



Operation and Maintenance Manual

Kelt Exploration

Sullair PDR-20

Oak | 6-35-86-18W6M

100421A



Project # 100421A

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Oak | 6-35-86-18W6M

Sullair PDR-20

TABLE OF CONTENTS

- 1. Compressor**
- 2. Driver**
- 3. Cooler**
- 4. Instrumentation / Auxiliary Equipment**
- 5. Drawings/Panel Documentation**
- 6. Bill of Materials**



1. Compressor

Sullair Long term storage

3.2 long-Term Storage

The compressor package should be stored at all times in a dry location to prevent corrosion damage. The inlet and discharge lines are covered for shipment and short-term storage. If the unit is to be stored for a prolonged period of time, the unit should be checked occasionally to insure that the holding charge of dry nitrogen remains above atmospheric pressure. This will prevent corrosion from any moisture that might enter the compressor package, Refer to dry and wet storage below.

Long-Term and Seasonal Storage Procedures

Dry Storage (No Lube Oil in Machine) if Applicable

1. For long-term storage drain lubricant from machines and place desiccant (silica gel) inside:
 - Lube/Gas Separator
 - Duplex Strainer
 - Bearing
 - lube Filters
 - Control Panel
2. Close off all external connections with gaskets and steel flanges according to connection size.
3. Follow recommended vendor driver storage procedure.
4. A nitrogen purge can be supplied from a nitrogen bottle with a pressure regulator to maintain a few inches of positive water pressure in the system

Note: to be effective, the system must be positively sealed except for the relief valve.

Wet Storage (lube Oil in Machine) if applicable

1. Close off all external connections with gaskets and steel flanges according to connection size.
2. A nitrogen purge can be supplied from a nitrogen bottle with a pressure regulator to maintain a few inches of positive water pressure in the system

to be effective, the system must be positively sealed except for the relief valve.

During wet storage,

- the auxiliary lube pump, at two week intervals, should be run to circulate lube oil through the system to insure proper lube protection. Run the pump(s) for approximately 60 seconds or a maximum of 10 PSIG is reached.
- Follow recommended vendor driver storage procedure.
- The compressor shaft should be rotated by hand 10 to 15 revolutions each week in storage.



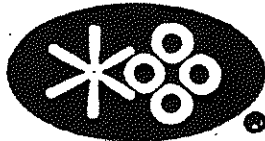
SERIES PD10, PD12, PD16 & PD20 GAS COMPRESSOR

OPERATOR'S MANUAL

Part Number 02250051-524
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1.1 Compressor Specifications

Machine

Physical Measurements

PD10 Bare Unit

Wght. lb.	190 *
Lgth. in.	16.0 *
Wdth. in.	13.8 *
Hght. in.	13.3 *
Rotor Dia. mm.	102
Gear Ratio	1.15 1.24 1.35 1.73 1.94 2.03 2.15 2.56 2.84 3.04 3.16 3.52 3.70 1.00
WR2 1b-1n2	64 74 86 136 167 181 201 277 334 378 406 497 541 33
L/D Ratio	1.47

Shaft Rotation (facing driveshaft): Gear driven units = CCW
Direct drive units = CW

Built-in Volume Ratio: 2.6 (low compression)
4.6 (high compression)

Max Inlet Pressure: 15 PSIG

Max Outlet Pressure: 150 PSIG

Operational Speed: 2808 MIN - 9362 MAX (Male rotor RPM)**

Bearings (outlet): Steel, tapered roller

Bearings (inlet): Poly, steel, brz, straight roller

Bearings (shaft): Steel, tapered roller

NOTES: * Overall dimensions of foot-mounted, gear driven unit.
** Consult Sullair for geared units

1.1 Compressor Specifications (continued)

Machine.

Physical Measurements

PD12 Bare Unit

Wght. lb.				346 *				
Lgth. in.				22.6 *				
Wdth. in.				15.7 *				
Hght. in.				11.8 *				
Rotor Dia. mm.				127				
Gear Ratio	1.51	1.76	1.91	2.06	2.29	2.52	2.74	
WR2 lb-in2	322	425	498	566	687	817	952	
L/D Ratio				1.70				

Shaft Rotation (facing driveshaft): Gear driven units = CCW
 Direct drive units = CW

Built-in Volume Ratio: 2.6 (low compression)
 4.3 (high compression)

Max Inlet Pressure: 15 PSIG

Max Outlet Pressure: 175 PSIG

Operational Speed: 2256 MIN - 7519 MAX (Male Rotor RPM)**

Bearings (outlet): Steel, tapered roller

Bearings (inlet): Poly, steel, brz, straight roller

Bearings (shaft): Steel, tapered roller

NOTES: * Overall dimensions of foot-mounted or driven unit.

** Consult Sullair for geared units.

1.1 Compressor Specifications (continued)

Machine

Physical Measurements

PD16 Bare Unit

Wght. lb.	599 *
Lgth. in.	36.6 *
Wdth. in.	18.3 *
Hght. in.	15.3 *
Rotor Dia. mm.	163
Gear Ratio	.85 1.0 1.17 1.24 1.34 1.45 1.54 1.69 1.85 1.91 2.03 2.26
WR2 1b-in2	316 335 582 647 747 863 964 1144 1352 1434 1604 1954
L/D Ratio	1.67

Shaft Rotation (facing driveshaft): Gear driven units = CCW
 Direct drive units = CW

Built-in Volume Ratio: 2.6 (low compression)
 3.0, 3.6 (med. compression)
 4.7, 5.5 (high compression)

Max Inlet Pressure: 25 PSIG

Max Outlet Pressure: 175 PSIG

Operational Speed: 1758 MIN - 5858 MAX (Male Rotor RPM)***

Bearings (outlet): Steel, tapered roller

Bearings (inlet): Poly, steel, brz, straight roller

Bearings (shaft): Steel, tapered roller

NOTES: * Overall dimensions of foot-mounted, gear driven unit.
 ** Overall dimensions of flange-mounted, gear driven unit.
 *** Consult Sullair for geared units.

1.1 Compressor Specifications (continued)

Machine

Physical Measurements

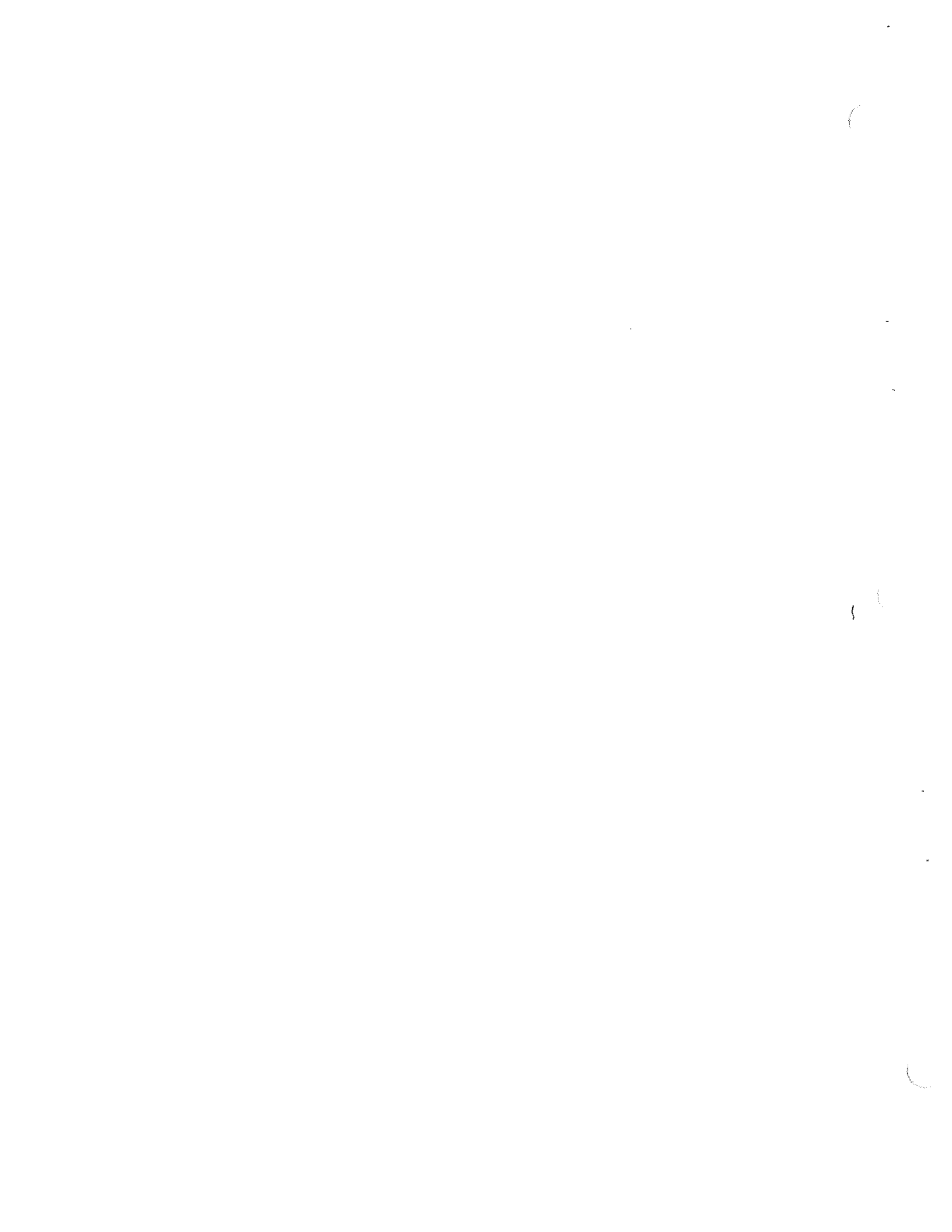
PD20 Bare Unit

Wght. lb.	1008 *											
Lgth. in.	45.0 *											
Wdth. in.	22.5 *											
Hght. in.	18.8 *											
Rotor Dia. mm.	204											
Gear Ratio	.96	1.11	1.17	1.36	1.45	1.57	1.65	1.80	1.94	2.13	2.06	1.00
WR2 L/D=2.2	1590	1078	2290	3023	3402	3940	4318	5071	5823	6920	6506	1426
WR2 L/D=1.7	1380	1800	1981	2606	2928	3384	3704	4340	4974	5896	5548	1200
L/D Ratio	1.7, 2.2											
Shaft Rotation (facing driveshaft):	Gear driven units = CCW Direct drive units = CW											
Built-in Volume Ratio:	2.6 (low compression) 3.5 (med compression) 4.3 (high compression)											
Max Inlet Pressure:	10 PSIG											
Max Outlet Pressure:	175 PSIG											
Operational Speed:	1404 MIN - 4681 MAX (Male Rotor RPM)***											
Bearings (outlet):	Poly, steel brz, straight roller & angular contac ball											
Bearings (inlet):	Poly, steel, brz, straight roller											
Bearings (shaft):	Poly steel, brz, straight roller, Conrad ball											

NOTES: * Overall dimensions of foot-mounted, direct driven unit.
 ** Overall dimensions of flange-mounted, gear driven unit.
 *** Consult Sullair for geared units.

SECTION 2

DESCRIPTION



2.1 Introduction

Your new Sullair Rotary Screw Compressor will provide you with improved reliability and reduced maintenance if installed, started, operated and serviced according to this manual. As with all compressors, only trained personnel should install and operate the Sullair compressor. Take special note of the items marked IMPORTANT, DANGER or WARNING, as overlooking these can lead to dangerous situations. Should you have any questions which are not answered in this manual, contact Sullair Corporation or their agents for assistance.

To ensure correct application, the compressor package must be installed in a system designed to currently accepted practices.

Immediately on arrival of your new Sullair compressor, unpack all the crates and boxes and check the items against shipping lists for any possible shortages. Examine the compressor, package components and loose items for possible damage in transit. Notify the shipper of any shortages or damages and enter the appropriate claim.

2.2 The Compressor Unit

The U.S. made Sullair Rotary Screw Compressor is an advanced design incorporating many years of experience in the screw compressor field. The positive displacement, pulse-free compressor includes the following design features:

- . 175 PSIG design casting (200 PSIG for PD10)
- . Stator, inlet and discharge housings are SAE G3000 cast iron
- . Stator is double wall design for strength and noise reduction
- . Rotors are asymmetrical, Sullair designed and manufactured from AISI-1141 free machining carbon steel
- . Bearings: Various anti-friction styles used

Also included:

- . Shaft seal, rotary face mechanical, single unit for PD10 & PD12, double for PD16 & PD20.
- . Shaft driven, bearing lubricant oil pump on PD16 & PD20 units.

Lubricant is injected into the compressor unit and mixes directly with the gas as the rotors turn compressing the gas. The lubricant has three functions:

- . As a lubricant; it acts as a lubricating film between the rotors allowing the male rotor to directly drive the female rotor and to lubricate the thrust and sleeve bearings.
- . As a sealant; it seals the leakage paths between each rotor and the stator and also between the two rotors
- . As a coolant; it controls the rise of the gas temperature associated with the heat of compression

Lubricant selection requires careful study of service conditions.

SERVICE CONDITIONS

Process nature (i.e., refer, pumping, etc.)
Gas composition (including liquids)
Flowing pressure & temperatures
Ambient temperature
Compressor speed

OIL PROPERTIES

Composition
Viscosity
Lubricity
Antioxidation
Anticorrosion
Flash Point

The gas-lubricant mixture discharged by the compressor is fed through a high efficiency separation process, and the recovered oil is subsequently cooled, filtered, and distributed for re-injection.

SECTION 3

INSTALLATION

This section contains instructions for the proper installation of Sullair Screw Compressors. All items in this section must be carried out by those with installation responsibility before the Sullair Representative arrives for start-up.

3.1 General

This section contains instructions for the proper installation of Sullair Screw Compressors. All items in this section must be completed by those with installation responsibility before the Sullair Representative arrives for start-up.

1. All piping is to be complete. Relief valves are to be properly vented.
2. The water piping is to be completed with the water valve installed for water-cooled machines.
3. The system and the compressor package are to be pressure-tested for leaks. See Section 3.5.
4. The system is to be evacuated to remove air and moisture. High and low point vents have been provided in all process lines (if specified).
5. The compressor lubrication system is packaged filled with the correct amount and type of lubricant. Check that the oil separator lubricant has maintained a level indicating half of gage glass level while compressor is running. If the lubricant level has fallen below this level, fill the separator with the proper lubricant. See proper Section for lubricant type and restore this level.
6. The electrical wiring is to be completed as required. Do not energize the compressor until the lubricant is added or the lubricant heater is connected (if applicable).

IMPORTANT

USED LUBRICANT SHOULD NEVER BE ADDED TO A SCREW COMPRESSOR
UNDER ANY CIRCUMSTANCES. USE ONLY NEW LUBRICANT.

7. The lubricant is to be warmed up if necessary.
8. The control panel is to be energized to check the protective controls. See Section 3.9

3.2 Long-Term Storage

The compressor package should be stored at all times in a dry location to prevent corrosion damage. The inlet and discharge lines are covered for shipment and short-term storage. If the unit is to be stored for a prolonged period of time, the unit should be checked occasionally to insure that the holding charge of dry nitrogen remains above atmospheric pressure. This will prevent corrosion from any moisture that might enter the compressor package. Refer to dry and wet storage this page.

Long-Term and Seasonal Storage Procedures

Dry Storage (No Lube Oil in Machine) if Applicable

For long-term storage drain lubricant from machines and place desiccant (silica gel) inside:

- . Lube/Gas Separator
- . Duplex Strainer
- . Bearing Lube Filters
- . Control Panel

Close off all external connections with gaskets and steel flanges according to connection size. Follow recommended vendor driver storage procedure.

A nitrogen purge can be supplied from a nitrogen bottle with a pressure regulator to maintain a few inches of positive water pressure in the system - to be effective, the system must be positively sealed except for the relief valve.

Wet Storage (Lube Oil in Machine) if applicable

Close off all external connections with gaskets and steel flanges according to connection size.

A nitrogen purge can be supplied from a nitrogen bottle with a pressure regulator to maintain a few inches of positive water pressure in the system - to be effective, the system must be positively sealed except for the relief valve.

Refer to Section 5.6 for further information. During wet storage, the auxiliary lube pump, at two week intervals, should be run to circulate lube oil through the system to insure proper lube protection. Run the pump(s) for approximately 60 seconds or a maximum of 10 PSIG is reached. Follow recommended vendor driver storage procedure. The compressor shaft should be rotated by hand 10 to 15 revolutions each week in storage.

3.3 Foundation and Rigging

The compressor package can be mounted and secured to any hard rigid and level surface which is adequate to support the weight of the package. Since the screw compressor is a relatively vibration-free rotary machine, it does not have to be mounted on an inertia block or pad.

If the mounting surface is not level, jacking screws may be required to distribute the weight evenly over the entire frame. Any gross distortion of the frame will complicate the alignment of the coupling.

Do not grout the package frame to the foundation at this stage (for 200 HP and above). Grouting with an expanding grout around the entire base is necessary after the piping is connected and the compressor and motor are roughly aligned (approximately 1/32 in (1 mm) total indicated reading).

3.4 Piping

All piping must conform to ANSI B31.3 Chemical Plant & Petroleum Refinery Piping. The customer must supply piping, fittings and equipment up to the terminating connections on the Sullair package. The size and location of the inlet, discharge and water connections can be found on the installation drawing of the package provided with manual.

The inlet, discharge and relief header connections should be installed and supported such that there is no load exerted on the compressor frame from either static forces or vibration. External forces from the piping can distort the flange alignments and cause major leak problems.

Gasketed Joints

When using flanges, suitable gasket material should be used. Prior to tightening flange bolts, the pipe to be connected should be in parallel alignment and the bolt holes should be in line. Do not use flanges as a means of straightening pipe, as they may stress adjacent compressors, valves and controls.

Flange bolts should be drawn up evenly when connecting flanges to prevent flange breakage.

Threaded Joints

The use of litharge and glycerine for sealing threaded joints has been replaced by many commercially available compounds and sealing tapes designed for use with different gases. Check for compatibility and follow instructions accompanying these compounds for method of application. Do not use excessive amounts or apply on female threads because any excess could contaminate the system.

IMPORTANT

GREAT CARE SHOULD BE EXERCISED IN WELDING ALL JOINTS ON THE INLET AND DISCHARGE LINES TO MINIMIZE THE AMOUNT OF WELD SLAG INSIDE THE SYSTEM PIPES.

ALL STEEL LINES (ESPECIALLY INLET AND LUBE INJECTION LINES) SHOULD BE THOROUGHLY CLEANED BY BLOWING OUT THE LINES WITH COMPRESSED AIR.

DO NOT GROUND THROUGH THE COMPRESSOR WHEN ARC WELDING.

3.5 Pressure Test

The package components shall all have been pressure-tested prior to leaving the factory. The compressor unit should, however, be leak-checked at the jobsite to detect leaks which may be present due to rough handling during shipment. This test should be done simultaneously with the system pressure test and system leak check.

Before the system pressure test, check that the lubricant separator element is seated correctly and that the gaskets are in the correct position. When the package is under pressure, tighten the manhole access cover.

1. Isolate the compressor package from the system.
2. Through a supplied vent or drain on the process piping, apply 25 PSIG of a dry inert gas to the package, e.g. nitrogen.
3. Leave pressurized for approximately two hours and check pressure gauge for a loss of pressure.
4. If pressure is lost, perform a soap bubble test on all flanged and threaded connections and correct as necessary.
5. Evacuate the system by opening the supplied inlet or discharge bypass/blowdown valve to relieve the pressure in the system.

3.6 Coupling Alignment - Foot-Mounted Units

The compressor shall be supplied leveled and secured to the package base frame. Do not loosen the bolts or disturb the compressor. Tighten the compressor mounting bolts to the torque given in Table 12 in Section 6.3 as they may have loosened in shipment.

Preparation for Alignment:

1. The compressor package should be leveled and securely anchored without base distortion as in Section 3.3.
2. Have available a supply of clean stainless steel shim stock in various thicknesses from 0.001" to 0.020" (0.02 to 0.50 mm) and slotted to fit the mounting bolts.
3. Check to make sure the driver feet and the package mounting pads are free of dirt and burrs.
4. Remove the coupling spacer and flexible elements, if fitted, by removing the nuts, bolts and thin and thick washers with the bevel facing the element pads.
5. Tie a wire through one bolt hole of each element pad to retain the original orientation of each element in the pad and to ensure that each element pad contains the same number of elements.
6. If the hubs are not mounted on the compressor shaft and the driver shaft, assemble the hubs.
7. Have a crowbar or other strong lever available to raise the driver for access to the shims.

Preliminary Alignment

1. Loosen inlet and discharge piping at compressor flanges and check for piping misalignment and strain. Retighten piping.
2. Adjust driver components of compressor package as necessary.

IMPORTANT

**PRECISE COUPLING ALIGNMENT IS THE GOAL IN THIS PROCEDURE.
DO NOT ALIGN THE PIPING IN SUCH A MANNER AS TO PUT EXCESS
MISALIGNMENT ON THE COMPRESSOR OR DRIVER.**

3. After correct compressor location is achieved, dowel pin the compressor to the package frame.
4. Roughly align the driver to the compressor to get approximate shaft separation and heights.

3.6 Coupling Alignment - Foot-Mounted Units (continued)

5. Set a pair of calipers to the proper shaft separation value.
6. Check the distance between the hubs at points N and S, Figure 3-1 using the calipers.
7. Add or remove shims at each corner of the driver base and use the jack screws(if supplied) to achieve the proper shaft separation around the complete perimeter of the hubs.

IMPORTANT

DO NOT ADD OR SUBTRACT SHIMS FROM UNDER THE COMPRESSOR. DOING THIS MAY RESULT IN DAMAGE TO PROCESS PIPING AND THE COMPRESSOR.

