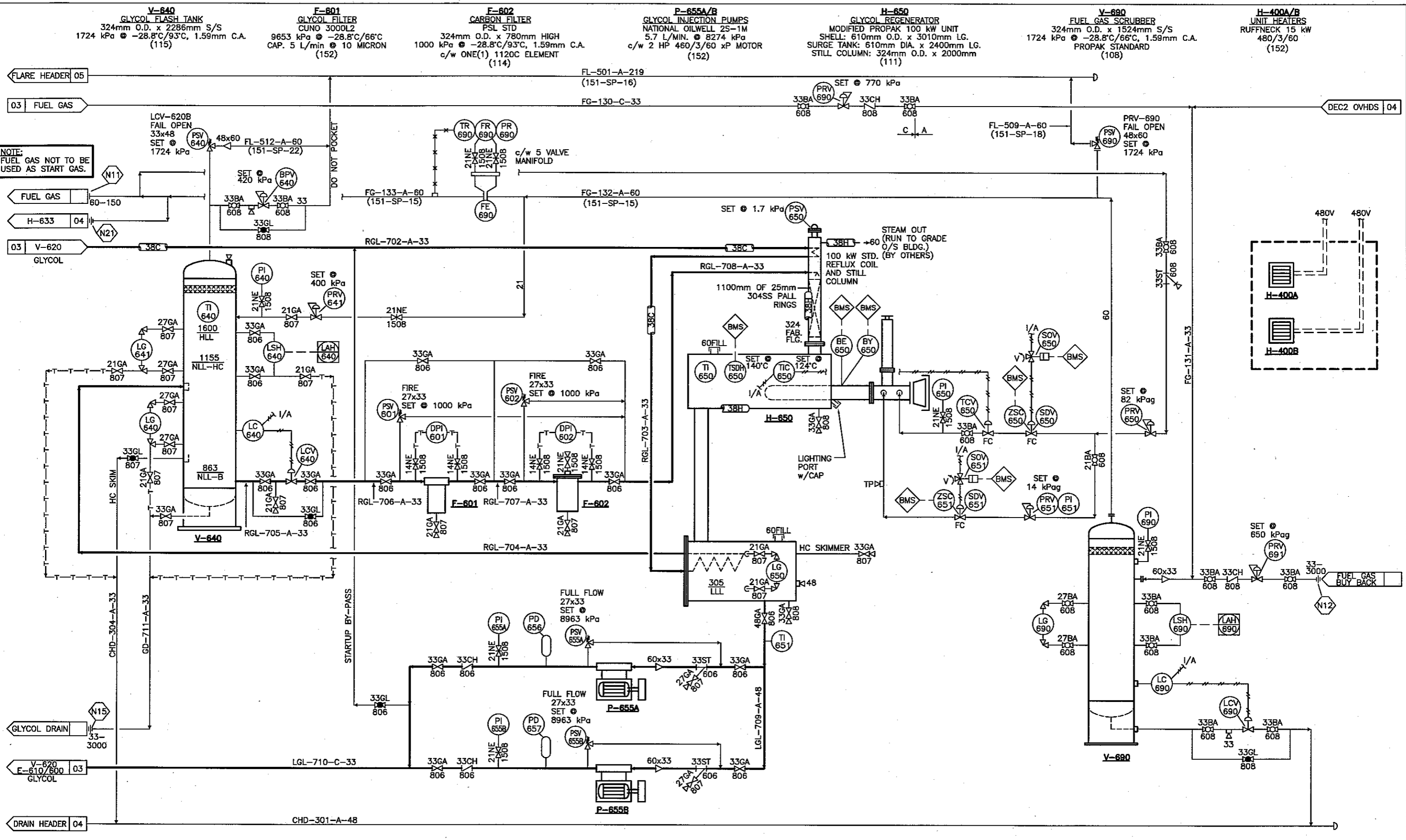
**FORT ENERGY CORP.**  
REFRIGERATION UNIT - REF88  
MYCOM 88 REFRIGERATION PLANT  
MECHANICAL FLOWSHEET