8. Place a straight edge across the rim of one hub flange to the rim of the other at points E or W in Figure 3-2.
9. Measure the gap between the straight edge and the rim of the second hub flange with a feeler gauge. See Figure 3-4.
10. Use jack bolts at points A, B, C and D in Figure 3-2 to move the driver the proper distance.
11. Recheck the shaft separation and correct if necessary.
12. Again, place a straight edge across the hubs as in Figure 3-4 except now at points N and S in Figure 3-3.
13. Repeat Step 6.
14. Add or remove the same amount of shims at each corner of the driver base to achieve the same shaft elevations.
15. Recheck the shaft separation and angularity in elevation and correct as needed.
16. Recheck the concentricity in plan and correct as needed.
17. Recheck the concentricity in elevation if any previous adjustments were made.

Final Alignment

1. Attach two dial indicators together securely to either coupling hub using a chain block or a vise clamp as in Figure 3.5. Set in one plunger on the top of the face of the opposite hub close to the rim or outside diameter (to measure the angularity) and set the other plunger on the top center of the rim (to measure the concentricity). Make sure that the plunger point is on a clean unpainted surface. Position both indicators such that their plungers are approximately half depressed to allow the movement of the pointer in either direction.
2. Set both dial faces to zero as in position N in Figure 3-5.

3.6 Coupling Alignment - Foot-Mounted Unit (continued)

3. Make sure that the indicators are securely attached by rotating the compressor shaft and the driver shaft together 360° or one complete revolution. The dial readings should return to zero. If the indicators do not return to zero, check the mounting of the indicators and tighten the chain block or the vise clamps. Indicator sag of 5-10 mils over a 12" span is possible; thus, elevation measurement concentricities may be severely affected if correction for sag is not made.

IMPORTANT:

4. The maximum allowable coupling angularity or concentricity misalignment is 0.002" (0.05 mm) total indicator reading (T.I.R.). The total indicator reading is obtained by subtracting the lowest reading from the highest reading. Use care to observe the sign change when subtracting a negative reading, e.g. $0.003 - (-0.002) = 0.005$ and $0.003 - (+0.002) = 0.001$.
5. The adjustment for misalignment should be made in a specific sequence. The three positions of alignment in Figures 3-1, 3-2 and 3-3 are arranged in the recommended order.
6. The following example shows the recommended procedure for correcting coupling misalignment.
7. When making shim changes, use a small number of thick shims rather than a large number of thin shims to prevent excessive compression of the shim packs when the mounting bolts are tightened.
8. When making shim changes, change and secure one foot at a time. Tighten the bolt only enough to prevent the driver from moving about while making shim changes. The next best procedure is to shim both inboard and outboard feet at the same time. This method helps to retain any corrections already obtained.
9. Whenever shims are changed and the motor is moved, the mounting bolts should be tightened evenly in the sequence in Figure 3-6 to the same torque given in Table 12 in Section 6.3. This minimizes misalignment caused by the driver shifting when tightening the bolts and by the motor pads not being level.
10. Whenever shims are changed and the driver is moved and the mounting bolts are tightened, a continuing sequential record should be kept of each set of 8 indicator readings on a simple elliptical sketch as in Figure 3-5.
11. Set both dial indicators to zero (0.000", 0.00 mm) in position N in Figure 3-5. Rotate both the compressor shaft and the driver shaft together in 90° steps. Turning both hubs together ensures that readings are recorded at the same point on each hub eliminating the effect of any irregularities on the rims or faces of the hubs. A mirror may assist in taking the readings. A sample set of readings is given in Figure 3-5.

3.6 Coupling Alignment - Foot-Mounted Unit (continued)

12. Never accept a single reading. Look for repeatability by rotating both shafts together several time and check that the reading remains the same.
13. The "angularity in elevation" misalignment from 0.000" (0.00 mm) at point N to -0.006" (-0.15 mm) at point S indicates that the rear of the driver is higher than the front in relation to the compressor. The T.I.R. is 0.006" (0.15 mm).
14. Calculate the distance to move the driver feet as follows: (Refer to Figure 3-7).
 - (a) Measure the angularity indicator plunger circle diameter (a little smaller than the coupling hub diameter) D (for example 6" (150 mm)).
 - (b) Measure the distance between the front and rear driver mounting bolts L, for example 30" (750 mm).
 - (c) Let the angularity in elevation misalignment T.I.R. as measured in Step 13 be M.
 - (d) Let the shim thickness to be added or removed be S.
 - (e) Then the shim thickness to be added or removed is calculated by dividing the bolt distance L by the coupling diameter D and multiplying the result by the misalignment M.
15.
$$S = \frac{LM}{D}$$
$$= \frac{30 \times 0.006}{6} = \frac{750 \times 0.15}{150}$$
$$= 0.030" \quad = 0.75 \text{ mm}$$

Add 0.030" (0.75 mm) of shim from the two rear driver feet. Use a crowbar or other strong lever to raise the driver for access to the shims.
16. Tighten the mounting bolts to the torque given in Table 12.
17. Recheck the angularity in elevation misalignment as in Steps 11 to 14. Record all 8 dial indicator readings. Note that the driver shaft can be above or below the compressor shaft (i.e., not concentric) and this will not affect the angularity in elevation calculation. When this is checked, the driver shaft is parallel in elevation to the compressor shaft, completing Figure 3-1.
18. The "concentricity in plan" misalignment in Figure 3-2 from 0.020" (0.25 mm) at point W indicates that the driver is displaced in the direction of point W. The T.I.R. is 0.020" (0.5 mm).
19. The distance to move the driver feet is half of the concentricity in plan misalignment T.I.R. This is 0.010" (0.25 mm).

3.6 Coupling Alignment - Foot-Mounted Unit (continued)

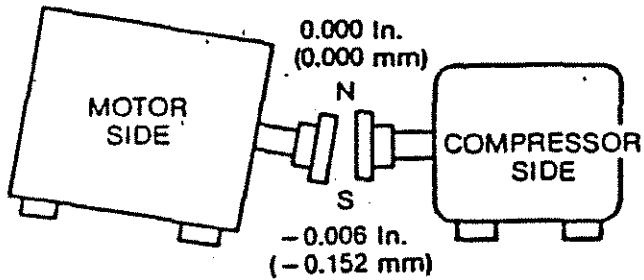
20. Fit jack screws (if applicable) to the frame at points C and D in Figure 3-2. Bring both jack screws into contact with the driver frame and then turn them in the direction of the arrows to move both feet 0.010" (0.25 mm).
21. Tighten the mounting bolts to the torque given in Table 12 in Section 6.
22. Recheck the concentricity in plan misalignment and record all 8 dial indicator readings as in Step 11 above. If necessary, readjust the driver as outlined in the preceding steps if either of the angularity or concentricity indicators exceeds the maximum allowable misalignment of 0.002" (0.05 mm). When this is checked, the driver shaft should be satisfactorily aligned with 0.002" (0.05 mm) angularity and concentricity from top to bottom (elevation) and from side to side (plan) to the compressor shaft.
23. The concentricity in elevation^m misalignment in Figure 3-5 from 0.000" (0.00 mm) at point N to 0.008" (0.20 mm) at point S indicates that the driver is lower than the compressor. The T.I.R. is 0.008" (0.00 mm).
24. The distance to move the driver feet is half of the concentricity in elevation misalignment T.I.R. This is 0.004" (0.10 mm) from Step 18.
25. Add 0.04" (0.10 mm) of shim to each of the four driver feet.
26. Tighten the mounting bolts to the torque given in Table 12.
27. Recheck the concentricity in elevation misalignment and record all 8 dial indicator readings. When this is checked, the driver shaft is both level and parallel in elevation to the compressor shaft, completing Step 2 in Figure 3-3. No more shims should need to be added or removed from the driver feet to complete the alignment.
28. Reverse the checking procedure by adjusting both dial indicators to zero at point S. Again, readjust the driver as in the preceding steps.
29. Check the spacing between the driver shaft and the compressor shaft to make sure there is sufficient room to accept the coupling spacer.
30. Finally, tighten the driver mounting bolts in sequence as in Figure 3-6; then, tighten bolts to the torque in Table 12 in Section 6.
31. Finally, recheck the alignment as in Step 22. If difficulty is experienced obtaining the alignment within the tolerance, proceed to Step 34 as the driver feet may not be sufficiently level.
32. Set the flange to flange spacing to the specified distance in Section 1.1. When setting coupling spacing on motors with sleeve bearings, it is mandatory that the motor armature be located on its magnetic center. Contact the motor manufacturer for details.

3.6 Coupling Alignment - Foot-Mounted Units (continued)

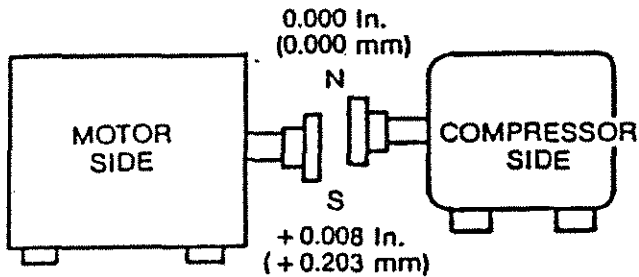
33. Do not assemble the coupling and dowel pin the motor to the frame until the alignment has been verified by a Sullair Service Representative. The Sullair Representative will be available to supervise these operations, but the customer must supply the dowel pins, drill reamer, drill bits and the labor.
34. Leveling the Driver Feet - All driver or support feet must be in the same plane. If they are not level, it makes alignment difficult. If one foot is not level, it makes exact alignment difficult. If one foot is higher, it stresses and springs the framework and the motor, or, if badly out of level, it can break the foot. Each time this foot is tightened, it must be tightened to the same torque value or a different indicator reading will result. The following procedure levels the motor feet in relation to the package base frame.
 - (a) Tighten all mounting bolts evenly in the sequence in Figure 3-6 to the torque in Table 12 in Section 6.
 - (b) Attach a dial indicator plunger on the top center of the rim (to measure the concentricity) in position N on Figure 3-3. Position the plunger so it is half depressed to allow movement of the pointer in either direction.
 - (c) Set the dial face to zero.
 - (d) Loosen one of the inboard feet and record the total movement on the indicator. Tighten the foot.
 - (e) Loosen the adjacent inboard foot and record the total movement before tightening it.
 - (f) If this reading is greater than the reading for the first foot, add shims to this second foot equal to the difference.
 - (g) When the reading on the second foot is less than or equal to 0.003" (0.08 mm), recheck the first foot. This will confirm that the inboard feet checked are level.
 - (h) Repeat the procedure for the outboard pair of adjacent feet.
 - (i) An acceptable reading on any foot is less than or equal to 0.003" (0.08 mm) when three bolts are tight and one is loose.
 - (j) Finally, tighten the driver mounting bolts evenly in the sequence in Figure 3-6 to the torque in Table 12 in Section 6.

3.6 Coupling Alignment (continued)

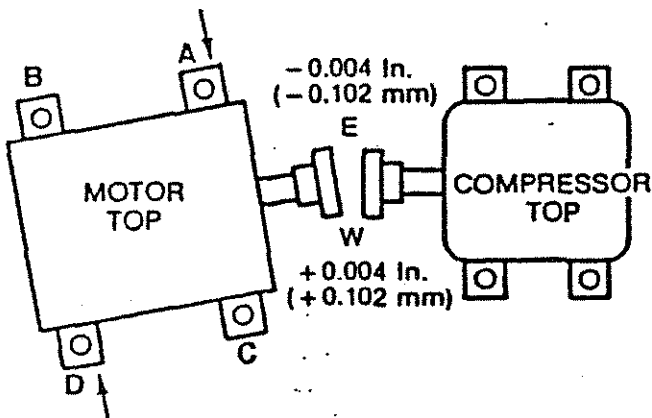
Alignment Sequence



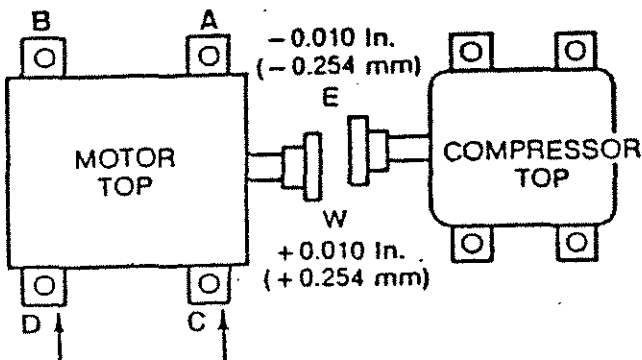
Step 1: Angularity in elevation—This alignment adjusted with shims and is not readily lost in making the other adjustments.



Step 2: Concentricity in elevation—This alignment also made with shims, but it cannot be made without there is angular misalignment in elevation.



Step 3: Angularity in plan—This position can easily be lost if placed ahead of the two adjustments in elevation.



Step 4: Concentricity in plan—This adjustment cannot be made while there is still angular misalignment in plan, and can easily be lost if elevation adjustments are made.

3.6 Coupling Alignment (continued)

Figure 3-4.

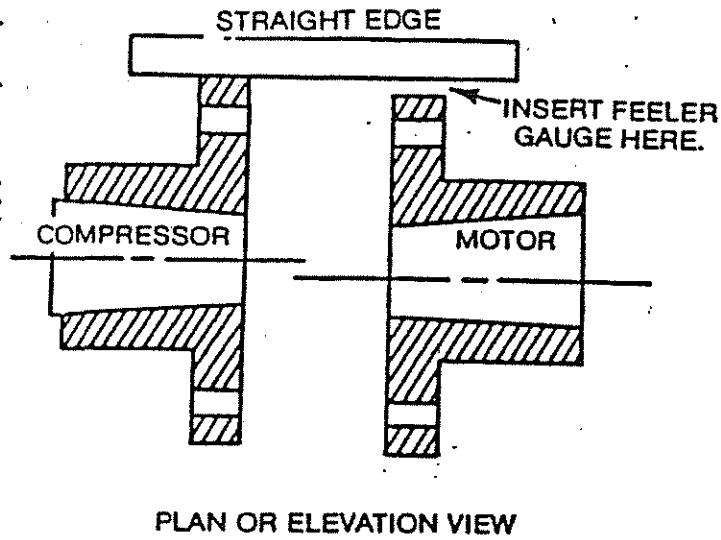
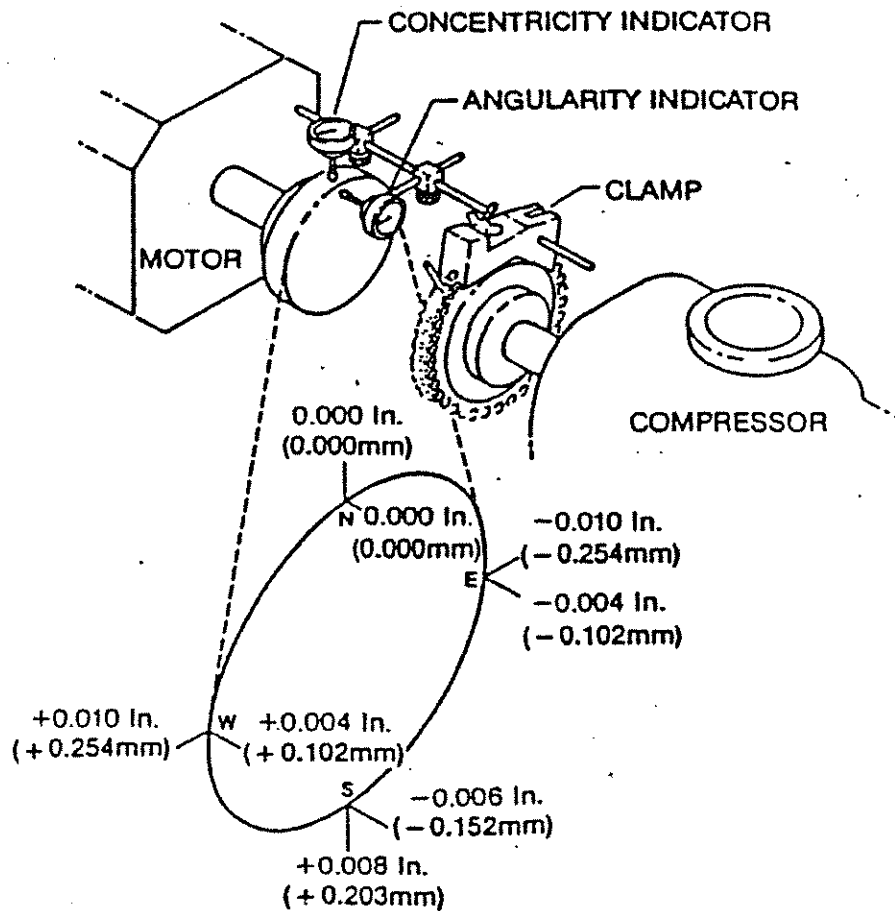


Figure 3-5 Final Alignment Procedure



3.6 Coupling Alignment (continued)

Motor Mounting Bolts
Tightening Sequence

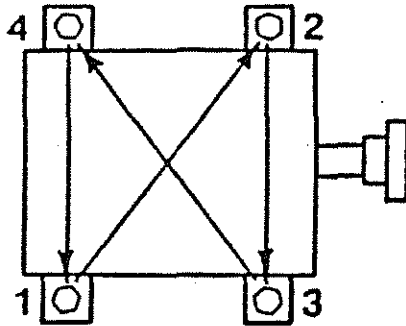


Figure 3-6

Angular Alignment

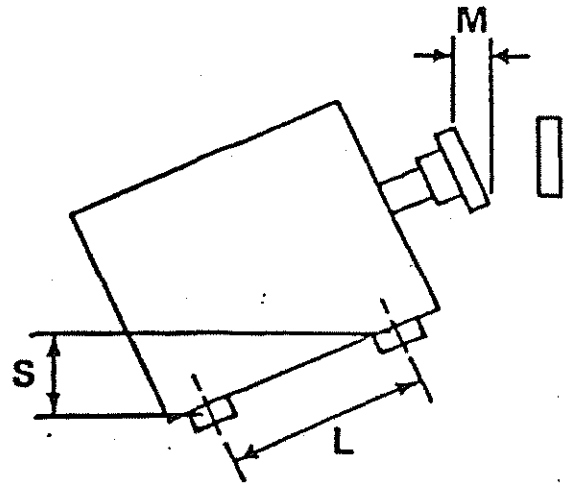


Figure 3-7

3.7 Driver Rotation Check

IMPORTANT

CONSULT SECTION 1 FOR PROPER COMPRESSOR ROTATION. DO NOT RUN THE COMPRESSOR IN THE REVERSE DIRECTION FOR MORE THAN ONE SECOND. FAILURE TO OBSERVE THIS CAUTION COULD RESULT IN SERIOUS DAMAGE TO THE COMPRESSOR. IF COUPLING ALIGNMENT HAS NOT BEEN PERFORMED, IT IS PREFERABLE TO CHECK DRIVER ROTATION WITH DRIVER UNCOUPLED.

3.8 Pre-Start-Up Lubrication Charge

Before starting the compressor for the first time, a charge of lubricant shall be administered to ensure that the compressor, cooler, and lube lines have sufficient oil to build up pressure at start-up.

Units With Pre-Lube Pumps - (PD16, PD20)

Run the pre-lube pump, but no longer than 1 minute, until 10-15 PSIG is achieved. If this pressure level cannot be reached, refer to Section 5.5, "Low Lube Pressure".

Once the charge is complete, check for lube oil leaks throughout the supply lines and correct as needed.

Finally, rotate the compressor shaft approximately 10 revolutions to equalize the lubricant level in the compressor. Failure to do this may result in damage to the shaft seals during initial start-up.

Units Without Pre-Lube Pumps - (PD10, PD12)

Introduce 1 to 2 gallons of lubricant through a suitable opening in the supply lines between the oil filter and the compressor. Shop air may be used to aid distribution of the charge, but care must be taken to direct said charge towards the compressor.

As previously stated, rotate the compressor shaft approximately 10 revolutions to equalize the lubricant level in the compressor.

SECTION 4

OPERATION

After all the installation functions in Section 3 have been completed, it will be possible for the Sullair Service Representative to perform start-up service. Sullair should be notified a minimum of two weeks before a scheduled start-up to assure timely arrival of the Sullair Service Representative. It is necessary that key plant operating personnel be available to go through the start-up, since a great deal of knowledge can be obtained in this manner. The operations covered in this section will be performed as start-up under the supervision of a Sullair Service Representative.

4.1 Start-Up Service Outline

Before the Sullair Service Representative arrives, the following must be completed in the order given.

1. The compressor is to be leveled and securely anchored to the foundation to assure stability of the coupling alignment.
2. All piping is to be complete. Relief valves are to be properly vented.
3. The water piping is to be completed with the water valve installed for water-cooled machines (if applicable)
4. The system is to be evacuated to remove air and moisture.
5. The system and the compressor package are to be pressure-tested for leaks as outlined in Section 3.5.
6. The system is again to be evacuated to remove air and moisture.
7. Driver lubrication is completed.
8. The Sullair Service Representative will verify that the coupling alignment has been achieved within the limits prescribed in Section 3.6. When alignment has been verified, it will be necessary for those with installation responsibility to dowel pin the motor (if required), assemble the coupling spacer and mount the coupling guard. The Sullair Representative will be available to supervise these operations but the customer must supply the dowel pins, drill, reamer, drill bits and labor.
9. The compressor is to be filled with the correct type and amount of lubricant (see Section 1.1).
10. The Electrical wiring is to be completed as required. Do not energize the compressor control panel until lubricant is added and the lube heater is connected (if applicable).
11. The lubricant is to be warmed up (if applicable).
12. The control panel is to be energized to check the protective switches and the capacity control. (See Section 3.9)
13. The direction of rotation of the motor is to be checked.
14. Have available two dowel pins, drill and reamer for the driver. The driver will be dowel pinned by the customer after the alignment is checked by the Sullair Service Representative.
15. All valves at the cooling water supply lines are fully open (water in and out), if applicable.

4.1 Start-Up Service Outline (continued)

The Sullair Service Representative will supervise the following with customer-supplied labor.

1. Check the overall installation of compressor package.
2. Check the coupling alignment. Customer will then dowel pin the motor.
3. Check all protective controls.
4. Check capacity control actuator adjustment (if applicable).
5. Start the compressor for the first time and adjust all the valves and controls on the package.
6. Explain compressor operation to the operating personnel.

4.2 Pre-Start Check List

The following section covers only the initial start of the compressor. Be sure that all necessary system valves are open and that the system is ready for start-up. Use the following check list to guarantee that no items of importance regarding the compressor package have been overlooked.

1. Driver Fuel/Power disengaged.
2. Instrument air/gas connected and regulated to the value given.
3. All protective switches verified for correct operation.
4. The lubricant in the separator sump is above 50oF (10oC). The compressor package should not be started if lubricant temperature is below this value.
5. Correct lubricant level.
6. Pre start-up lubrication charge has been performed.
7. Cooling water to lube cooler turned on if water-cooled.
8. Isolating valves to the pressure gauges and switches are opened.
9. Manual blowdown valve closed, inlet and discharge valves open.
10. Coupling turns freely by hand.
11. Direction of motor rotation checked and coupling guard mounted.
12. Driver lubrication is completed.
13. Capacity control actuator indicator at minimum (if equipped).
14. Capacity control selection switch in manual (if equipped).

When the above items are verified, the compressor is ready for the initial start.

4.3 Initial Start Procedure

Your Sullair gas compressor has been supplied with an electrical control system. Refer to an applicable wiring diagram and corresponding vendor instructions for proper field wiring before any start-up procedures are initiated.

If the compressor shuts down on low lube differential pressure after start-up, clean up the lube strainers and pump one (1) gallon (four litres) of lubricant into the lube filter to prelubricate the compressor bearings. Restart the compressor and, if it stops again because of low lube pressure differential, see "Troubleshooting", Section 5.6, under Low Lube Pressure.

IMPORTANT

THE COMPRESSOR PACKAGE MUST BE ISOLATED FROM THE SYSTEM BY CLOSING THE ISOLATING VALVES AND PRESSURE RELIEVED BEFORE REMOVING STRAINERS. FAILURE TO OBSERVE THIS CAUTION COULD RESULT IN SERIOUS INJURY.

After a successful start, run the compressor until the operating limits stated in Section 2.2 are met. The primary concern is to achieve and satisfy the correct discharge pressure. This pressure will help to achieve the remaining operating parameters of the compressor. If the operating limits are not met within approximately 30 minutes, refer to "Troubleshooting", Section 5.6 of this manual.

4.4 Lube Pressure Adjustment

Before adjusting the lube pressure relief valve and the lube pressure regulating valve, make certain that the lube strainers are clean and the lube temperature is at its normal operating temperature (see Section 1.2).

1. Loosen the locknut on the relief valve and screw in the adjustment screw with an allen wrench as far as it will go.
2. Loosen the locknut on the lube pressure regulator and screw in the adjustment screw with an allen wrench until the lube pressure is 75 PSI (9500 kPa) above the discharge pressure.
3. Back out the adjustment screw on the lube pressure relief valve while watching the lube pressure gauge until the lube pressure begins to drop. This indicates the valve is starting to relieve and bypass lube at 75 PSI (9500 kPa). Tighten the locknut.
4. Back out the adjustment screw of the lube pressure regulator while watching the lube pressure and discharge pressure gauges until the lube pressure drops to 45 to 50 PSI (300 to 350 kPa) above discharge pressure. Tighten the locknut.

4.5 Start-Up Data Record

After the compressor has run fully automatically for an hour and the pressures and temperatures have remained stable for 15 minutes, a Sullair Representative will fill out the start-up data record on the following page. A copy will be sent to Sullair Process & Gas Compressors, Inc. for the permanent file Sullair maintains on your machines.

4.6 After Start-Up Maintenance

After the compressor has run for twenty-four hours, change the lube filters if its pressure differential exceeds 30 PSI (200 kPa).

Check the compressor shaft seal for excessive leakage of more than 10 drops per minute. If excessive, replace the seal as in Section 6.5.

IMPORTANT

WHENEVER THE COMPRESSOR STOPS, IT RUNS IN THE REVERSE DIRECTION FOR SEVERAL SECONDS. AFTER THE DISCHARGE CHECK VALVE CLOSES, THE HIGH PRESSURE GAS IN THE SEPARATOR EXPANDS BACK THROUGH THE COMPRESSOR TO THE CLOSED INLET CHECK VALVE WHICH CAUSES THE COMPRESSOR TO RUN IN REVERSE. IT IS A COMPLETELY NORMAL ACTION AND IS NO CAUSE FOR ALARM. CONTINUED BACK SPIN FOR A FULL SECOND INDICATES EXCESS LEAKAGE THROUGH THE INLET CHECK VALVE. INSPECT OR REPLACE THE CHECK VALVE IF THIS SHOULD OCCUR. NOTE THAT COMPRESSOR BACK-SPIN EXCEEDING ONE (1) SECOND MAY RESULT IN SERIOUS DAMAGE.

START UP DATA RECORD

Customer _____

Contractor _____

Persons Contacted _____

Persons Contacted _____

Phone _____

Phone _____

Telex _____

Telex _____

Qwip/Telefax _____

Qwip/Telefax _____

Identification (Section 1.1)

Package Model No. _____

Package Serial No. _____

Compressor Serial No. _____

Wiring Diagram No. _____

Pneumatic Diagram No. _____

Piping & Instr. No. _____

Lubricant Cooling: Water / DX / Air _____

Installation No. _____

Coupling Alignment (Section 3.7)

T.I.R. Concentricity _____ in/mm

T.I.R. Angularity _____ in/mm

Coupling Spacing _____ in/mm

Protective Switch Settings (Section 1.2 and 3.9)

Anti-recycle Timer _____ min

Low Oil Pressure 25 psi / 175 kPa (Factory Set)

High Lube Temperature _____ °F/°C

High Discharge Temperature _____ °F/°C

Low Discharge Temperature _____ °F/°C

High Discharge Temperature _____ °F/°C

High Inlet Pressure _____ PSIG/in Hg/kPa

Low Inlet Pressure _____ PSIG/in Hg/kPa

Low Discharge Pressure _____ PSIG/in Hg/kPa

High Discharge Pressure _____ PSIG/in Hg/kPa

Control Switch Settings

Inlet Pressure: Cut In _____ PSIG/in Hg/kPa

Cut Out _____ PSIG/in Hg/kPa

Capacity Control Pressure: P1 Unload _____ PSIG/in Hg/kPa

P2 Load _____ PSIG/in Hg/kPa

START UP DATA RECORD

Driver Equipment

Driver Manufacturer _____ Sullair Supplied: Yes / No
Driver Serial Number _____ Driver Rated Power _____ HP/kW

If Electric Drive:

Electric Supply _____ Volts _____ Hertz _____ Phase

Operational Data

Gas _____
Inlet Pressure _____ PSIG/in. Hg/kPa Inlet Temperature _____ °F/
Disch Pressure _____ PSIG / kPa Disch Temperature _____ °F/
Lube Pressure _____ PSIG / kPa Lube Temperature _____ °F/
Lube Filter _____
 Press Drop _____ PSID / kPa
Lube Type _____
Water Temp:
 Inlet - _____ °F/°C
 Outlet - _____ °F/°C

Water Supply:

 Condenser/Cooling Tower/Treated/Untreated/Mains/Well/Other _____
Current _____ amps at above conditions with capacity control at _____

Comments:

Sullair Representative Signature _____ Date _____

SECTION 5

MAINTENANCE

5.1 General

Although the maintenance for your Sullair Screw Compressor is minimal, it must be carried out for a long compressor life. The instrumentation and indicators provided will alert you of the first sign of a maintenance requirement. Observe these instruments and indicators at regular intervals to be certain that the machine is performing properly. Become familiar with the normal operating sound of the compressor and if something does not sound just right, shut down the machine. Excessive vibration is a good indication that something is wrong and that vibration checks should be periodically made. This precaution may save the cost of a major repair.

Keep the compressor package clean to minimize dirt entering the compressor whenever components are opened during routine maintenance.

Before cleaning a component with a solvent to remove gum or resin-like deposits, remove all the O-rings as they can be chemically attacked. Alternatively, check the compatibility of the solvent with the O-rings. Unfortunately, those solvents which most readily remove carbon deposits (e.g. trichlorethylene) rapidly attack viton. (To ensure no traces of solvent will be left to react with the lubricant and gas, thoroughly dry the component with an air blast.)

5.2 Daily Operation

It will be necessary to check the lube level inside the sump. Should the level be low, simply add the necessary amount of the proper lubricant.

After a routine start has been made, observe the instrument panel and be sure the gauges indicate the correct reading for that particular phase of operation.

After the machine has warmed up, check the overall compressor and instrument panel to make sure it is running properly. Immediate attention should be given to the following:

- . Lubricant Pressure Gauge
- . Lubricant Temperature Gauge
- . Discharge Temperature Gauge
- . Discharge Pressure Gauge
- . Inlet Pressure Gauge
- . Other Gauges

A log of the operating temperatures, pressures and service requirements can be valuable in troubleshooting. It is strongly recommended that a log be kept of all readings at least every eight hours as in Table 10.

Check the lubricant level in the oil separator sight glass. If the level is low, refer to Section 3.1 proper fill level and instructions.

WARNING

DO NOT REMOVE CAPS, PLUGS OR OTHER COMPONENTS WHEN COMPRESSOR IS RUNNING OR PRESSURIZED.

STOP COMPRESSOR AND RELIEVE ALL INTERNAL PRESSURE BEFORE DOING SO. DO NOT EXHAUST HAZARDOUS GASES INTO THE ATMOSPHERE.

IMPORTANT

USED OR FILTERED LUBRICANT SHOULD NEVER BE ADDED TO A SULLAIR SCREW COMPRESSOR UNDER ANY CIRCUMSTANCE. USE ONLY NEW LUBRICANT.

Lubricant should be added if needed after the compressor has stopped or been shut down. Add sufficient lubricant into the separator to the proper level with a hand or electric pump.

If the addition of lubricant becomes too frequent, a problem may have developed causing this excessive loss. See "Troubleshooting", Section 5.5 under High Lube Consumption for a probable cause and remedy.

5.3 Maintenance After Initial 200 Hours of Operation

After the initial 200 hours of operation, a few maintenance tasks are necessary to rid the system of foreign materials which may have accumulated during assembly and installation. Other procedures, stated below, are required to ensure that the initial operation of the machine is correct.

1. Replace the lubricant filter elements
2. Clean the lube strainers
3. Check the settings of the capacity control (if applicable)
4. Check the pressure gauge calibration (0 PSIG or 0 kPa when open to atmosphere).
5. Tighten package fasteners, especially driver and compressor mounting bolts.
6. Check compressor shaft seals for excessive leakage. A small lubricant loss of 1 to 2 drops per minute is normal, maximum being 10 drops per minute.
7. Check coupling alignment. Alignment changes may be an indication of sub-support settlement and/or over-hung (pipe strain) loads.
8. Check pertinent protection switches.
9. Check lubricant oil separator element and gaskets (of oil loss is excessive).
10. Perform driver maintenance as required.
11. Restart and check all operating temperatures and pressures.

5.4 Maintenance Schedule

OPERATION	SCHEDULING TIME PERIOD
1. Check all operating indicators.	
Net Lube Pressure (Equals Lube pressure gauge minus discharge pressure gauge)	Daily
Lube Temperature	Daily
Discharge Pressure	Daily
Discharge Temperature	Daily
Inlet Pressure	Daily
Lube Filter Pressure Drop	Daily
Lube Level	Daily
Motor Current	Daily
2. Test all protective controls on monthly basis.	
3. Maintain lube quality with a lube analysis program.	
Sample lube to check appearance and run a lube analysis	Every 1,000 hours for first 6,000 hours and every 2,000 hours thereafter.
Change lubricant	Every three months or 2,000 hours unless using lube analysis. Maximum time six months.
Change lube filter cartridge	Whenever lubricant is changed or when pressure drop across the filter exceeds 30 PSI (200 kPa) or is less than 4 PSI (30 kPa).
Clean lube strainers	Whenever lubricant is changed.
4. General Maintenance	
Check Noise Level	Daily
Check Driver Bearings Temperature	Monthly or as recommended by motor manufacturer
Lubricate Driver Bearings	Yearly or as recommended by driver manufacturer
Engine Lubricant Sump (if applicable)	Yearly or as recommended by driver manufacturer

5.4 Maintenance Schedule (continued)

<u>OPERATION</u>	<u>SCHEDULING TIME PERIOD</u>
Check Coupling Alignment and tighten coupling bolts	Yearly
Tighten Driver and Compressor Mounting Bolts	Yearly
Inspect Rotor End Play	Every six months
Inspect Lubricant Separator Filter Element	Refer to separator differential gauge. Inspect at 10 PSID.
Inspect For Cleanliness	Every three months until required cleaning frequency is established.

5.5 Troubleshooting

The information contained in the Troubleshooting Chart has been compiled from data gathered from field service reports and factory experience. It contains symptoms and usual causes for the service problems described, however, DO NOT assume that these are the only problems that may occur. All available data concerning the trouble should be systematically analyzed before undertaking any repairs or replacing components.

With any problem, make a detailed visual and audible inspection. Some important things to look for are:

1. Damaged control tubing.
2. Loose wiring
3. Loose connections.
4. Unfamiliar noises or vibrations (driver, compressor, tanks, etc.)

Analyze the problem logically, step by step, with the aid of the Troubleshooting Chart.

Should your problem persist after making these checks, contact the Sullair Service Department.

Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE AND REMEDY
1. Compressor will not start	<ul style="list-style-type: none"> A. No power supply to control circuit. Check power supply. B. One of the protective switches tripped. Remove cause. Check setting and reset. C. Recycle timer activated. Wait for timer to time out. D. Defective pre-lube pump.
2. Compressor shuts down immediately after starting.	<ul style="list-style-type: none"> A. Low lube pressure. See #3. B. Cold lubricant
3. Low lube pressure	<ul style="list-style-type: none"> A. Plugged lube strainer. Clean Strainer. B. Plugged lube filter. Replace cartridge. Do not clean. C. Low lubricant charge. Check lube level with compressor shut down. D. Worn lube pump (when supplied). E. Low lube viscosity, (to be determined by oil analysis). Change lubricant.
4. High lube pressure	<ul style="list-style-type: none"> A. Lube temperature too low. See #5
5. Low lube temperature	<ul style="list-style-type: none"> A. Thermal valve element defective. Replace element. B. Lube heater or thermostat defective (where applicable).

Troubleshooting Chart (continued)

SYMPTOM	PROBABLE CAUSE AND REMEDY
6. High lube temperature	<ul style="list-style-type: none">A. Thermal valve element defective. ReplaceB. Cooler fan not working or defective fan start switch (if applicable).C. Dirty lube cooler. Clean.D. Low lube viscosity (to be determined by oil analysis). Change lubricant.
7. High discharge temperature	<ul style="list-style-type: none">A. High lube temperature. See #6.B. Plugged lube strainer. Clean strainer.C. Abnormal operating condition, e.g. abnormally high inlet pressure or high discharge pressure. Check system.
8. Low inlet pressure	<ul style="list-style-type: none">A. Excessive inlet line pressure drop. Check system valves open.B. Capacity control not modulating. See No. 10.C. Check inlet line strainer.
9. High lubricant consumption	<ul style="list-style-type: none">A. Lubricant not returning to compressor from final stage of separator. Check lube return sight glass at separator. If abnormal level shows, clean orifice and/or strainer.B. Lube separator gaskets incorrectly seated and sealed or defective. Reseat and seal or replace.C. Excessive lubricant charge. Check lube level with compressor off. Drain if excessive.

Troubleshooting Chart (continued)

SYMPTOM	PROBABLE CAUSE AND REMEDY
10. Excessive compressor vibration	A. Rotor end play excessive. Con Sullair with results. B. Loose compressor anchoring. Tighten bolts. C. Check coupling alignment. D. Any other persistent vibration noise, contact Sullair.
11. Driver Malfunction (Refer to Driver Manual)	

5.6 Seasonal or Long-Term Shutdown

To shut down a compressor for four months or longer, tightly shut both the inlet and discharge stop valves. Disconnect all power and air sources. Place a moisture-absorbing compound (e.g. a desiccant such as silica gel) inside the control panel and the pneumatic valve actuator. If water-cooled, close the cooling water supply valves and drain the water from the lube cooler. Drain all liquid from the inlet separator system.

Place warning tags on the compressor control system and all closed stop valves.

Every week, while the compressor is shut down, turn the compressor and motor shafts 10 to 15 revolutions by hand.

Prior to starting up after a shutdown, change the lubricant and repeat the items in Section 4.2.

SECTION 6

SERVICING

6.1 General

The following paragraphs outline the general servicing procedures for the Sullair Screw Compressors.

For assistance with any detail of service or servicing of an item not covered by this manual, please consult Sullair or their agents. Service supervisors are available from Sullair who will assist on any servicing procedure.

To prevent needless downtime, have available on site all parts that may be needed to carry out the repair before commencing any work. Refer to recommended spare parts list for assistance.

To prevent dirt from entering opened components, keep the surroundings clean and cover the exposed working areas with plastic whenever possible.

Before cleaning a component with a solvent to remove gum or resin-like deposits, remove all the O-rings as they can be chemically attacked. Alternatively, check the compatibility of the solvent with the O-rings. Unfortunately, those solvents which most readily remove carbon deposits, (e.g. trichlorethylene) rapidly attack viton. (To ensure no traces of solvent will be left to react with the gas and lubricant, thoroughly dry the component with an air blast.)

6.2 Shutdown Procedure

WARNING

BEFORE COMMENCING WORK ON ANY ITEM ON THE PACKAGE, ENSURE THAT THE FOLLOWING ARE CARRIED OUT FOR YOUR OWN PERSONAL PROTECTION.

COMPRESSOR SHUTDOWN

1. Whenever the compressor is to be shut down for service, place warning tags on the system and the line valves. Others who do not know the machine may be faulty or is being repaired must not attempt to start the compressor until the servicing is complete and it is ready for normal operation.
2. Stop the compressor with the stop button.
- * 3. Secure the driver.
- * 4. Disengage driver power/fuel.
5. Close compressor inlet stop valve and discharge stop valve.
6. Relieve the gas pressure in the package by opening the blow down valve on the lube separator.
7. Leave the blow down valve open all the time while working on the package.

WARNING

HAZARDOUS GASES MUST NOT BE EXHAUSTED INTO THE ATMOSPHERE.

- * Note: Disengage electric power supply. Exposed electrical wiring must always carry a warning tag even though it is disconnected from the power supply.




6.3 Bolt Tightening Torques

The tightening torques for servicing the various bolts and screws used in the package are given in Table 12. All fasteners (e.g. the ferry head screws) used in the compressor unit are high-tensile Grade 8 only and they must always be torqued to Condition B when the compressor is serviced. (The fasteners on the package (e.g. flange bolts) are high tensile Grade B7 with Grade 2H nuts and the tightening torques below may be used as a guide).

Bolts of different grades are distinguished by the number of slashes on the hexagonal head. Grade 8 bolts have six slashes, see Table 12. All ferry head screws are Grade 8.

TABLE 12
TIGHTENING TORQUES FOR THREADED BOLTS

Fastener		Tightening torques: Lb/ft in top line N.m in bottom line														
Diameter	Pitch	Grade 2 **					Grade 5 **					Grade 8 **				
Inch	Thread	*Condition					*Condition					*Condition				
Inch	Inch	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1/4	20	5.5	4.0	3.7	2.8	5.0	8.0	6.0	5.5	4.0	7.2	12	9.0	8.0	6.0	11
		7.5	5.4	5.0	3.8	6.8	10.8	8.1	7.5	5.4	9.8	16.3	12.2	10.8	8.1	14.9
5/16	18	11	8.0	7.5	5.5	10	17	13	11.5	8.5	15.3	25	18	17	12.5	22.5
		14.9	10.8	10.2	7.5	13.6	23	17.6	15.6	11.5	21	34	24	23	16.9	31
3/8	16	20	15	13.5	10	18	30	23	20	15	27	45	35	31	22.5	40
		27	20	18.3	13.6	24	41	31	27	20	37	61	47	42	31	54
1/2	13	50	35	34	25	45	75	55	50	38	68	110	80	74	55	99
		68	47	46	34	61	102	75	68	52	92	149	108	100	75	134
5/8	11	100	75	67	50	90	150	110	100	75	135	220	170	147	110	198
		136	102	91	68	122	203	149	136	102	183	298	230	199	149	268
3/4	10	175	130	117	68	158	260	200	174	130	234	380	280	255	190	342
		237	176	159	92	214	353	271	236	176	317	515	380	346	258	464
7/8	9	165	125	110	82	148	430	320	288	215	387	600	460	402	300	540
		224	169	149	111	201	583	434	390	291	525	813	624	545	407	732
1	8	250	190	168	125	225	640	480	429	320	576	900	680	603	450	810
		339	258	228	169	305	868	650	582	434	781	1220	922	818	610	1098

GRADE **	IDENTIFICATION MARK	TENSILE STRENGTH		YIELD STRENGTH		DIAMETER Inch
		PSI	MPa	PSI	MPa	
2		74,000	510	57,000	390	Up to 3/4
		60,000	415	36,000	250	7/8 to 1
5		105,000	725	81,000	560	All Sizes
8		150,000	1035	130,000	900	All Sizes

*CONDITIONS

- A) Non-lubricated solvent-cleaned and dry.
- B) Lubricated with rust preventative or cadmium or zinc plated.
- C) Lubricated with oil or grease.
- D) Lubricated with dry lube film or graphite/oil mixture.
- E) Lubricated with loctite or sealants.