**PROPAK**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

DWG. No.: D-MFS-054468-100 SHT. 5 OF 6 REV. 4



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GENERAL NOTES		GENERAL NOTES	
2	AS BUILT	1	ISSUED FOR CONSTRUCTION
1			

REVISION		BY	DATE	CHKD	ENG
2	AS BUILT	P. YU	05/09/16	MZ	MZ
1	ISSUED FOR CONSTRUCTION	H. MENG	05/07/19	RDD	RDD

APPROVED		DRAWN	
MECH/SRICT	BY	PSC	DATE
DATE		JUN. 29/05	
ELECTRICAL	BY	CHECKED	DATE
DATE			
PROJECT	R. TURSKI	DATE	JUN. 29/05
DATE	JUN. 29/05	SCALE	

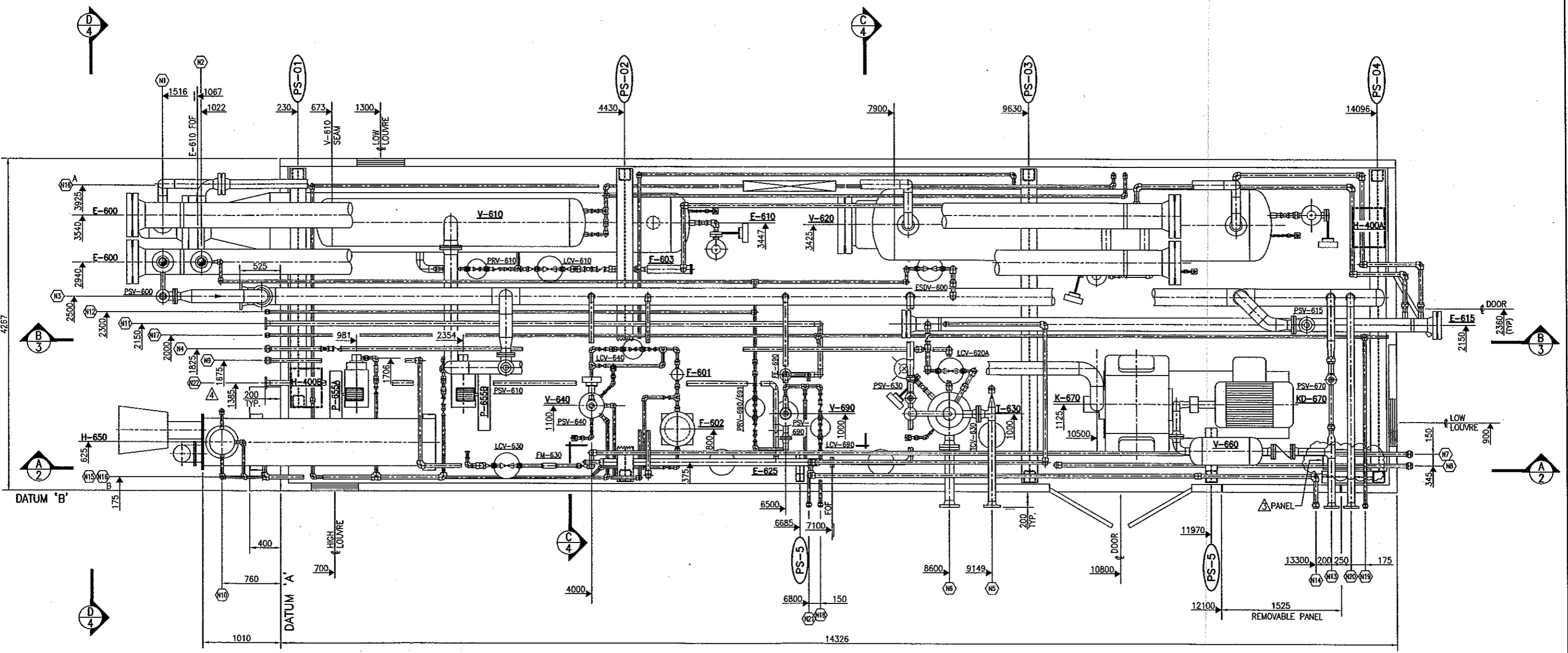
FORT ENERGY CORP.	
REFRIGERATION UNIT - REF88	
MYCOM 88 REFRIGERATION PLANT	
MECHANICAL FLOWSHEET	
DWG. No.:	D-MFS-054468-100
SHT.	6 OF 6
REV.	2