6.4 Lube Separator Element Servicing

INSPECTION

1. Carry out the shutdown procedure in Section 6.2.
2. Remove the access cover on the top of the separator.
3. Inspect the access cover gasket and replace if necessary.
4. Inspect the element gaskets for tightness. If the gaskets are blown on either end, gaskets and elements must be replaced.

REMOVAL

1. Remove locking nut, flat washer and cover plate.
2. Remove element.
3. Scrape old gaskets from both ends of the element if the elements are to be reused.
4. Thoroughly clean the gasket surfaces, cover plate and the bulkhead in the separator.

INSTALLATION

1. Cement new gaskets to the element using Loctite No. 404 (available from Sullair).
2. Replace element.
3. Tighten nut until the cover plate bows (1/16" (1 mm)).
4. Replace the access cover on the lube separator using a new gasket if necessary.
5. Close the blowdown valve.
6. Open the inlet stop valve and discharge stop valve.
7. Start the compressor.

6.5 Shaft Seal Replacement

Preparation

1. Carry out the shutdown procedure in section 6.2

WARNING

MAKE SURE THE STARTER IS DISCONNECTED BEFORE ANY WORK IS PERFORMED ON ELECTRIC DRIVEN COMPRESSORS.

Service of PD10, PD12 Units - Refer to Fig. 6.1

When shaft seal replacement is necessary, use replacement kit per recommended spare parts list and follow the procedure explained below.

Disassembly

1. Remove screws (S5 or (S9) and remove shaft seal cover (S4). The cover can be removed by forcing the cover off by prying under the notch of the flange with a screw driver or similar tool. Care should be used in removing shims. They must be reinstalled to insure proper endplay.

WARNING

THE AXIAL ENDPLAY OF THE SHAFT IS ADJUSTED BY THE USE OF SHIMS (S6). WHEN THE COVER IS REMOVED, CARE MUST BE TAKEN THAT THE SAME SHIM SET IS REINSTALLED TO INSURE PROPER ENDPLAY. IF HOUSING (S4) MUST BE REPLACED, THE SHAFT END CLEARANCE MUST BE ADJUSTED BY THE USE OF SHIMS. ORDER SHIM SET P/N 026397 (S6). SHAFT END CLEARANCE TO BE ADJUSTED TO .002 - .003 AS MEASURED WITH INDICATOR ON THE END OF THE SHAFT.

2. Remove seal (S1) from cover (S4) by laying machine edge of cover on a flat surface. Remove seal from housing by tapping on exposed part of seal with Sullair seal repair press tool, P/N 232958. Note: This tool is also used when installing new seal.
3. Remove seal seat from shaft. Do not remove spacer (S29).
4. Remove O-ring (S7) from seal cover (S4) and discard.

Reassembly

1. Clean all parts thoroughly and scrape off any old sealants on the housing and mating parts. Check the bore and edges of seal cover (S4) for burrs and break any sharp edges found in seal cover. Check the shaft for burrs or sharp edges. Remove all that are found. Clean shaft with fine emery cloth to remove any dirt, metal particles, etc.
2. Install the seal seat by lightly coating input shaft O.D. with lube kit oil (001901A). Unwrap the seat.

6.5 Shaft Seal Replacement (PD10, PD12) (continued)

IMPORTANT

THE FINISH OF THE LAPPED FACE IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. THE LAPPED FACE CAN BE IDENTIFIED BY ITS HIGHLY POLISHED SURFACE. COAT THIS SURFACE WITH OIL FROM LUBE KIT 001901A. KEEP FINGERS OFF LAPPED SURFACE.

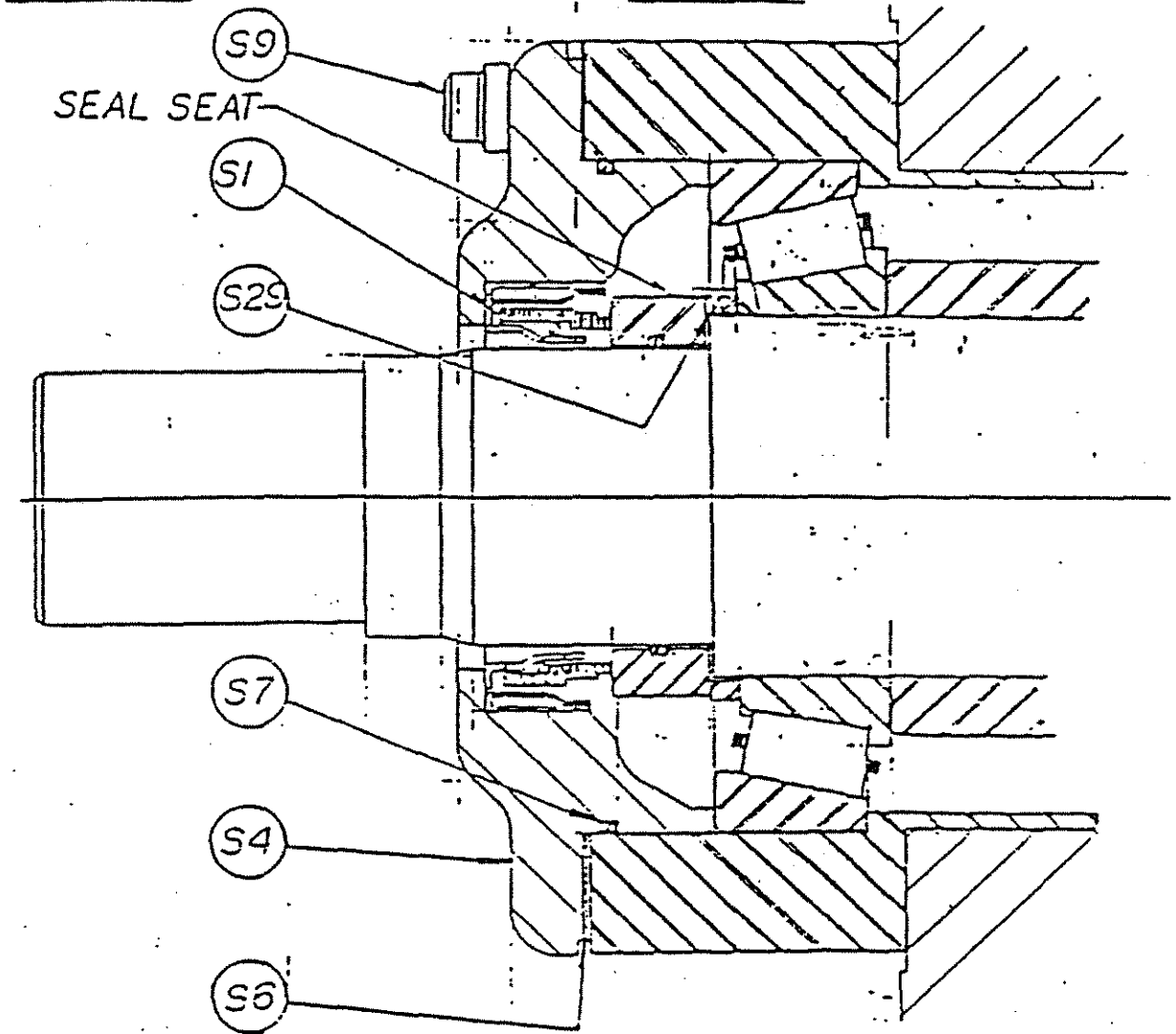
3. Install seal over input shaft. Use only hand force to install. Seal should come to rest up against seal spacer (S29).
4. Install seal assembly as follows: Coat the seal cover (S4) bore lightly with lube kit 001901A. Unwrap seal (S1). Install seal (S1) into bore of seal cover (S4) using Sullair seal repair press tool (P/N 232958). Note: This tool is also used in removing oil seal from cover by using the opposite side.

IMPORTANT

SEAL ASSEMBLY (S1) MUST BE STARTED SQUARELY INTO BORE OF SEAL COVER (S4) BY HAND FORCE AGAINST THE LAPPED CARBON FACE. IF SEAL BECOMES LOCKED IN BORE, REMOVE AND START OVER; EXCESSIVE FORCE SHOULD NOT BE NECESSARY. EXTREME CAUTION MUST BE EXERCISED NOT TO DAMAGE THE LAPPED CARBON SURFACE AND TO KEEP IT CLEAN. KEEP FINGERS OFF THE LAPPED CARBON SURFACE.

5. Reinstall the shim pack (S6) which was removed in paragraph 2-1. If different housing is used, follow the instructions for setting shim endplay as described in the warning note immediately following paragraph 2-1.
6. Coat lapped surface of seal (S1) in seal cover (S4). Install seal cover (S4) over the shaft. Line up the bolt holes until shim pack (S6) and seal cover flange are flush against gear housing. NOTE: Seal cover (S4) and shim pack (S6) to be flush against adapter housing on belt-driven models. Hold housing into position with one hand while screws (S5) or (S29) are installed. Torque screws to 18 ft./lbs.

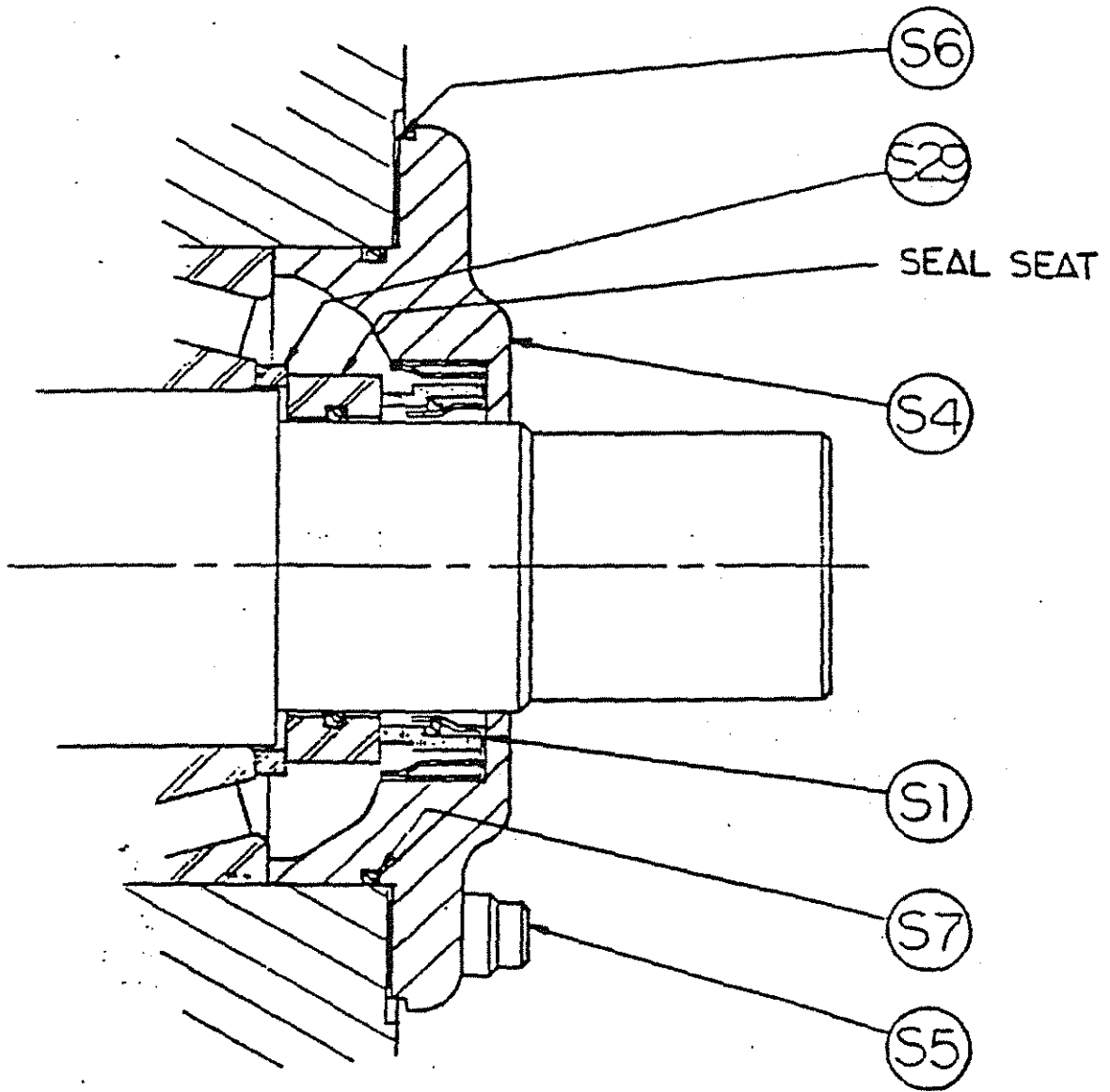
6.5 Shaft Seal Replacement (Figure 6.1)



OPTIONAL DRIVE

6.10 Shaft Seal Replacement (continued)

FIGURE 6-1 Shaft Seal Assembly



6.5 Shaft Seal Replacement - PD16, PD20

PREPARATION

1. Carry out the shutdown procedure in Section 6.2.

WARNING

MAKE SURE THAT THE STARTER IS DISCONNECTED BEFORE ANY WORK IS PERFORMED ON ELECTRIC-DRIVEN COMPRESSORS.

2. Remove the coupling guard, coupling spacer and coupling hub from the compressor shaft.

Service of PD16, PD20 Units - Refer to Figure 6-1.a and 6-1.b.

DISASSEMBLY

1. Disconnect oil connection from seal housing (S3) on PD20 unit, seal cover (4) on PD16 unit.
2. Remove screws (S19) and remove shaft seal cover (S4). The adhesive under the flange can be broken loose by screwing screw (S19) in 3/8 - 16 UNC puller hole in seal cover.
3. Remove seal (S11) and (S12) from the shaft. The rubber bellows are bonded to the shaft and have to be broken loose by pushing the whole seal further down the shaft. If tools are used care should be taken that the shaft is not scratched or damaged. When the bond is broken the seal can easily be removed.
4. Remove screws (S6) and remove seal housing (S3). The adhesive under the flange can be broken loose by screwing screw (S19) in the 3/8 - 16 UNC puller hole in seal housing.
5. Remove seats from both the seal cover (S4) and seal housing (S3) by first removing snap ring (S13). Then lay machined edge of cover and housing on flat surface and push stationary ring out of cover and housing by tapping on exposed part of ring with punch or similar tool.
6. If pins (S14) are sheared or bent, remove from seal cover (S4) and seal housing (S3) by using a punch or similar tool.

INSPECTION & PREPARATION FOR SEAL ASSEMBLY

1. Clean all parts thoroughly and scrape off any old adhesive material on the housing and mating parts.
2. Check the bore edges of the seal cover (S4) and seal housing (S3) for burrs, break any sharp edges found in the seal housing, and clean part. Make sure oil supply orifices in cover are open and threads are clean.

6.5 Shaft Seal Replacement (continued)

3. Check the shaft for any burrs on sharp edges and remove all burrs and break all sharp edges.

WARNING

BE CAREFUL NOT TO LET ADHESIVE GET INTO THE EXPOSED BEARING.

NEW SEALS MUST SLIDE OVER THE SHAFT. ANY SHARP EDGES WILL CUT THE SEAL; THEREFORE, THE EDGES MUST BE ROUNDED OFF OR BROKEN.

4. Clean the shaft thoroughly with fine emery cloth to remove any dirt, metal particles, etc.

INSTALLATION

1. Install the seal housing seat as follows:

1-1 If a new pin (S14) is required, install in seal housing (S3) by tapping with a hammer.

1-2 Lightly coat the bore of the seal housing with lubricant provided in lube kit 001901a.

1-3 Unwrap the seat.

WARNING

THE FINISH OF THE LAPPED FACE IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. THE LAPPED FACE CAN BE IDENTIFIED BY ITS HIGHLY POLISHED SURFACE. COAT WITH LUBRICANT PROVIDED IN LUBE KIT 001901A. KEEP FINGERS OFF THE LAPPED SURFACE.

1-4 Install seat into bore of seal housing (S3) with lapped surface facing the outside of the compressor. Check to make sure seat fits over the pin.

1-5 Install snap ring (S13) using a pair of snap ring pliers.

2. Install ~~new adhesive~~ against the flange of the seal housing (S3).

3. Install seal housing (S3) over shaft and line up bolt holes. Push down ~~squarely~~ and slowly against the seal housing until flange contacts inlet housing. Hold the housing in position with one hand while the screws (S6) are installed. Torque the screws (S6) to 95 ft.-lbs. on the PD20 unit; 40 ft.-lbs. on the PD16 unit.

6.5 Shaft Seal Replacement (continued)

4. Install the seal assembly as follows:

- 4-1 Coat the shaft with lubricant provided in lube kit 001901A.
- 4-2 Unwrap seal assembly. Coat ID of bellows and lapped face with lubricant provided in lube kit 001901A.
- 4-3 Install seal assembly as follows: slide first seal on shaft (with lapped carbon surfaces facing inside) until it contacts seat. Slide spring on shaft until it contacts seal. Slide second seal on shaft (with lapped carbon surface facing out) until it contacts spring.

WARNING

SEAL ASSEMBLY MUST BE STARTED SQUARELY OVER SHAFT BY HAND FORCE AGAINST THE LAPPED CARBON FACE. IF THE SEAL ASSEMBLY BECOMES LOCKED ON THE SHAFT, REMOVE AND START OVER. EXCESSIVE FORCE SHOULD NOT BE NECESSARY. EXTREME CAUTION MUST BE EXERCISED NOT TO DAMAGE THE LAPPED CARBON SURFACE AND TO KEEP IT CLEAN. KEEP FINGERS OFF THE LAPPED SURFACE.

5. Install seal cover seat as follows:

- 5-1 If a new pin (S14) is required, install in seal cover (S4) by tapping with a hammer.
- 5-2 Lightly coat the bore of the seal cover with lubricant provided in lube kit 001901a.
- 5-3 Unwrap the seat.

WARNING

THE FINISH OF THE LAPPED FACE IS EASILY DAMAGED AND MUST BE HANDLED CAREFULLY. THE LAPPED FACE CAN BE IDENTIFIED BY ITS HIGHLY POLISHED SURFACE. COAT WITH LUBRICANT PROVIDED IN LUBE KIT 001901A. KEEP FINGERS OFF THE LAPPED SURFACE.

- 5-4 Install seat into bore of seal cover (S4) with lapped surface facing the inside of the compressor. Check to make sure seat fits over the pin.
 - 5-5 Install snap ring (S13) using a pair of snap ring pliers.
6. Install adhesive against the flange of the seal cover (S4).

6.5 Shaft Seal Replacement (continued)

7. Install seal cover (S4) over the shaft and line up the bolt holes. Push down squarely and slowly against the seal assembly until cover flange contacts seal housing. The seal will then be at proper operating height. Hold the cover in position with one hand while the screws (S19) are installed. Torque the screws (S19) to 40 ft.-lbs.

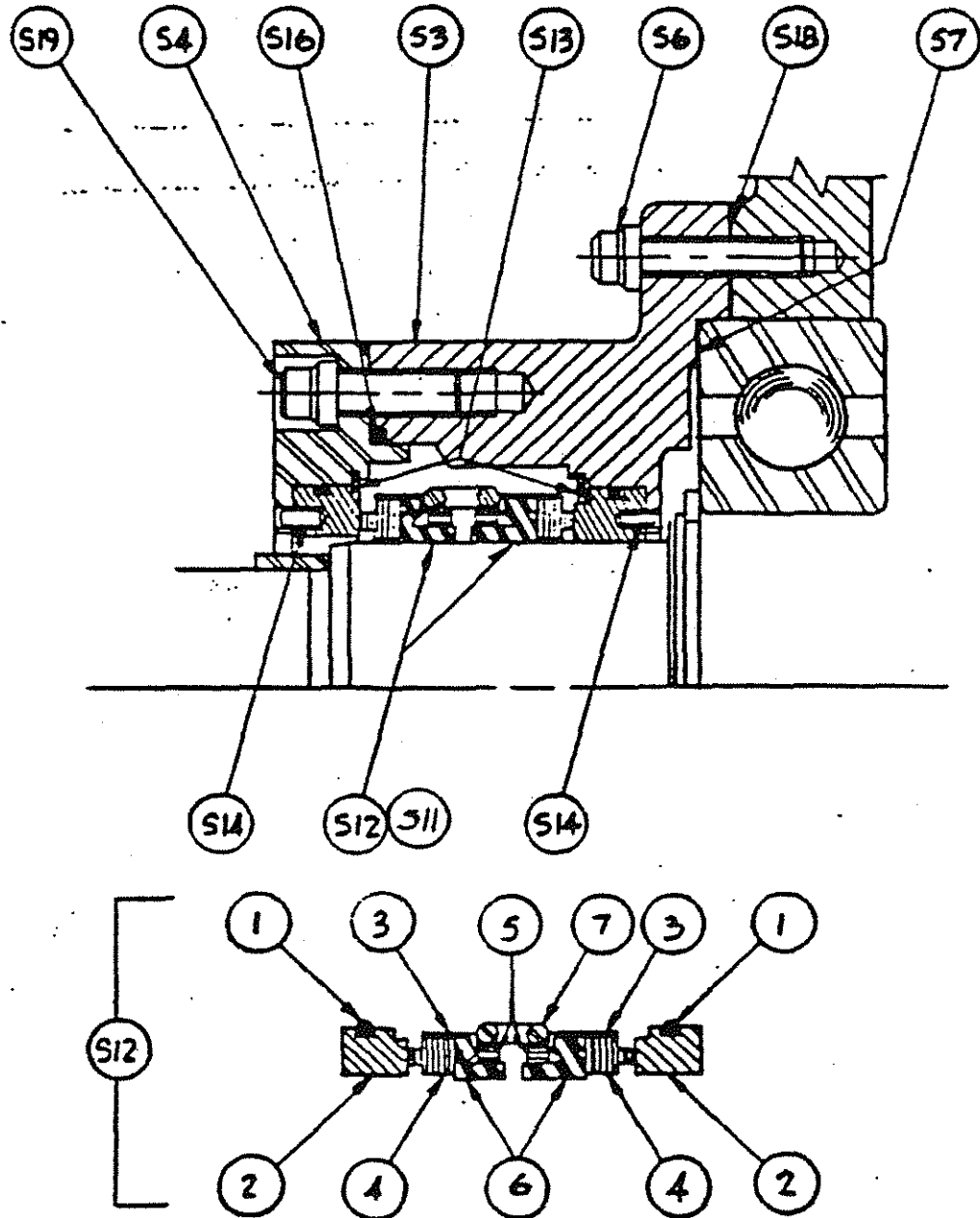
WARNING

THE SEAL COVER (S4) MUST BE HELD IN POSITION UNTIL THE SCREWS (S19) ARE INSTALLED SINCE RELEASING THE HOUSING MAY ALLOW THE SPRING FORCE TO PUSH THE RUBBER BELLOWS (6) OUT OF POSITION. IF THE BELLOWS (6) GRIP THE SHAFT WHILE OUT OF POSITION, IT WILL NOT ALLOW THE SPRING TO EXERT THE CORRECT PRESSURE BETWEEN THE LAPPED FACES. THIS WILL RESULT IN SEAL FAILURE WITHIN A SHORT PERIOD OF TIME.