**PROPAC**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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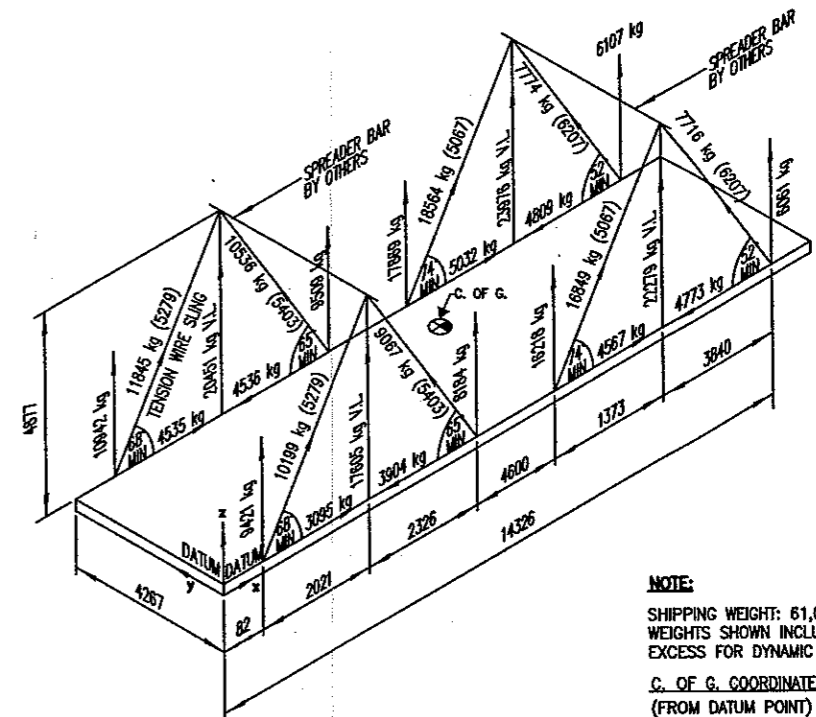
NOZZLE SCHEDULE					
MK	SIZE	RATING	FACING	SERVICE	± ELEVATION
N1	114	600#	RFWN	GAS INLET	4025 F.O.F.
N2	114	600#	RFWN	GAS OUTLET	4025 F.O.F.
N3	219	150#	RFWN	FLARE HEADER	2710
N4	48	3000#	UNION	HC LIQUID INLET (FROM INLET SEP.)	2724
N5	89	300#	RFWN	HC LIQUID TO H-633	3144
N6	114	300#	RFWN	VAPOR RETURN FROM H-633	2194
N7	48	300#	UNION	CONDENSATE TO AC-610	2624
N8	48	300#	UNION	CONDENSATE FROM AC-610	2624
N9	48	3000#	UNION	CONDENSATE TO STORAGE	2624
N10	60	-	NPT	REBOILER STEAM OUTLET	4060
N11	60	150#	RFWN	FUEL GAS OUT	2630

NOZZLE SCHEDULE					
MK	SIZE	RATING	FACING	SERVICE	± ELEVATION
N12	33	3000#	UNION	FUEL GAS BUY BACK	2617
N13	89	150#	RFWN	REFRIG. VAPOUR TO AC-620	3078
N14	48	3000#	UNION	REFRIG. LIQUID FROM V-680	3063
N15	33	3000#	UNION	GLYCOL DRAIN	225
N16	48	3000#	UNION	HC DRAIN HEADER	125
N17	33	3000#	UNION	INST. AIR INLET	2617
N18	33	3000#	UNION	INST. AIR TO H-633	1500
N19	33	3000#	UNION	INST. AIR TO PC-680	3056
N20	89	150#	RFWN	FLARE FROM PSV-681	3078
N21	33	3000#	UNION	FUEL GAS TO H-633	1500
N22	60	150#	RFWN	GAS TO RECYCLE	2630



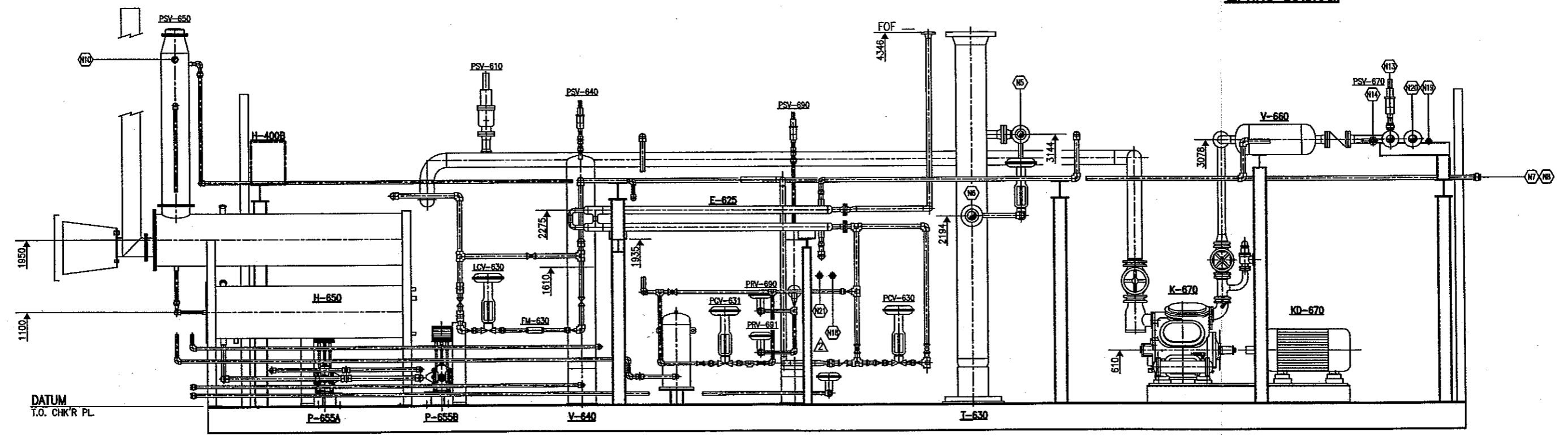
<b>GENERAL NOTES</b> DATE: 2005/09/02 09:35 AM J:\JOBS05\054468\20-DRAWINGS\FAB\ASY\ASY-054468-152.DWG hsn		<b>GENERAL NOTES</b> No. REVISION		BY DATE CKD ENG		<b>APPROVED</b> MECH./STRUCT. DATE BY DATE ELECTRICAL DATE BY DATE PROJECT RT DATE DATE 04/09/17 SCALE 1:25		<b>DRAWN</b> BY PSC DATE 04/09/17 CHECKED JLS DATE 04/09/17		<b>PROPAK</b> STOCK REFRIGERATION UNIT - REF8B REFRIGERATION SKID PIPING LAYOUT		<b>PROPAK</b> 440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
4 ADDED N22 (RECYCLE GAS) M.DIETER 05/08/07 BS RD 3 MOVE PANEL L. VERGARA 05/08/04 BS RD 2 REMOVED WINDOWS IN BUILDING L. VERGARA 05/07/06 DL RD 1 ISSUED FOR CONSTRUCTION L. VERGARA 05/03/15 BS RD		No. REVISION		BY DATE CKD ENG		DATE 04/09/17 SCALE 1:25		DWG. No.: D-ASY-054468-152 SHEET 1 OF 4 REV. 4					