8. Reconnect the oil line to seal housing (S3).

6.5 Shaft Seal Replacement (continued)
- PD20 Compressor -

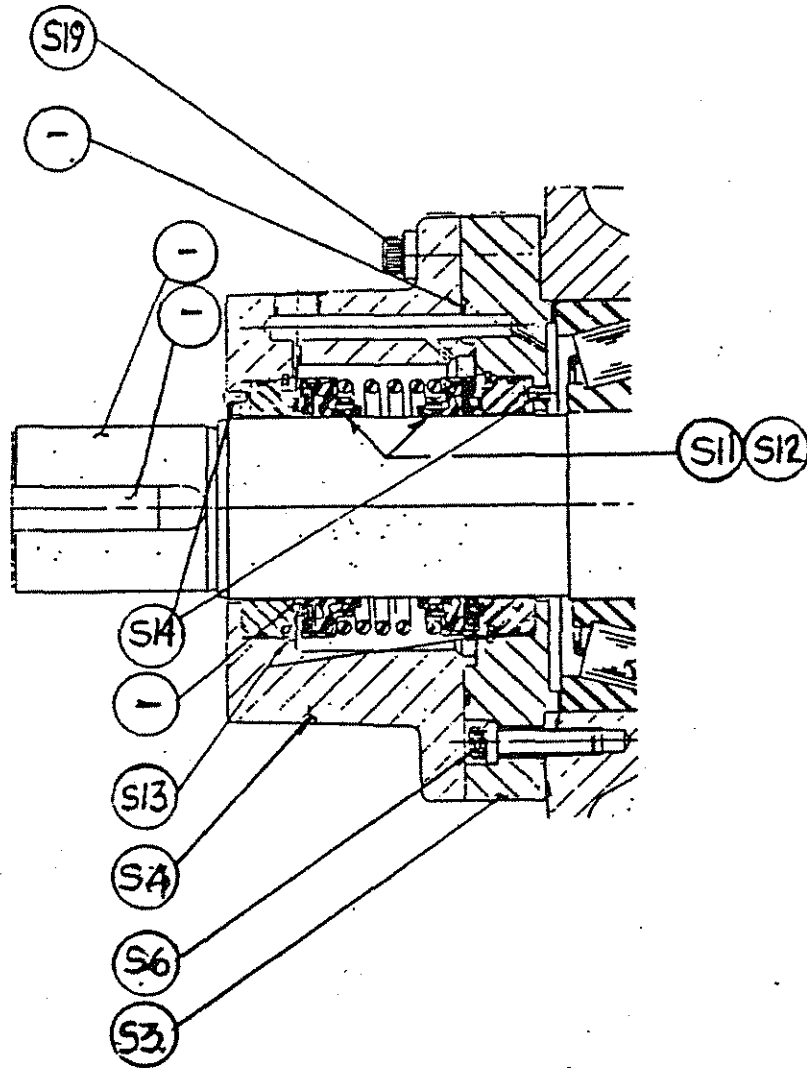
Figure 6-1A Shaft Seal Assembly



6.5 Shaft Seal Replacement (continued)

- PD16 Compressor -

Figure 6-1B



6.6 Compressor Unit Replacement

Should replacement of the Sullair compressor unit be necessary, the following procedures will ensure correct replacement and minimize down time. Contact Sullair Service Department immediately, to determine if compressor replacement is required, with unit part and serial numbers.

They will also assist in the ordering of the new unit and scheduling of Sullair Servicemen if required.

REMOVAL

1. Carry out the shutdown procedure in Section 6.2.
2. Remove tubing in large sub-assemblies. This will save time and confusion when installing the new unit. Avoid bending the tubing assemblies. In most cases, the assemblies will fit the new unit.
3. When removing the old unit, install temporary pipe hangers to facilitate installation of the new unit.
4. Return the old unit to Sullair in the same crate in which the replacement was shipped.

INSTALLATION

1. Change the lube filter cartridge and thoroughly clean every lube strainer.
2. Thoroughly clean all tubing and piping with solvent and brush before refitting to compressor.
3. Reconnect the tubing and piping as originally installed. If tubing is to be replaced, do so with correct size only.
4. Follow the pressure test procedure, Section 3.5.
5. Evacuate the pressure in the system by opening the blowdown valve on the lube separator.
6. Follow the alignment procedure, Section 3.6.
7. Drain and discard all the lubricant from the package by opening the drain valve on the bottom of the lube separator and then removing drain plugs from the bottom of the lube cooler and the bottom of the compressor stator.
8. Replace the drain plugs, close the lube separator drain valve and charge the system with new lubricant.
9. Follow the pre-start check list, Section 4.2.
10. Follow the initial start-up procedure, Section 4.3.
11. Follow the initial maintenance procedures as for a new machine, Section 5.3.

6.7 Lube Pump Servicing (PD16 & PD20 Units Only)

Refer to Figure 6.3

PREPARATION

1. Carry out the shutdown procedure in Section 6.2.
2. Remove the connecting pipework on either side of the pump (2).

DISASSEMBLY

1. Remove 3/8 x 1 capscrews (8) and lay aside for future use.
2. Pull oil pump (2) straight out from compressor unit. NOTE: Pump must be returned to factory for credit.

INSPECTION

1. Inspect drive assembly to determine if all pieces of shear pin are still in the drive assembly. NOTE: Missing pieces will require removing the outlet cover to recover the broken parts.

Inspect end of rotor to check that dowel pin (6) is intact. NOTE: Replace the bearing retainer (10) and the dowel pin (6) only in the event the pin has also been broken.

REASSEMBLY

1. Install drive assembly on the shaft of pump assembly (2).
2. Insert set screws (2) in the drive assembly but do not tighten.
3. Adjust drive assembly to provide a minimum of 1/32" clearance with the end of the shaft of the pump assembly (2).
4. Torque set screws (1) to 9 ft-pounds.
5. Install O-ring (9) over pump assembly (2).
6. Line up slot in drive assembly with dowel pin (6). Insert drive assembly over dowel pin (6) and install capscrews (8) to retain the pump assembly.
7. Torque capscrews to 35 ft-pounds.
8. Connect fluid lines.

ADJUSTMENT

1. Check to make sure pump assembly fits flush with the housing.
2. Turn unit over by hand. Unit should turn easily.

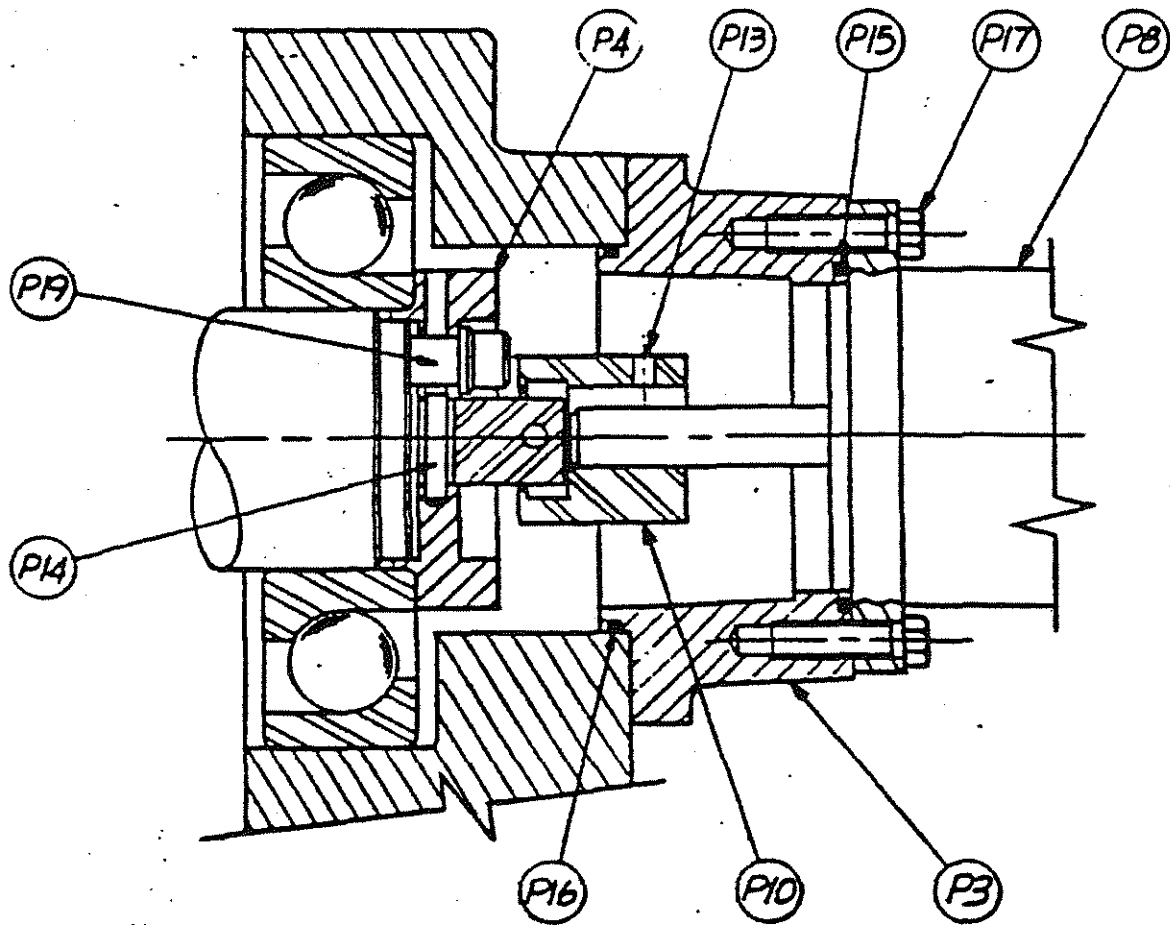
6.7 Lube Pump Servicing (Con't)

PREPARATION FOR START-UP

1. Reconnect oil lines to pump.
2. Close the blowdown valve.
3. Open the suction stop valve and discharge stop valve.
4. Reconnect the control panel to the air line.
5. Engage driver power/fuel.
6. Start the compressor.

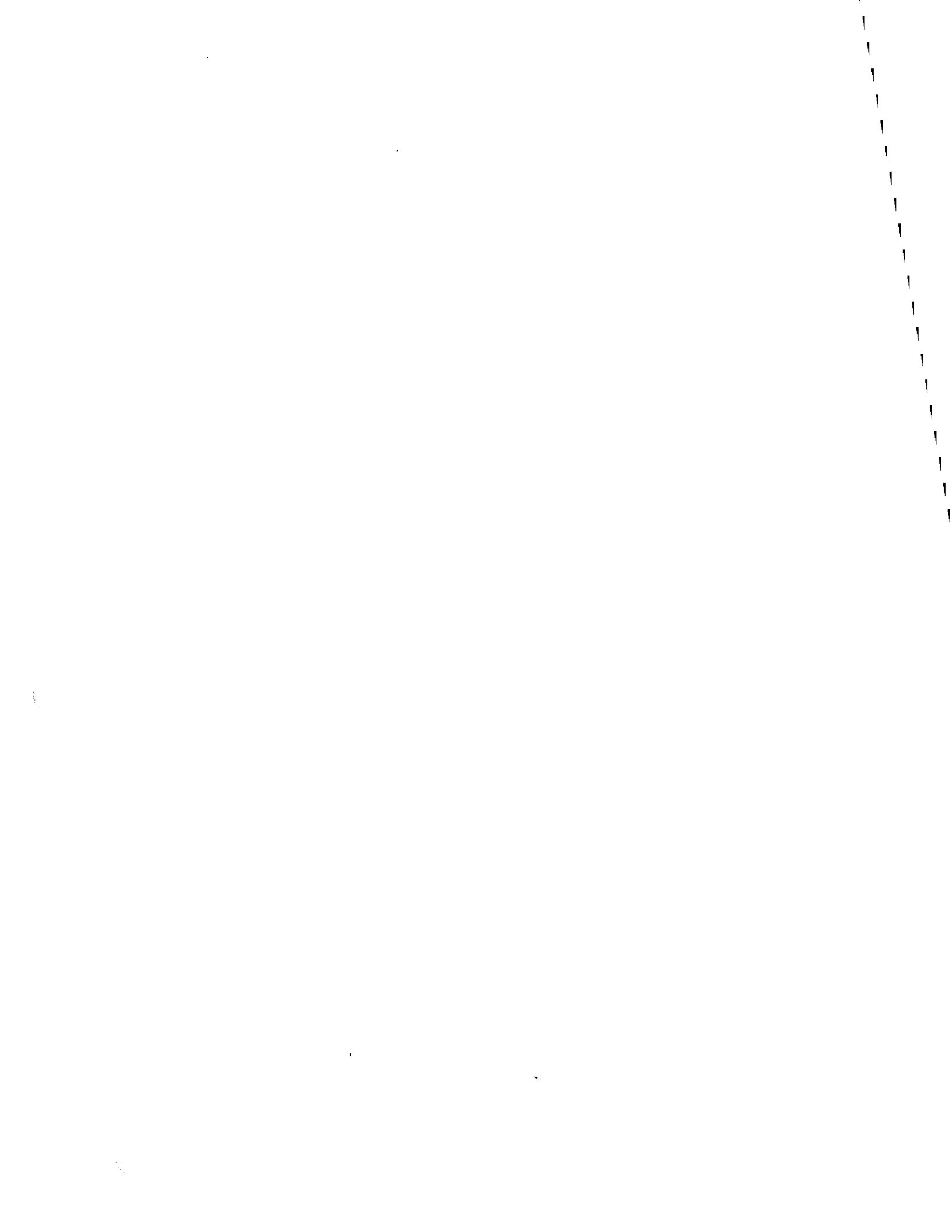
6.10 Lube Pump Servicing (continued)

Figure 6-4

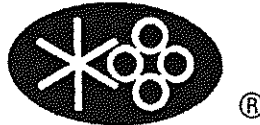


SECTION 7

RECOMMENDED SPARE PARTS LIST, VENDOR DATA AND CATALOGS



WORLDWIDE SALES AND SERVICE



SULLAIR ASIA, LTD.
Sullair Road, No. 1
Chiwan, Shekou
Shenzhen, Guangdong PRV.
P.R.C. Post Code 518068
Telephone: 755-6851686
FAX: 755-6853473

SULLAIR EUROPE, S.A.
Zone Des Granges BP 82
42602 Montbrison Cedex, France
Telephone: 33-477968470
Fax: 33-477968499

SULLAIR CORPORATION
Subsidiary of Sundstrand Corporation
3700 East Michigan Boulevard
Michigan City, Indiana 46360 U.S.A.
Telephone: 1-800-SULLAIR (U.S.A. Only) or
1-219-879-5451
FAX: (219) 874-1273
FAX: (219) 874-1835 (Parts)
FAX: (219) 874-1805 (Service)

Part Number



02250051-524



Printed in U.S.A.

Specifications Subject To
Change Without Prior Notice

E97



Rotary Screw Gas Compressors

Job Description:
Customer Name: Kelt

Job/Run Ref No: 20711 re:100421
Customer Ref No:

RESULTS (Rating at Given Conditions)

Capacity Loading	100.0	100.0	%
Volume Flow Predicted	0.494	0.494	mmscfd
Mass Flow Predicted	18.9	18.9	lb/min
Power Required	149.5	149.5	bhp
Torque Required	436.3	436.3	ft-lb
Efficiency, Volumetric	NA	70.7	%
Efficiency, Adiabatic	NA	51.5	%
Oil Flow, Total	31.9	31.9	USgpm
Oil Flow, Brgs & Gears	6.8	6.8	USgpm
Oil Flow, Injection	25.2	25.2	USgpm
Heat Load, Oil Cooler	5,056	5,056	Btu/min
Heat Load, Aftercooler	644	644	Btu/min

SITE CONDITIONS

Elevation Above Sea Level	2500 feet
Barometric Pressure	13.400 psia

PRESSURES

Suction Flange, Skid	0.00 psig
Suction Loss, Skid	1.50 psi
Suction Flange, Compr	-1.50 psig
Discharge Flange, Compr	157.00 psig
Discharge Loss, Skid	7.00 psi
Discharge Flange, Skid	150.00 psig
Pressure Ratio, Compressor	14.32
Pressure Loss, Oil System	10.00 psi

COMPRESSOR

PDR20X

Rotor Diameter	204.0 mm
Male Rotor L/D	2.20
Volume Ratio Type	Fixed
Internal Volume Ratio (Vi)	3.6
Ideal Volume Ratio	8.49
Internal Gear Ratio	1.04
Compressor Input Speed	1800 rpm CW
Displacement	0.3205 ft ³ /rev
Male Rotor Tip Speed	20.0 m/s
Maximum Discharge Pressure	175 psig
Minimum Manifold Pressure	73 psig

TEMPERATURES

Ambient Air	90.0 °F
Compressor Suction	60.0 °F
Compressor Discharge	200.0 °F
Aftercooler Outlet	130.0 °F
Compressor Injection Oil	160.0 °F

GAS PROPERTIES (given Specific Gravity)

Specific Gravity	0.720
Mole Weight	20.808
Specific Heat Ratio, Cp/Cv	1.244
Specific Heat, Cp	0.486 Btu/lb/°F
Inlet Compressibility	0.997

DRIVER

Available Motor Power	200 bhp
Actual Motor Loading	74.8 %
Actual Motor Speed	1800 rpm
Gearbox Ratio	1.000

COMPRESSOR OIL

POLYGLYCOL 115

Solubility of Gas in Oil	Low (0%-10% by wt)
Diluted Oil Viscosity	25 cSt
Density	62.131 lb/ft ³
Specific Heat, Cp	0.474 Btu/lb/°F

STATUS: Application requires PAA.

NOTICES:

No warranty or guarantee, either implied or expressed, is given on results from this program.

Data and procedures in this program are subject to change by Sullair Corp. without notice.

Accuracy of full-load compressor capacity and power predicted by this program is within +/-5% at the specified operating conditions. Part-load performance is estimated and has no tolerance.

PRODUCT APPLICATION ANALYSIS (PAA) BY SULLAIR:

Sullair has the right to verify all applications and performance estimates prior to order acceptance.

An application will require PAA prior to order acceptance if any Formal Limit is violated but the corresponding PAA Limit is not violated.

Any PAA limit violation precludes both Product Application Analysis and application acceptance by Sullair.

All applications with H2S or CO2 require approval by Sullair Corp. prior to order acceptance.

All engine-driven applications require torsional analysis by the compressor skid packager.



Rotary Screw Gas Compressors

Job Description:
Customer Name:

Job/Run Ref No: 20711 100421 1.24-4.
Customer Ref No:

RESULTS (Rating at Given Conditions)

Capacity Loading	100.0	100.0	%
Volume Flow Predicted	0.643	0.643	mmscfd
Mass Flow Predicted	24.6	24.6	lb/min
Power Required	159.8	159.8	bhp
Torque Required	466.4	466.4	ft-lb
Efficiency, Volumetric	NA	77.1	%
Efficiency, Adiabatic	NA	62.6	%
Oil Flow, Total	32.6	32.6	USgpm
Oil Flow, Brgs & Gears	6.8	6.8	USgpm
Oil Flow, Injection	25.8	25.8	USgpm
Heat Load, Oil Cooler	5,106	5,106	Btu/min
Heat Load, Aftercooler	956	956	Btu/min

SITE CONDITIONS

Elevation Above Sea Level	2500 feet
Barometric Pressure	13.400 psia

PRESSURES

Suction Flange, Skid	0.00 psig
Suction Loss, Skid	1.50 psi
Suction Flange, Compr	-1.50 psig
Discharge Flange, Compr	157.00 psig
Discharge Loss, Skid	7.00 psi
Discharge Flange, Skid	150.00 psig
Pressure Ratio, Compressor	14.32
Pressure Loss, Oil System	10.00 psi

COMPRESSOR

PDR20X

Rotor Diameter	204.0 mm
Male Rotor L/D	2.20
Volume Ratio Type	Fixed
Internal Volume Ratio (Vi)	4.7
Ideal Volume Ratio	8.49
Internal Gear Ratio	1.24
Compressor Input Speed	1800 rpm CW
Displacement	0.3205 ft ³ /rev
Male Rotor Tip Speed	23.8 m/s
Maximum Discharge Pressure	175 psig
Minimum Manifold Pressure	78 psig

TEMPERATURES

Ambient Air	90.0 °F
Compressor Suction	60.0 °F
Compressor Discharge	200.0 °F
Aftercooler Outlet	120.0 °F
Compressor Injection Oil	160.0 °F

GAS PROPERTIES (given Specific Gravity)

Specific Gravity	0.720
Mole Weight	20.808
Specific Heat Ratio, Cp/Cv	1.244
Specific Heat, Cp	0.486 Btu/lb/°F
Inlet Compressibility	0.997

DRIVER

Available Motor Power	200 bhp
Actual Motor Loading	79.9 %
Actual Motor Speed	1800 rpm
Gearbox Ratio	1.000

COMPRESSOR OIL

POLYGLYCOL 115

Solubility of Gas in Oil	Low (0%-10% by wt)
Diluted Oil Viscosity	25 cSt
Density	62.131 lb/ft ³
Specific Heat, Cp	0.474 Btu/lb/°F

STATUS: Application requires PAA.

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All applications with H2S or CO2 require approval by Sullair Corp. prior to order acceptance.

All engine-driven applications require torsional analysis by the compressor skid packager.



Rotary Screw Gas Compressors

Job Description:
Customer Name:

Job/Run Ref No: 20711 (100423) 0-175
Customer Ref No:

RESULTS (Rating at Given Conditions)

Capacity Loading	100.0	100.0	%
Volume Flow Predicted	0.626	0.626	mmscfd
Mass Flow Predicted	23.9	23.9	lb/min
Power Required	176.0	176.0	bhp
Torque Required	513.4	513.4	ft-lb
Efficiency, Volumetric	NA	75.1	%
Efficiency, Adiabatic	NA	59.1	%
Oil Flow, Total	36.9	36.9	USgpm
Oil Flow, Brgs & Gears	7.4	7.4	USgpm
Oil Flow, Injection	29.5	29.5	USgpm
Heat Load, Oil Cooler	5,834	5,834	Btu/min
Heat Load, Aftercooler	931	931	Btu/min

SITE CONDITIONS

Elevation Above Sea Level	2500 feet
Barometric Pressure	13.400 psia

PRESSURES

Suction Flange, Skid	0.00 psig
Suction Loss, Skid	1.50 psi
Suction Flange, Compr	-1.50 psig
Discharge Flange, Compr	182.00 psig
Discharge Loss, Skid	7.00 psi
Discharge Flange, Skid	175.00 psig
Pressure Ratio, Compressor	16.42
Pressure Loss, Oil System	10.00 psi

COMPRESSOR

PDR20X

Rotor Diameter	204.0 mm
Male Rotor L/D	2.20
Volume Ratio Type	Fixed
Internal Volume Ratio (Vi)	4.7
Ideal Volume Ratio	9.48
Internal Gear Ratio	1.24
Compressor Input Speed	1800 rpm CW
Displacement	0.3205 ft ³ /rev
Male Rotor Tip Speed	23.8 m/s
Maximum Discharge Pressure	175 psig
Minimum Manifold Pressure	84 psig

TEMPERATURES

Ambient Air	90.0 °F
Compressor Suction	60.0 °F
Compressor Discharge	200.0 °F
Aftercooler Outlet	120.0 °F
Compressor Injection Oil	160.0 °F

GAS PROPERTIES (given Specific Gravity)

Specific Gravity	0.720
Mole Weight	20.808
Specific Heat Ratio, Cp/Cv	1.244
Specific Heat, Cp	0.486 Btu/lb/°F
Inlet Compressibility	0.997

DRIVER

Available Motor Power	200 bhp
Actual Motor Loading	88.0 %
Actual Motor Speed	1800 rpm
Gearbox Ratio	1.000

COMPRESSOR OIL

POLYGLYCOL 115

Solubility of Gas in Oil	Low (0%-10% by wt)
Diluted Oil Viscosity	25 cSt
Density	62.131 lb/ft ³
Specific Heat, Cp	0.474 Btu/lb/°F

STATUS: Application requires PAA.

NOTICES:

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All engine-driven applications require torsional analysis by the compressor skid packager.



2. Driver



Instructions For Three Phase Induction Motors

**Large Cast Iron Frame Type
IEC Frame 280 (NEMA Frame 444) and above**



INDEX

Page

1. INTRODUCTION.....	3
1.1 General.....	3
1.2 Serial number of the machine	4
1.3 Mounting.....	4
1.4 Direction of rotation.....	4
2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION	5
2.1 Inspection upon receipt	5
2.2 Storage.....	5
2.3 Transportation.....	10
3. INSTALLATION.....	11
3.1 Site and environment for motor installation.....	11
3.2 Foundation.....	11
3.3 Installation of shaft coupling.....	14
3.4 Installation for belt drive.....	19
3.5 Conveyance with chain or gear	20
3.6 Electrical connections	21
4. OPERATION.....	23
4.1 Examination before start.....	23
4.2 Starting operation	29
5. MAINTENANCE	34
5.1 Major points in regular inspection and maintenance	34
5.2 Motor windings	35
5.3 Clean the interior of the motor	35
5.4 Clean the exterior of the motor	36
5.5 Maintenance of anti-friction bearing	38
5.5.1 Frequency of relubrication	38
5.5.2 Kinds of grease.....	38
5.5.3 Grease quantity	40
5.5.4 Re-greasing	40
5.5.5 Oil relubrication (For oil lubrication types only).....	41
5.5.6 Cleaning and installation of bearings.....	42
5.6 Maintenance of sleeve bearing	43
5.6.1 Daily inspections.....	43
5.6.2 Regular examination	43
5.6.3 Disassembly	44
5.6.4 Reassembly	45

5.6.5 Oil viscosity for vertical motors.....	46
5.7 Maintenance of slip ring (For Wound Rotor only).....	47
5.8 Maintenance of non-reverse ratchet mechanism	49
5.9 Dismantling and Assembly Procedure	50
5.10 Records of operation and maintenance.....	51
6. FAULT FINDING AND RECOGNITION	52
7. RECYCLE	54
Appendix 1. Daily inspection.....	57
Appendix 2. Monthly inspection	58
Appendix 3. Regular Inspection	59
Appendix 4. Typical motor cross sectional drawings : SCIM, TEFC.....	62
Appendix 5. Typical motor cross sectional drawings : ODP	63
Appendix 6. Typical motor cross sectional drawings : SCIM, TEWC	64
Appendix 7. Typical ball bearing construction drawing	65
Appendix 8. Typical roller bearing construction drawing	66
Appendix 9. Typical ball bearing with insulation bushing construction drawing	67
Appendix 10. Typical thrust bearing assembly drawing (vertical machine)	68
Appendix 11. Sleeve bearing construction	69
Appendix 12. Mounting of Insulated Sleeve Bearings	71
Appendix 13. Shaft earth brush assembly drawing (TAC)	72
Appendix 14. Shaft earth brush assembly drawing (TECO).....	73
Appendix 15. Bolt Torque (kg-cm)	74
Appendix 16. TECO Worldwide Operations.....	75

1. INTRODUCTION

1.1 General

This and the following instructions address the more common situations encountered in motor installation, operation and maintenance. For the TECO motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions, and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of contact with live electrical and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transport, assembly, operation, etc.... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should however be considered and checked.

- Technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- General erection and safety regulations.
- Local (job site) and plant-specific specifications and requirements.
- Proper use of transport, lifting devices and tools.
- Use of personal protective equipment.

The following safety indications should be observed when reading these instructions:



Electric Hazard.



Danger.

ATTENTION !

Warning of possible damage to the motor or installation.

This instruction manual is for **TECHNICAL USE ONLY, NOT FOR COMMERCIAL PURPOSE**. The warranty is limited to coverage expressed in your sales contract. Documentation of storage, transportation, installation and examination, if required, shall be obtained from TECO-Westinghouse service centers before start and maintenance.

1.2 Serial number of the machine

Each electric motor is identified with a serial number. It has been stamped on a main name plate which is attached on the frame by rivets. This serial number is very important as an index for tracking this motor's history.

1.3 Mounting

In this instruction manual, the arrangements for most of the electric motor are as follows:

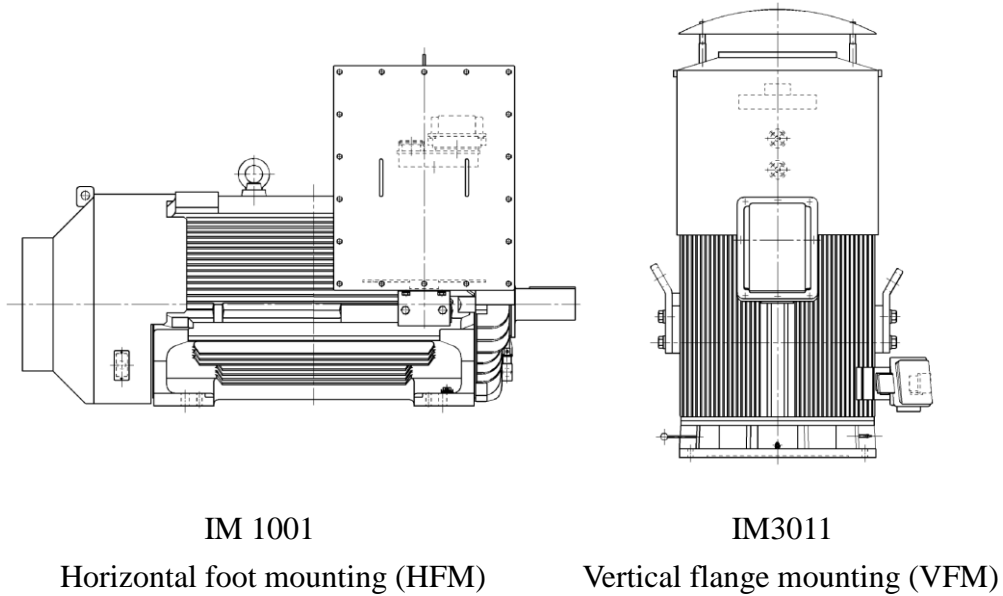


Fig. 1 Mounting arrangement

1.4 Direction of rotation

The arrow on the direction nameplate indicates the direction of the rotation of the Rotor, looking in front of the DE-Shaft-end.

The motor must be operated just on the plate shown direction.

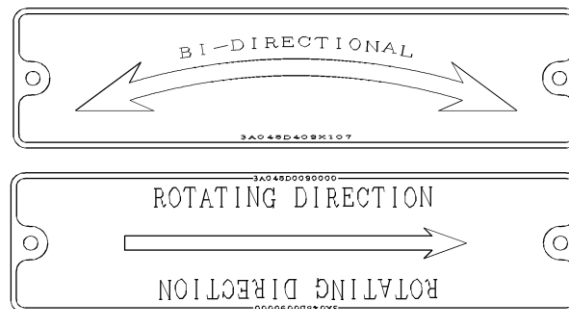


Fig. 2 Direction nameplate

ATTENTION !

Operating the motor in the incorrect direction may cause serious damage to both the motor and driven equipment.

2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION

2.1 Inspection upon receipt

Check the following points upon receipt :

- Is there any visible damage to the motor or case? Any damage should be photographed, documented and reported to the carrier and TECO-Westinghouse immediately.
- Are the nameplate ratings identical with your confirmed order ?
- Are dimensions and color in compliance with your specifications ?
- Are the nameplate ratings for heater, thermal protector, temperature detector, etc. identical with your confirmed order ?
- Are all accessories and accompanying instruction manuals in good order ?
- Does the arrow head indicate the correct direction of rotation?
- If there are any specific requirements, please ensure they are in conformity with your specification.

2.2 Storage

2.2.1 General

When motors are not in operation, the following precautionary measures must be taken to insure the motors do not suffer deterioration or damage from moisture, dust and dirt, or careless handling. The climate, length of time the equipment is to be stored, and the adequacy of the storage facilities will determine the storage precautions required.

Any deterioration or damage of the motors due to customer's incorrect storage of the motors is not covered by the warranty. This includes all periods of time when the motor is installed on site but has not been placed into operation.

The following procedures must be followed and a maintenance log must be kept to keep from voiding factory warranty. The records are also useful to decide if a motor is suitable or not to be put into service.

2.2.2 Location

The ideal storage area is a clean, heated, and well-ventilated building.

- (a) High and dry, well-ventilated indoor, without exposure to direct sun lights, free from dust, corrosive gas (such as chlorine, sulfur, dioxide, and nitrous oxides) and fumes, and infestation by vermin or insects.
 - (b) The ideal storage temperature range is from 10°C to 50°C (50°F to 125°F)
 - (c) Not close to a boiler or freezer.
 - (d) Entirely free from vibration. Vibration levels above 2.5 mm/s (0.1 in/sec) velocity could damage the bearings and cause "brinelling" of the bearing races.
 - (e) Motors should be put on pallets to prevent moisture from accumulating underneath.
 - (f) Motors should be stored in a heated building, outdoor storage is not suitable for motors. If motors have to be stored outdoors for some reasons, they should be well covered with a tarpaulin and protected from contamination and the elements. Motors should be well shielded from dust, but under well-ventilated circumstances. This should be for a very short period of time (say less than one month) only and the risk of deterioration is the responsibility of the users.
-

2.2.3 Moisture prevention

Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3°C above the dew point temperature by providing either external or internal heat. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor. Check weekly that the space heaters are operating. Incandescent light bulbs can be placed within the motor to provide heat, if the anti-condensation space heaters are not fitted. However, if used, incandescent bulbs must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

2.2.4 Prevent Corrosion and frost damage

When motors are shipped from the factory, the shaft extension and bearing journals on sleeve bearing motors, are covered with a protective coating. This coating should be examined to see that it has not been accidentally removed. The coating should be renewed if there are any signs of corrosion or if the coating has been removed. Care should be taken to keep parts such as fitted surface, key, shaft extension, mounting feet or face, and axial central hole from any collision with foreign matters, and to have rust preventative in place. It is a good practice to seal any shaft openings with silicone, rubber caulking, or tape. If any rust is observed, measures should be taken to remove the rust and protect against it. Grease or anti-corrosion agent should also be generously applied to prevent rusting.

Water-cooled motors or motors using bearings with water-cooling coils, please make sure the water is dried off to prevent tube corrosion or frost damage.

TECO-Westinghouse reserves the right to void warranties based upon evidence of rust or other indications of moisture inside the motor that indicate that the motor was improperly stored.

2.2.5 Insulation resistance test

Even during storage, the insulation resistance should be kept above the specified values.

- (a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 4.1.2 "Measurement of insulation resistance".
- (b) Insulation resistance test should be performed once every three months.
- (c) Resistance measurement of each temperature detector (ex. PT 100Ω/°C) is necessary once every three months.

2.2.6 Long period of idle (storage)

If the motor is not in operation for a long period of time (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

- (a) Protect the motor as measures stated in 2.2.3 and 2.2.4.
 - (b) Insulation resistance test should be performed as stated in 2.2.5.
 - (c) Bearing Protection per 2.2.7.
 - (d) Operation test should be performed once every three (3) months.
-

- (e) If external vibration is present, the shaft coupling should be opened.
- (f) If motors are mounted shaft up, a solid protective plate or shield shall be mounted above the installation if needed.
- (g) If motors are mounted shaft down, drip covers are to be mounted to give satisfactory protection if needed.
- (h) If motors are equipped with drain plugs, they should be removed.
- (i) When motors equipped with brushes, the brushes should be lifted in the brush holder, if there is no protective strip (such as MYLAR) between the brushes and collector rings.
- (j) Water-cooled motors or motors using bearings with water-cooled coils, ensure the water is dried off to prevent tube corrosion or frost damage.
- (k) Storage maintenance must be documented for warranty and reference purposes.

2.2.7 Bearing protection

- (a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor.

It is very important that this brace be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.

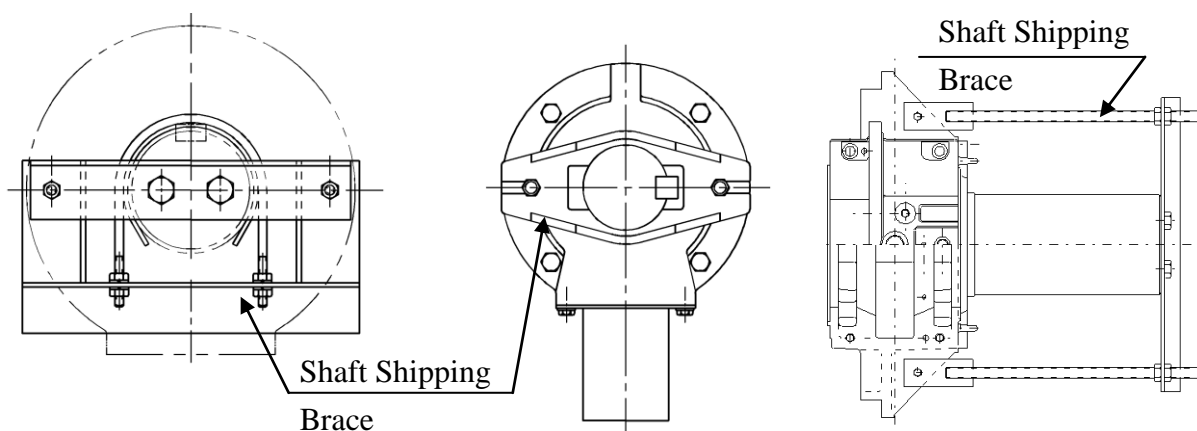


Fig. 3 Shaft shipping brace

- (b) Motors equipped with sleeve bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil. To keep the bearing journals well oiled and prevent rusting, the motor shaft should be rotated several revolutions every month ensuring the shaft does not come to rest in its original position. While the shaft is rotating, it should be pushed to both extremes of the endplay. If the motor is not in operation for over six months, dismount the upper cover of the sleeve bearing housing and check the anti-corrosion protection.

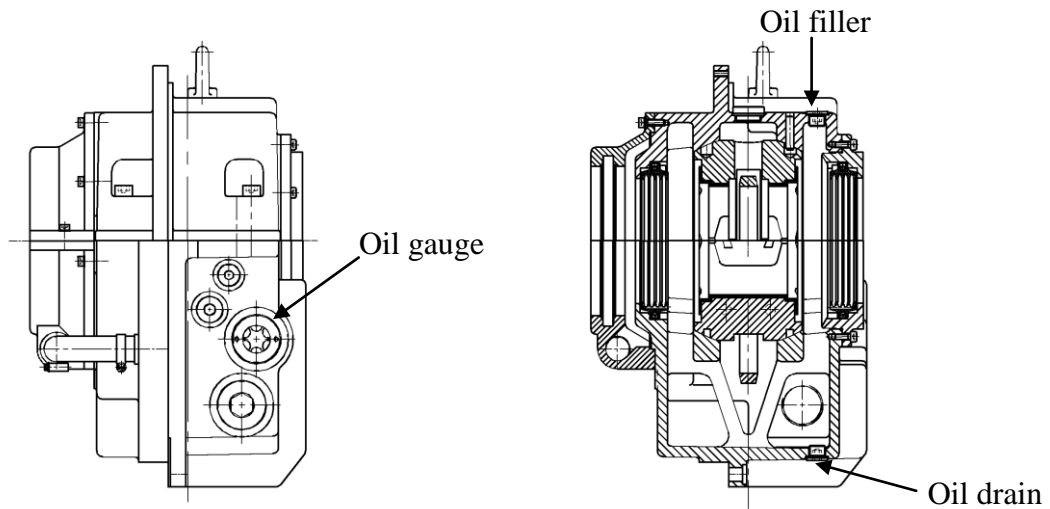


Fig. 4 Sleeve bearing

- (c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. If the motor is not in operation for over three months, add grease to each bearing per lubrication nameplate. The shaft should be rotated several revolutions every month to maintain proper distribution of the grease within the bearings.
- (d) Tilt-pad bearings are a type of sleeve bearing used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage interval, oil must be manually introduced periodically into the pads and housing to prevent the occurrence of oxidation of the precision machined components.
- (1) Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
 - (2) Pour in approximately one cup of oil every month and rotate the shaft a few revolutions every two (2) weeks.
- For long periods of storage, the oil that accumulates in the housing should be removed.
- (e) The bearing assembly parts of motors with oil mist lubrication are put on with anti-rust oil, so they can be preserved for several months in good condition. The motor should be stored indoor and well-ventilated environment and prevent contact with contaminated or corrosive air. The following points should be noted :

- (1) During preservation, the Inpro seal can not prevent moisture from going through into the bearings. Please use the oil mist to lubricate the bearings every two (2) weeks.
 - (2) If the color of flow out oil is changed, the bearing should be rusted or have contamination in it. Please contact TECO-Westinghouse.
 - (3) Avoid using grease as it will plug the vent/drain.
 - (4) All assembly surfaces are painted with seal bonds, do not disassemble them at anytime.
 - (5) Do not remove the plugs in vent/drain to prevent the moisture.
 - (6) Do not apply any force on the Inpro seal to prevent damage.
 - (7) The Inpro seal is a labyrinth type seal. Therefore it can not contain a pressure differential.
- (f) If the storage is over two (2) years, it is recommended that the bearing assembly is dismantled and the bearing parts are inspected before commissioning. Any corrosion has to be removed with fine emery cloth.
- (g) Motors with anti-friction bearings with provisions for oil mist are shipped from factory with the correct grade of grease in the bearings and therefore it is not necessary to hook up the motors to the oil mist system. The shaft should be rotated several revolutions every month to maintain proper distribution of the grease within the bearings. If customers choose to hook up to the oil mist system, all grease must be removed from the bearings.

2.2.8 Removal from storage

After long period of idle or storage, and, prior to energizing the motor, a thorough inspection and megger test of windings is required. The bearings should be inspected for corrosion, brinelling and deformation.

If any of the following conditions pertain, then re-conditioning may be required before putting a motor into service.

- (a) Winding resistance is less than recommended.
- (b) Evidence of rust or other indications of moisture inside the motor.
- (c) Corrosion or brinelling or deformation occurred in bearings.
- (d) Idle or storage longer than the warranty period.
- (e) Idle or storage in dirty or damp surroundings.
- (f) Storage in unheated area where the temperature and humidity fluctuate.
- (g) Idle or storage where it has been subject to vibration, such as from nearby machinery or passing traffic.
- (h) Outdoor storage.
- (i) No maintenance records showing that the storage procedures have been followed.