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**NOTE:**  
 SHIPPING WEIGHT: 61,000 Kg  
 WEIGHTS SHOWN INCLUDE 50% EXCESS FOR DYNAMIC LOADING  
 C. OF G. COORDINATES (FROM DATUM POINT)  
 x = 6656mm  
 y = 2248mm  
 z = 1300mm

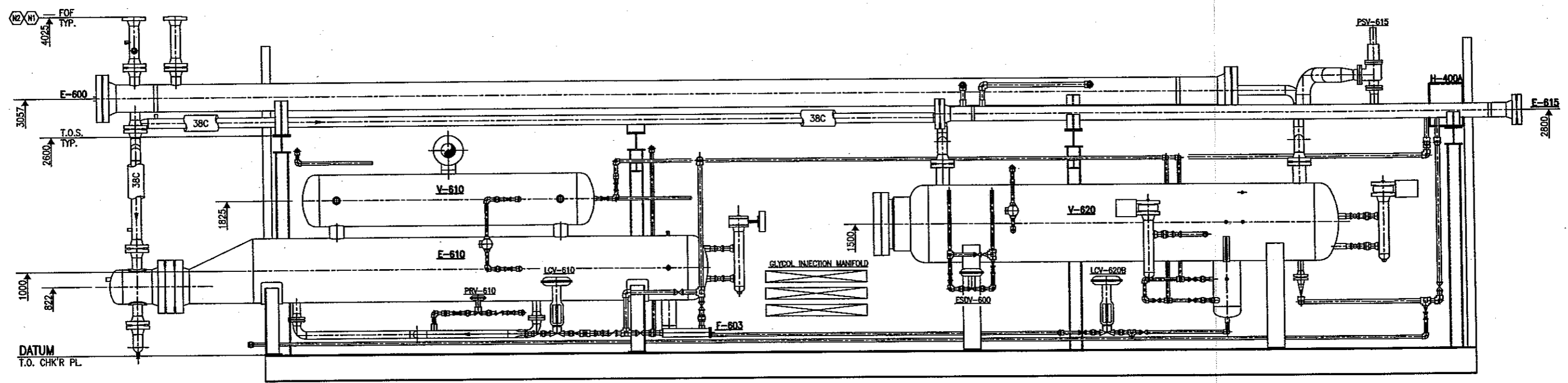
**LIFTING DIAGRAM**



**SECTION 'A-A'**

DATE: 2005/09/02 09:35 AM J:\JOBS05\054468\20-DRAWINGS\FAB\ASY\ASY-054468-152.DWG hsun		No.		REVISION		BY DATE CKD ENG		APPROVED		DRAWN		PROPAC		440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
GENERAL NOTES		GENERAL NOTES		2 REVISED PCV-630 PIPING		M.DIETER 05/09/02		MECH/STRUCT.		BY PSC		STOCK REFRIGERATION UNIT -- REF88		REV. 2	
		1 ISSUED FOR CONSTRUCTION		L. VERARA 05/03/15		BS RD		DATE 04/09/17		DATE 04/09/17		REFRIGERATION SKID		DWO. No.: D-ASY-054468-152 SHEET 2 OF 4	
								PROJECT RT		BY JLS		PIPING LAYOUT		SCALE 1:25	
								DATE 04/09/17		DATE 04/09/17					

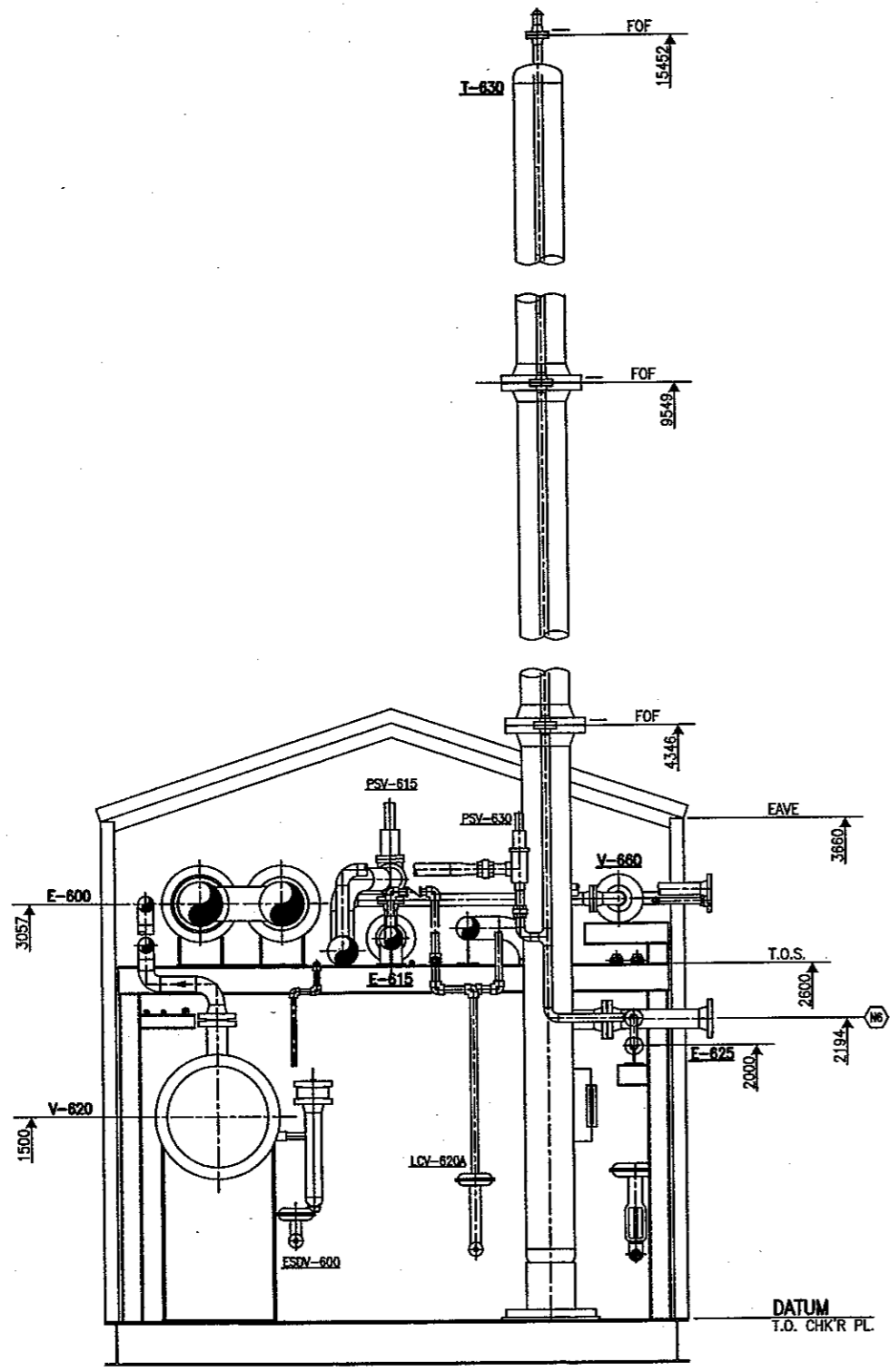
OF PROPAC  
 TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT  
 THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAC SYSTEMS LTD. AND SHALL NOT BE DISCLOSED