Any reconditioning required, as noted by the inspections after removal from storage, should be performed prior to putting the motor into service. Such inspection and testing or re-conditioning are available from local TECO-Westinghouse service/facilities. Reconditioning after idle or storage is not covered by factory warranty. Any parts that must be replaced due to damage or deterioration will be at customer's cost.

2.3 Transportation

ATTENTION !

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled, exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported.

Vertical mount type motors should be transported in the vertical position only.



Do not use the hoisting hook/eyebolts to lift more than the motor itself. They are designed to support the motor only.

Make sure the hoisting hook is correctly attached to the eyebolt(s) or lug(s) of the motor and that the eyebolt(s)/lug(s) are fully threaded in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring covers, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.

Do not twist or cross the steel cables. Make sure the eyebolts have been securely threaded with the shoulder flush and the sling angle is correct.

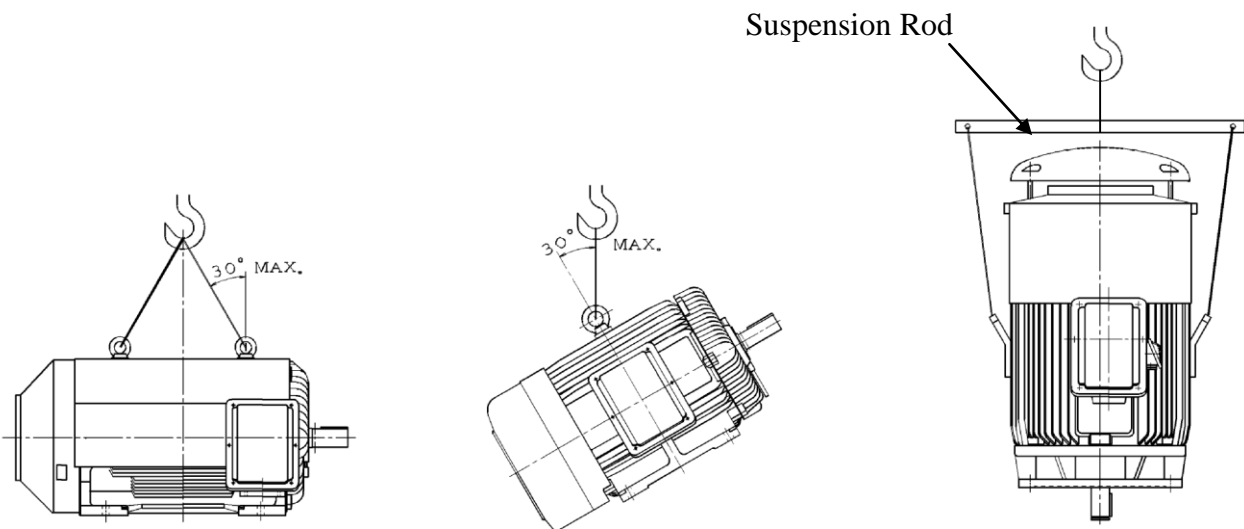


Fig. 5

3. INSTALLATION

3.1 Site and environment for motor installation

3.1.1 General

Standard environment and site conditions for the installation of motors are usually set as follows :

- (a) Ambient temperature : $-20 \sim +40$ °C
- (b) Humidity : Relative humidity shall be below 95%RH for totally-enclosed types, and below 80%RH for semi-enclosed types.
- (c) Elevation : Below 1000 meters.
- (d) Harmful gases, liquids, dusts and high moisture levels should be absent.
- (e) Foundations should be strong and free of vibration.

For water-cooled motors or motors using bearings with water-cooling coils, the ambient temperature must not drop below 5°C (41°F) to prevent frost damage. If there are any special environmental conditions, please inform us at time of order.

3.1.2 Ventilation and space

- (a) Installation area should be well-ventilated.
- (b) The installation space should be large enough to facilitate heat dissipation and maintenance.

3.2 Foundation

Motor manufacturer is not responsible for the foundation design. Motor weight, thrust load, twisting moments, seismic forces and other external applied loads must be considered in foundation design.

3.2.1 Reactions of horizontal motor

For a horizontal motor with four hold down bolts, the reactions necessary for foundation design are as follows – kgs per bolt at centerline of hold down bolt holes :

- (a) Static weight = motor weight / bolt number
- (b) Rated motor torque (T_R) , reactions = motor weight/bolt number $\pm T_R/2L$
- (c) Maximum motor torque (T_{max}) ,
Reactions = motor weight/bolt number $\pm T_{max}/2L$

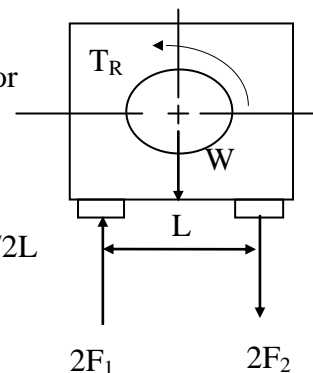


Fig. 6

3.2.2 Soleplate & common bed

Use rigid and solid soleplate or common bed as foundation.

ATTENTION !

For best motor performance, it is advisable to use a sole plate or common bed, particularly when using direct coupling.

If the sole plate or common bed does not have enough stiffness, the critical speed of motors or equipment will then be affected. This change may cause a large vibration (resonance) and decrease the life of the machines.

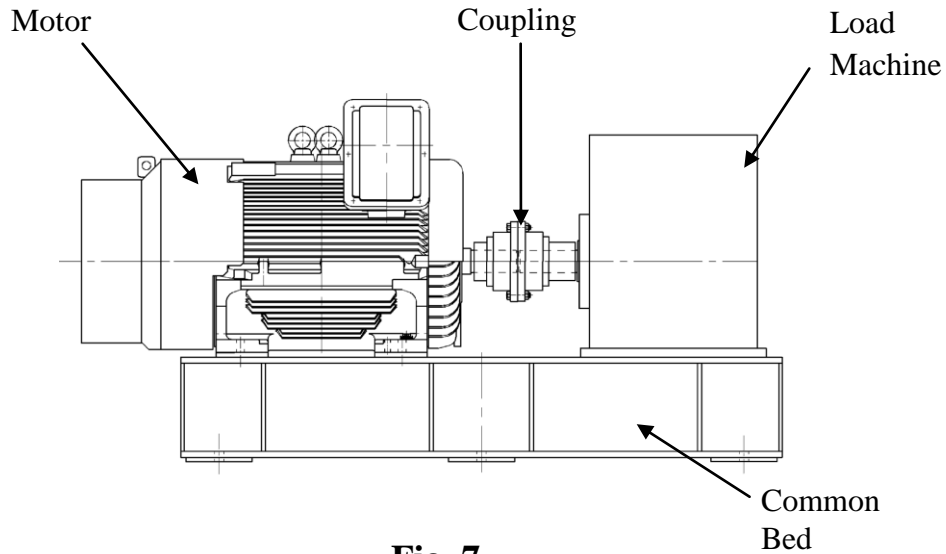


Fig. 7

3.2.3 Installation

- (a) Select an appropriate foundation surface for the soleplate or common bed which will be considered the ultimate level.
- (b) Align the position of the common bed with reference to that level at a minimum of four points. The accuracy should be within 0.04mm (1.5mil).
- (c) Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig.8. Stiff pads should also be installed beneath the wedges which are welded together at various spots about 400-500mm (15-20inches) apart to enable the foundation to evenly carry the weight of the whole motor.
- (d) The base should be sturdy and rigid to keep it flat and level.
- (e) Make sure the mortar and concrete are completely dry and the precision of the level is acceptable, then set the motor on the mounting foundation.
- (f) After accurately install shaft couplings, weld the wedges to prevent soleplate or common bed moving.

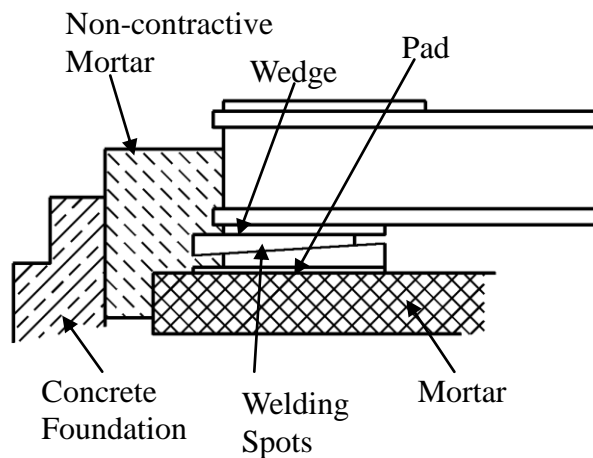


Fig. 8

3.2.4 The foundation of vertical induction motor (Also the foundation of pump)

- (a) Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
- (b) A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig.9 and Fig.10.

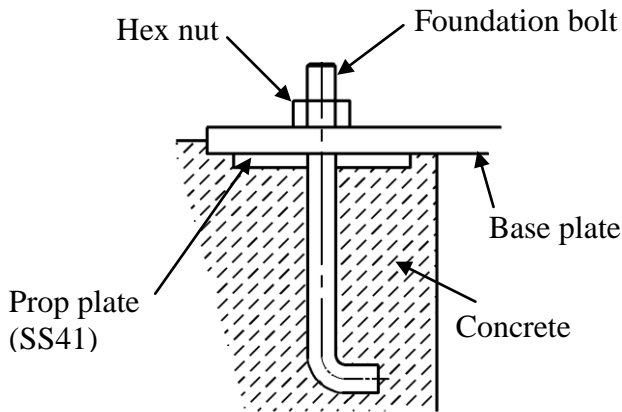


Fig. 9

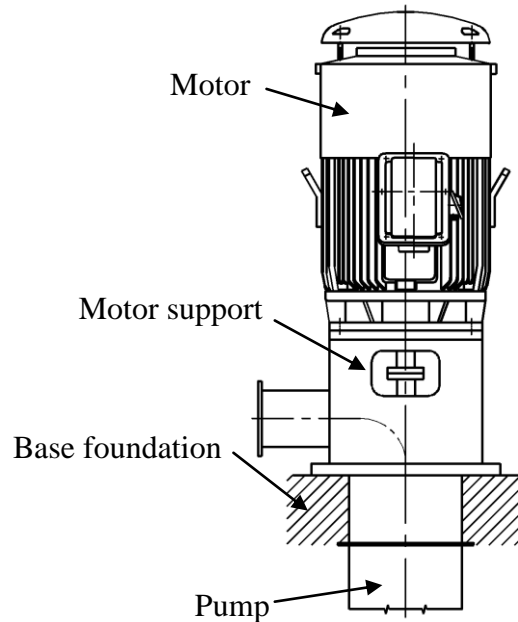


Fig. 10

3.2.5 Installation of vertical motor

- (a) All mounting surfaces must be planished and clean.
- (b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm flat and level.
- (c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, then set the motor on the mounting foundation.
- (d) Accurately install shaft couplings.

3.3 Installation of shaft coupling

3.3.1 General

ATTENTION !

Motors must always be accurately aligned, and this applies especially where they are directly coupled.

Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.

3.3.2 Mounting procedure

Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

3.3.3 End-play

Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from the load being transmitted to the motor bearings, which could cause bearing damage.

The recommended limits of end float for couplings are as follows :

- (a) When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.
 - (b) Unless otherwise specified, the designed end-play value X of the groove for TECO-Westinghouse motors in general is within 7mm (0.276") as illustrated in Fig. 11. In essence, the end-play indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus X equals to 7 ± 1 mm (0.276" \pm 0.039") or so, and the end-play value (Y) of the couplings should equal or be smaller than 2.4mm (0.094").
 - (c) If the desired value Y is greater than 3mm (0.118") caused for instance by a thrust load and/or load machine with large end-play, please inform us at time of order.
-

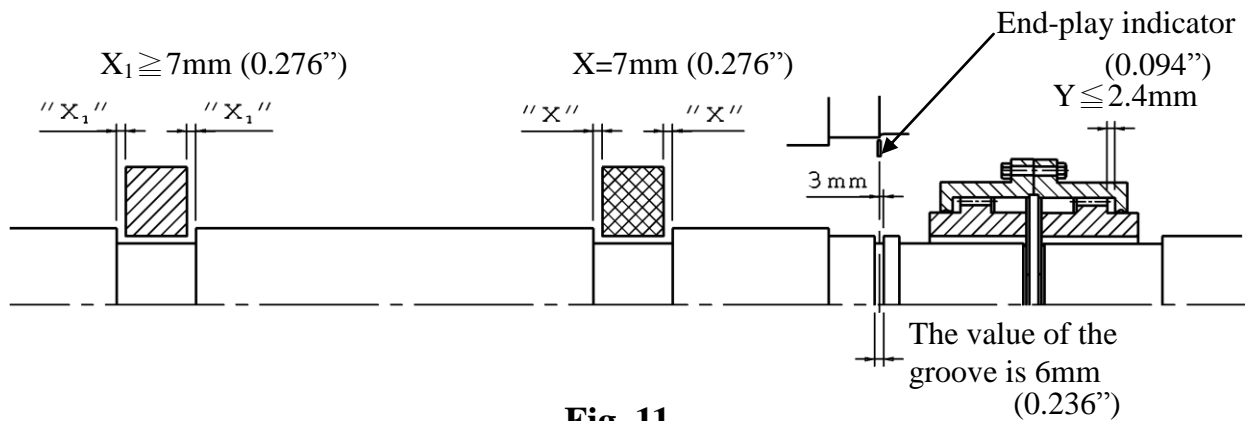


Fig. 11

3.3.4 Thermal growth

In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the end-play indicator position but also to axial shaft expansion and increase in shaft centerline height due to thermal effects. In general, the axial shaft growth for motors can be disregarded since neither bearing fixed nor any shaft growth due to temperature increase will produce an elongation away from the coupling.

Shaft height growth (change in shaft centerline elevation) for TEFC machines can be calculated as follows :

$$\Delta = (0.0005) \times (\text{motor foot to shaft centerline dimension})$$

For non-TEFC machines, divide this number by 2.

3.3.5 Alignment

It is desirable, in normal operation, that the motor operate on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment :

Unit : mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500rpm and above	0.03	0.03
	Below 2500rpm	0.04	0.05
A	2500rpm and above	0.03	0.03
	Below 2500rpm	0.03	0.04

Angular misalignment is the amount by which the centerlines of driver and driven shaft are skewed. It can be measured using a dial indicator set up as shown in Fig.12. The couplings are rotated together through 360 degrees so that the indicator does not measure run out of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

Parallel misalignment is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig.13. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

TIR = Total indicator reading (by dial indicator)

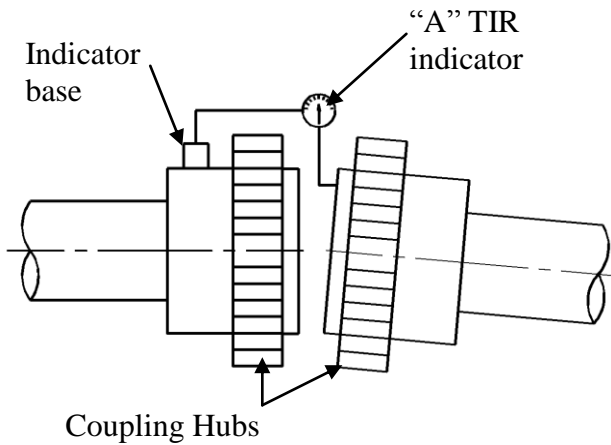


Fig. 12

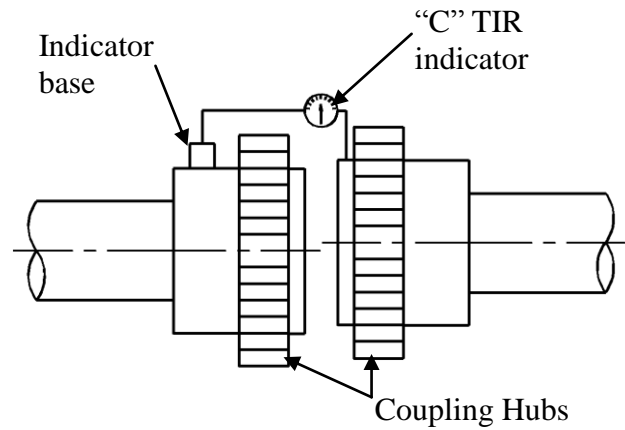


Fig. 13

ATTENTION !

Measurements should be made only after shimming and with hold-down bolts properly tightened.

3.3.6 Shims for horizontal motor

During alignment, the motor is adjusted vertically by shimming between the mounting surface and the motor feet. The shims (furnished only if part of the motor order) should be as large as the projected area of the motor foot pad and should either partially or completely encircle the hold-down bolts. Shimming must be done carefully to prevent any uneven support of the frame feet that could result in frame distortion due to hold-down bolt tension. When properly shimmed, it should be possible to insert 0.05mm thick feeler gauge between the top shim and the bottom of any frame foot.

3.3.7 Dowel for horizontal motor

After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frame, at least two dowel pins should be installed in two diagonally opposite motor feet.

For motors with fabricated frame, pilot holes are provided to facilitate final field drilling and reaming of the required dowel holes. Since the dowel pilot hole in the frame foot is set at a 45° angle from the vertical, it may first be necessary to spot face the motor mounting surface. This can be accomplished with a flat bottom drill utilizing the pilot hole as a guide.

3.3.8 Installation of shaft coupling (Vertical hollow shaft motor only)

Bolted coupling as Fig.14

- (a) Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
- (b) The coupling is fastened with bolts.
- (c) This coupling type is not auto-release type.

Note : Standard high thrust motors can absorb momentary upthrust load up to 30% of the standard downthrust load. If the upthrust is long duration (over 10 seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and a standard motor is not suitable.

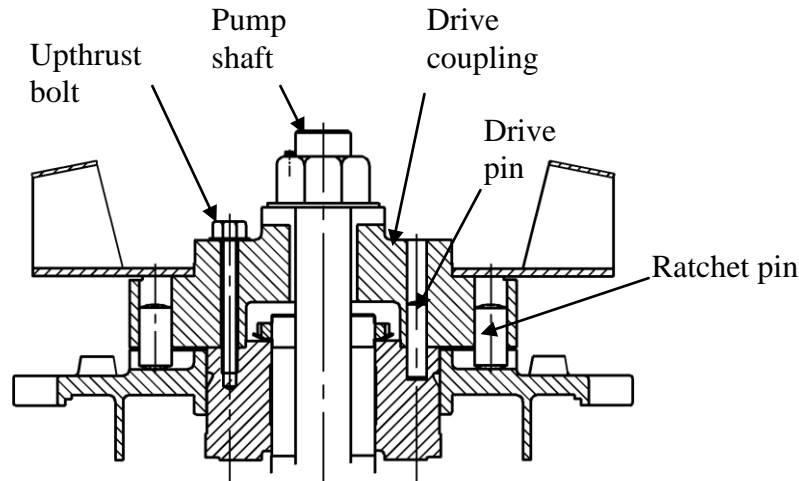


Fig. 14

3.3.9 Non-reverse ratchet/coupling, as Fig. 14 (If fitted)

The non-reverse coupling is also a bolted type and,

- (a) It prevents the pump and motor from rotating in the reverse direction.
- (b) It also prevents damage from over speeding and damage to pump shaft and bearings.
- (c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
- (d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
- (e) When installing the non-reverse coupling, do not use lubricant. Lubrication will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
- (f) As with the bolted coupling, the upthrust capabilities are 30% of the standard high thrust rating for downthrust.

ATTENTION !

Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.

3.3.10 Manual rotation of large vertical rotor with sleeve bearing during alignment (Vertical motor only)

- (a) If there is a thread in the non-drive end shaft center, the breakaway torque can be overcome by the use of torque wrench provided there is no ratchet. Remove the top cover, insert a bolt in the threaded shaft center and use a torque wrench to apply the rotating force. The breakaway torque is decided if a torque wrench is feasible.

$$\text{Torque [kg-mm]} = \text{Rotor Wt [kg]} * \text{Thrust Pad Center Radius [mm]} * 0.4$$

0.4 = coefficient of friction for dry lubrication

- (b) An alternate is to use a long bar bolted to the coupling to apply the torque.
- (c) If the rotor can be lifted either from above using a crane attached to the top of the rotor or from below using a jack, then the rotor weight is reduced and the torque needed to breakaway is much less. This does not always work, as sometimes the pads adhere to the thrust collar face due to cohesion.

There is no danger of Babbitt damage due to breakaway because it only takes a small revolution of the rotor to lubricate all shoe surfaces.

3.3.11 Removal of redundant shaft key

When the length of coupling hub is different from the length of shaft key, the motor may have a high vibration level due to this unbalance condition. The removal of redundant shaft key is necessary, shown as Fig.15.

Method (1) :

After installing the coupling, use a grinding wheel to remove the redundant key (hatch area).

Method (2) :

Before installing the coupling, calculate the different length between coupling hub and shaft key, then cut the half of this different value (hatch area) to achieve approximate-balance condition.

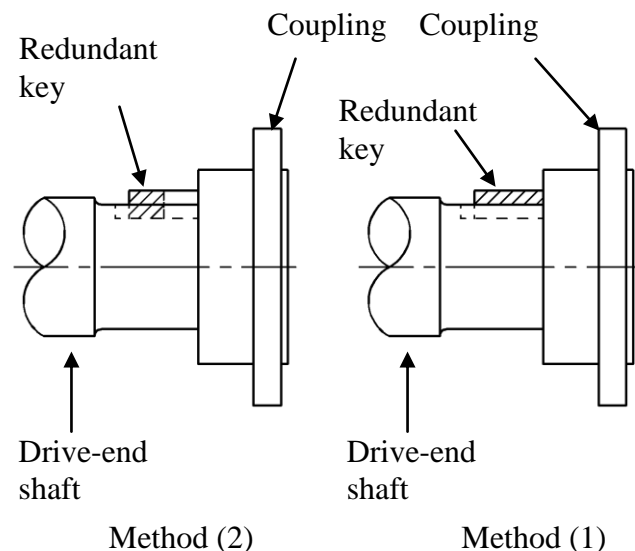


Fig. 15

3.4 Installation for belt drive

3.4.1 General

In general, power transmission through direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

3.4.2 Diameter of sheaves

The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belt. It is also advisable to limit the belt velocity to under 35 m/sec to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform us when you have decided the size of the sheaves and the length of the belts upon ordering.