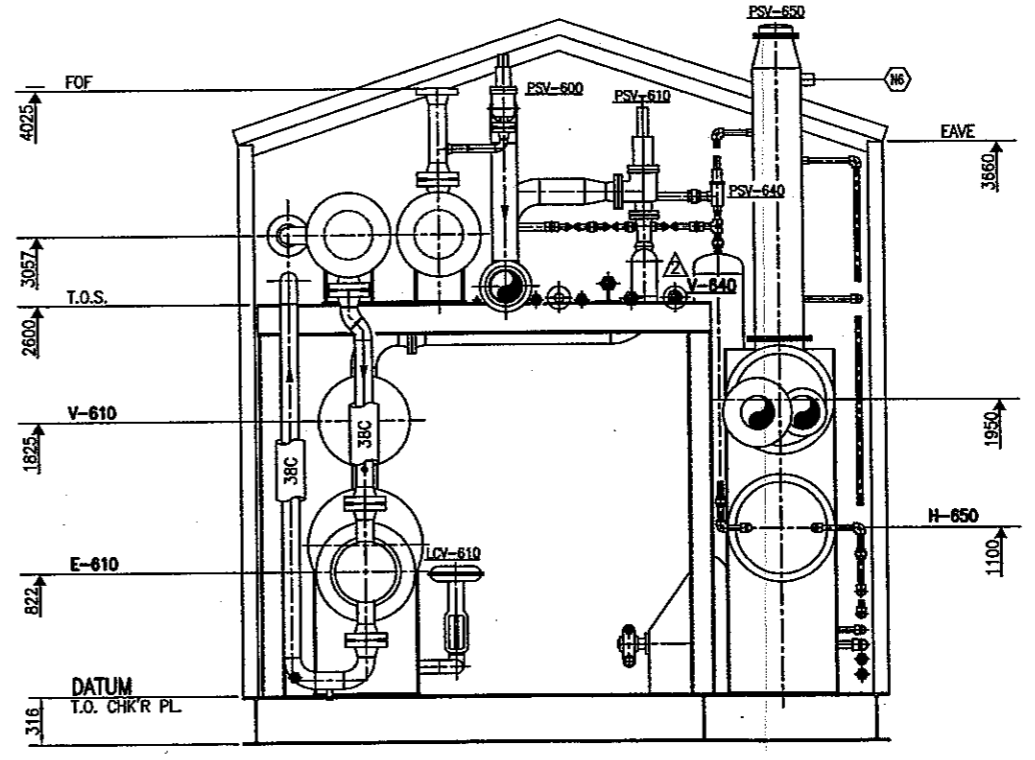
SECTION 'B-B'

THIS DRAWING AND THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAC SYSTEMS LTD. AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT												<b>PROPAC</b> 440 East Lake Road, Poind Bag 92 Airdrie, Alberta Canada T4B 2C3				
<b>GENERAL NOTES</b> DATE: 2005/03/15 11:56 AM J:\JOBS05\054468\20-DRAWINGS\FAB\ASY\ASY-054468-152.DWG ivergara		<b>GENERAL NOTES</b> 1 ISSUED FOR CONSTRUCTION		11/25/2005 JLS		11/25/2005 JLS		APPROVED MECH/STRUCT. BY PSC DATE 04/09/17 ELECTRICAL BY JLS DATE 04/09/17 PROJECT RT DATE 04/09/17		DRAWN BY PSC DATE 04/09/17 CHECKED BY JLS DATE 04/09/17		PROPAC STOCK REFRIGERATION UNIT - REF88 REFRIGERATION SKID PIPING LAYOUT		DWG. No.: D-ASY-054468-152	SHEET 3 OF 4	REV. 1
		No. REVISION		BY DATE CKD ENG				SCALE 1:25								

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**SECTION 'C-C'**



**SECTION 'D-D'**

NO.	REVISION	BY	DATE	CHKD	ENG
2	ADDED RECYCLE GAS NOZZLE	MDRETER	05/09/02	ES	JLS
1	ISSUED FOR CONSTRUCTION	VERGARA	05/03/15	ES	RD

APPROVED		DRAWN	
MECH/STRUCT.	BY	PSC	
DATE	DATE	04/09/17	
ELECTRICAL	BY	CHECKED	
DATE	DATE	04/09/17	
PROJECT	RT		
DATE	04/09/17	SCALE	1:25

<b>PROPAK</b>	
STOCK REFRIGERATION UNIT - REFBB	
REFRIGERATION SKID	
PIPING LAYOUT	
DWR. No.:	D-ASY-054468-152
SHEET 4 OF 4	REV. 2

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