ATTENTION !

Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig.16 equal to 0) to reduce the bending moment and improve shaft life.

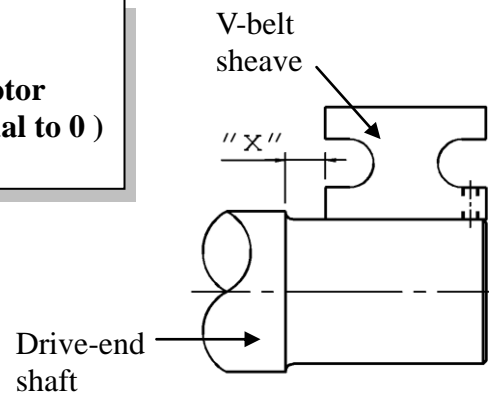


Fig. 16

3.4.3 Table of belt-sheave application for general electric motors

Output (kW)			V-Belt Sheave							
			Conventional V-Belt				Narrow V-Belt			
4P	6P	8P	V-Belt Type	Number of Belts	Min. PCD (mm)	Max. Width (mm)	V-Belt Type	Number of Belts	Min. PCD (mm)	Max. Width (mm)
45	--	--	C	6	265	162	5V	4	224	78
--	45	--	C	7	280	187	5V	5	224	95
--	--	45	C	7	315	187	5V	6	250	113
55	--	--	C	7	265	187	5V	5	224	95
--	55	--	C	8	300	213	5V	6	250	113
--	--	55	D	5	355	196	5V	6	280	113
75	--	--	C	8	315	213	5V	6	250	113
--	75	--	D	6	355	233	5V	6	315	113
--	--	75	D	6	400	233	5V	6	355	113
--	90	--	D	6	400	233	5V	6	355	113
--	--	90	D	6	425	233	8V	4	355	124
--	110	--	D	7	400	270	8V	4	355	124
--	132	110	D	7	450	270	8V	4	400	124
--	160	132	D	9	450	344	8V	4	450	124

3.5 Conveyance with chain or gear

3.5.1 Loading capacity

Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (overhung) of chain and gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.

3.5.2

Pay close attention to ensure the parallelism of shafts.

3.5.3

The teeth of couplings should be correctly and precisely matched; the force conveyance centers should lie on the same line.

3.5.4

There should be no skip, jumping, vibration or unusual noises.

ATTENTION !

Do not hammer the conveyance devices such as couplings, belt sheaves, chain wheels, gears etc. onto the shaft. Those shaft fitments should be fitted and removed only by means of suitable devices. Heat shrinking may be a better alternative to avoid damaging bearings and other components



The exposed rotating parts should be covered to prevent accidents.

3.6 Electrical connections

All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations.

Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams where provided.

3.6.1 Power

The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at the rated conditions :

+/- 10% of rated voltage

+/- 5% of rated frequency

+/- 10% combined voltage and frequency variation so long as frequency variation is no more than +/- 5% of rated

ATTENTION !

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage to or failure of the motor.

3.6.2 Main lead box

The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.



The bolted joints between the motor lead and the power cables must be made and insulated in accordance with the best industry practices.

3.6.3 Grounding

Both fabricated steel motors and fan cooled cast frame motors are provided with grounding pads or bolts.



The motor must be grounded by a proper connection to the electrical grounding system.

3.6.4 Rotation direction

The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner :

While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

3.6.5 Auxiliary devices

Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.

If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.

ATTENTION !

Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.

4. OPERATION

4.1 Examination before start

4.1.1 Wiring check

When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted :

- (a) Make sure all wiring is correct.
- (b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
- (c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
- (d) Ensure the capacity of fuse, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
- (e) Make sure that frame and terminal box are grounded.
- (f) Make sure that the starting method is correct.
- (g) Make sure switches and starters are set at their right positions.
- (h) Motor heaters must be switched off when the motor is running.

4.1.2 Measurement of insulation resistance



During and immediately after measuring, the terminals must not be touched as they may carry dangerous residual voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.

- (a) For rated voltage below 1000V, measured with a 500VDC megger.
For rated voltage above 1000V, measured with a 1000VDC megger.
- (b) In accordance with IEEE 43-2000, there are three recommendation minimum insulation resistance values. These values corrected to 40°C are :
 - (1) kV+1 in Megohms for most windings made before 1970, all field windings and windings not otherwise described.
 - (2) 100 Megohms for most DC armatures and AC windings built after about 1970 with form wound coils.
 - (3) 5 Megohms for machines with random wound stator coils and for form wound coils rated below 1kV.

ATTENTION !

After measurement the winding must be grounded or shunted to discharge residual voltages.

- (c) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to a winding :

- (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
- (2) Direct current (as from a welding equipment) can be passed through the winding. The total current should not exceed approximately 20% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the full applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.



Ensure there is adequate guarding so live parts cannot be touched.

- (3) Heated air can be either blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

ATTENTION !

Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40°C for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will be approximately halved for each 10°C increase in insulation temperature above the dew point temperature.

- (d) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

4.1.3 Power source

- (a) Ensure the capacity of the power source is sufficient.
- (b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
- (c) Voltage variation should be confined to $\pm 10\%$ of the rated value and the phase to phase voltages should be balanced.

4.1.4 Bearing lubrication

- (a) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibiting, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.
- (b) Motors which are supplied with provision for flood lubrication have an inlet orifice to meter the oil flow to the bearing. Refer to the outline drawing for these values. If the supply pressure does not match that stated on the outline, the orifice size must be adjusted to produce the specified flow rate. In line with operation conditions (degree of contamination of the oil) filters must be cleaned according to the instructions of the manufacturer. The recommendation mesh size of the filters is 15~20 μ m.

The drain adapter (also provided) has a weir plate fixed to the inside of the pipe to permit the establishment of the proper oil level. This weir plate must be located at the bottom of the pipe and must be parallel to the plane of the motor feet. To ensure optimum flow, the drain line should be vented to the atmosphere.

Oil inlet temperature :

Normal	20°C (70°F) ~ 49°C (120°F)
Alarm	60°C (140°F)
Trip	65°C (150°F)

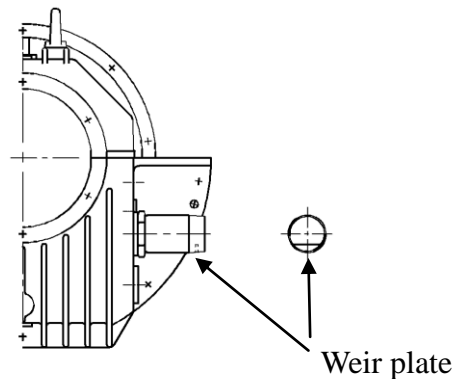


Fig. 17

- (c) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.
- (d) Grease lubricant type
- (1) The bearings have been well greased at factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage. Fill new grease until it overflows and the old grease is entirely replaced.
 - (2) Unless otherwise specified and shown on nameplate, ExxonMobil Polyrex EM is the standard applied to TECO-Westinghouse motors.
 - (3) If roller bearing is used, add a small amount of grease if abnormal sound occurs in the bearings. If this sound, disappears temporarily after regreasing, it is a normal condition and can operate as it is, as long as the temperature rise of the bearing is normal.

4.1.5 Oil-mist lubrication motors

Unless otherwise specified, Inpro seals are used as TECO-Westinghouse standard.

(a) Before operation :

Please check the rotor & stator parts of the Inpro seal, and make sure that they don't contact each other. A 0.03mm feeler gauge is suggested to inspect the gap between rotor and stator as shown in Fig.15. If they are touching on one side, it means that this seal is in the wrong position. You can use a wooden or rubber hammer to adjust this seal gently. If this can't be done, this seal may be damaged and have to be checked. Please contact with our service department.

(b) Lubricant :

Please use ISO VG68 or equal viscosity oil..

(c) About the oil mist lubrication generation system :

The users have to prepare an oil mist lubrication system and apply suitable inlet oil quantity and pressure. Please follow the instruction for the oil mist lubrication system that you used. Avoid high oil pressure to prevent oil from going into the inside of the motor damaging the insulation or causing oil leakage.

(d) Operation :

Before first operation or after a long time without running, please turn on the oil mist lubrication system for at least 5 hours to lubricate the bearings. If you use the central control system, the mist system shall operate continuously for a minimum of 48 hours. After making sure the pressure is stable and flow out oil is in good condition, you can operate this motor.

(e) Appendix :

Fitting or reclassifier of oil-mist lubrication system :

Reclassifiers or fittings are devices which convert small particle-size dry mist to larger particle sizes which can lubricate bearings. Please use correct fittings or reclassifiers.

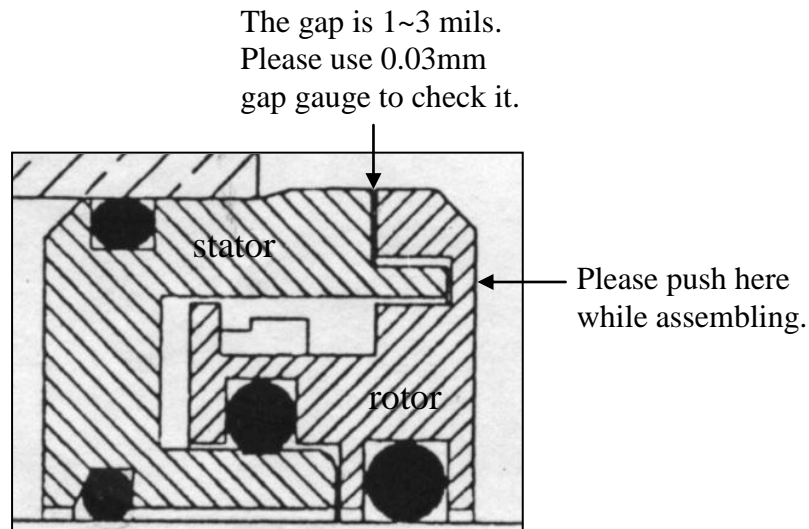


Fig. 18

4.1.6 Cooling water for the motors with water jacket (TEWC)

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water : General tower water or industrial water, the suspended solid shall be below 20 μ m/l

Volume : Please see outline drawing

Inlet temperature : Normal below 30°C (86°F) ; above 5°C (41°F)

Alarm 35°C (95°F)

Trip 40°C (104°F)

Special temperature settings will be noted in outline drawings.

4.1.7 For motors equipped with independent force-ventilating blower unit

- (a) Ensure the voltage and frequency of the power source are identical to the ratings shown on blower motor name plate.
- (b) Ensure the wiring to blower motor is according to the connection diagram.
- (c) Test run the blower motor to ensure the phase currents are within the tolerance limits.
- (d) Ensure the cooling air flow direction is correct. Refer to motor outline for cooling air flow direction.
- (e) Blower motor should be started prior to operating the main motor.
- (f) Do not switch off the blower motor immediately after the main motor is shut off. It must be left running for 15 minutes after the main motor is shut down.
- (g) For small blower motor, double shield and pre-lubricated ball bearings are used and re-lubrication is not necessary.

4.1.8 Remove all locks

ATTENTION !

Make sure all locks which fasten the movable parts of the motor during transportation are dismantled and the shaft can rotate freely.

4.1.9 Transmission system check

Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.



The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to prevent it from flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.

4.1.10 Test run

Make sure the items above are examined. Test the motor running with or without load. Record and check according to the statement of 5.11 "Records of operation and maintenance" at 15 minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If everything goes well, the motor can be classified as "in good order".

ATTENTION !

To avoid the abnormal bearing temperature and vibration level increase, we suggest do not run a vertical high thrust motor continuously without load.

4.2 Starting operation

4.2.1 Starting load

Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load which is then gradually increased proportional to the square of speed and at last reach 100% load at full load speed.

4.2.2 Starting

Too frequent starts can harm the motors. The following restrictions should be observed :

- (a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
- (b) Motor can be started only once when it is at normal running temperature.
- (c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted :
 - (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
 - (2) Let the motor cool down for 30 minutes before restarting, unloaded.
 - (3) Two inching starts can be regarded as one normal start.

ATTENTION !

If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately.

Investigate thoroughly and take corrective action before attempting a restart.

Possible reasons for not starting are :

- (1) Voltage drop at the motor terminals is more than allowed (check against motor data sheet).
- (2) The counter torque is too large to accelerate the rotor.
- (3) The driven machine is stuck, jammed or blocked.
- (4) The electrical connections have not been made correct to drawings and standards.
- (5) One phase is missing or single phase power has been applied.
- (6) Any combination of the above.

4.2.3 Rotating direction

- (a) Most TECO-Westinghouse motors can be operated in bi-directional rotation. However, when some special types, such as high speed 2P, certain large capacity motors, those with a non-reverse ratchet etc. should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.
 - (b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.
-

4.2.4 Power source, voltage, current

- (a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.
- (b) Voltage variation should be confined to $\pm 10\%$ of the rating and the three phase voltages should be in full balance.
- (c) Ensure the motor phase currents in no-load condition are within $\pm 5\%$ of the average values.

4.2.5 Power source, frequency

The variation of the frequency should be confined to $\pm 5\%$ of the rating. The aggregate variation of voltage and frequency should be confined to $\pm 10\%$ of the absolute value of the ratings.

4.2.6 Starting time and unusual noises

ATTENTION !

Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and refer to TECO-Westinghouse.

4.2.7 Sleeve bearing oil rings (sleeve bearing types only)

As the oil ring is used to carry lubricant to sleeve bearings, frequently check to ensure the oil ring is in motion.

4.2.8 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rise rate of bearing temperature is more indicative of impending trouble than is the actual temperature.

ATTENTION !

If the rise rate of the temperature is excessive, the motor exhibits excessive vibration or unusual noise, shut down the motor immediately. Before start up the motor again, a thorough investigation has been made to figure out the cause.

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature is stabilized.

Recommended limits on bearing temperature are as follows :

	Alarm Temperature setting	Trip temperature setting
Sleeve Bearings By permanently installed detector	90°C (194°F)	95°C (203°F)
Anti-friction Bearings By permanently installed detector	95°C (203°F)	100°C (212°F)

ATTENTION ! (For sleeve bearing)

- (1) Flood lubrication sleeve bearings without external lubrication supply, the bearing temperature must not be allowed to exceed 85°C in total.
- (2) Self-lube bearing, the rate of temperature rise should be from 11K to 14K for the first ten (10) minutes after starting up and approximately 22K at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.
- (3) When the rate of bearing temperature rise is less than $\pm 1K$ per (30) minutes, the bearing temperature is considered to steady conditions.
- (4) If the total bearing temperature exceeds 95°C, the motor should be shut down immediately and a thorough investigation has been made to figure out the cause.

ATTENTION !

If the rise rate of the temperature is excessive, the motor exhibits excessive vibration or unusual noise, shut down the motor immediately. Before start up the motor again, a thorough investigation has been made to figure out the cause.

4.2.9 Noise and Vibration

ATTENTION !

Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

(a) NEMA MG1, vibration limits at no load

Unfiltered Vibration Limits		
Speed, rpm	Rotational Frequency, Hz	Velocity, in./s peak (mm/s)
3600	60	0.15 (3.8)
1800	30	0.15 (3.8)
1200	20	0.15 (3.8)
900	15	0.12 (3.0)
720	12	0.09 (2.3)
600	10	0.08 (2.0)

(b) ISO 10816, overall vibration severity chart for customer’s reference

Machine	Vibration Velocity (r.m.s.)		Class I Small machine	Class II Medium machine	Class III Large rigid foundation	Class IV Large soft foundation
	in/s	mm/s				
	0.01	0.28				
	0.02	0.45				
	0.03	0.71				
	0.04	1.12				
	0.07	1.80				
	0.11	2.80				
	0.18	4.50				
	0.28	7.10				
	0.44	11.2				
	0.70	18.0				
	0.71	28.0				
	1.10	45.0				

Severity levels: Good (0.01-0.07), Satisfactory (0.07-0.18), Unsatisfactory (0.18-0.44), Unacceptable (0.44-1.10)

4.2.10 Recommended winding temperature settings

An electric motor normally has built in “over temperature protection devices” such as thermistors and RTD’s. They are set to trip at levels dependent upon the Class of Insulation of the motor windings. Motors designated Class F insulation have an allowable total temperature of 155°C in total. For those motors, the recommended alarm and trip settings are as below:

Alarm	Trip
140°C (284°F)	155°C (311°F)

4.2.11 Additional points to note

- (a) The motor characteristic data includes values for the acceleration and safe stall times, when specified by the customer. If the motor fails to reach full speed, shut off the power immediately. Investigate thoroughly and take corrective action before attempting to restart.
- (b) Each start of an induction motor subjects the motor to full inrush current with resulting heating of the stator and rotor windings. Each acceleration and repeated start can produce more heat than that produced and dissipated by the motor under full load.
The starting duty for which the motor is designed is shown by a nameplate mounted on the motor and must not be exceeded, if long motor life is expected. Abnormally terminal voltage drop and/or excessive load torque during motor start-up can cause extended acceleration time during which rotor speed is reduced and ventilation is minimized. This can cause rotor damage or can lead to extreme shorten of rotor life.
- (c) The temperature rating of the motor is shown on the main nameplate as a temperature rise above an ambient temperature. If there is a service factor, it is also shown.
If the motor does not have stator winding temperature detectors and abnormal winding temperatures (as might be indicated by high discharge air temperature, odor, etc.) are suspected, the motor should be shut down immediately and an investigation made before further operation is attempted.

5. MAINTENANCE

5.1 Major points in regular inspection and maintenance



Maintenance and repairs must only be carried out by properly trained personnel.



Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supply(ies).

Routine inspection and maintenance are usually performed visually, audibly, by odor, and by means of simple meters.



High temperature may arise under operating conditions on the motor surfaces, so touching should be prevented or avoided.

Keep away from moving and live parts.

Unless deemed necessary, do not remove guards while assessing the motor.

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

Owing to the varied time and circumstances motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically according to factory maintenance program. Generally, the inspection scope is determined by the following factors :

- (a) Ambient temperature and ambient conditions (dust, humidity, other contamination).
 - (b) Starting and stop frequency.
 - (c) Troublesome parts usually affect motor dysfunctions.
 - (d) Easily abraded parts (slipring, brushes, earthing brushes).
 - (e) The important position of motor in the operational system should be duly recognized.
Therefore, its life time should be intact and fully protected, especially when it is operating in severe conditions.
-

5.2 Motor windings

- (a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 4.1.2 "Measurement of insulation resistance".
- (b) Inspection of coil-ends :
 - (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
 - (2) Moisture must not accumulate. Keep coils warm when motor is not in use (use space heater, if it's installed).
 - (3) Discoloring. This is mainly caused by overheating.
- (c) Ensure no untoward change of wedges from original position occurs.
- (d) Ensure the binding at the coil end is in its normal position.

5.3 Clean the interior of the motor

- (a) After a motor has been in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.
- (b) Points to note during cleaning :
 - (1) If using compressed air or a blower :
 - a) Compressed air should be free of moisture. Be sure, that the dust and other materials can come out of motor housing, iron core and windings.
 - b) Maintain air pressure below 4 kg/cm^2 , since high pressure can cause damage to coils.
 - (2) Vacuum

Vacuum cleaning can be used before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tools should be non-metallic to avoid any damage to the winding insulation.
 - (3) Wiping

Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent.

In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.

ATTENTION !

Solvents of any type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.



Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an air line respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.

- (4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning.

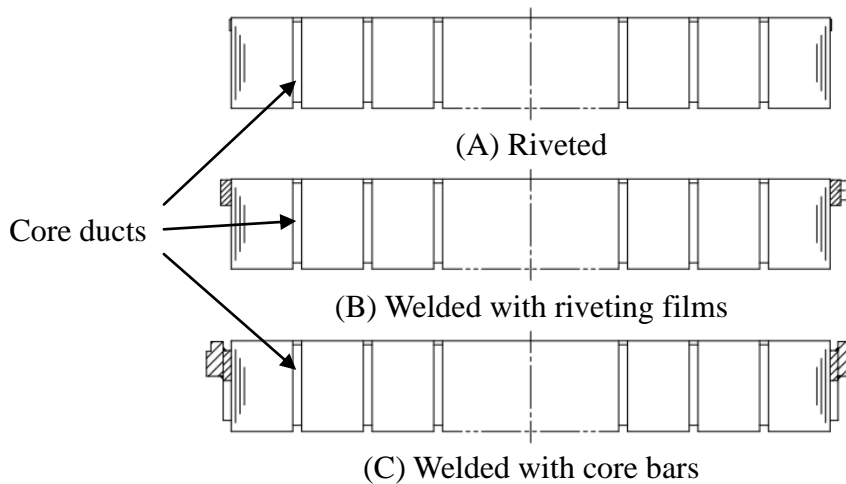


Fig. 19

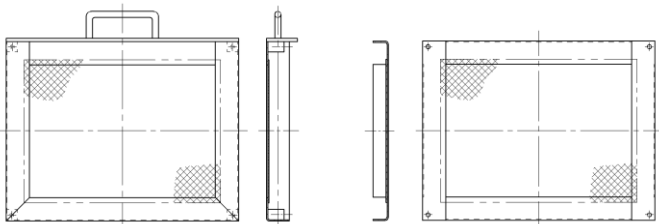
5.4 Clean the exterior of the motor

- (a) On open ventilated motors, screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air movement.

ATTENTION !

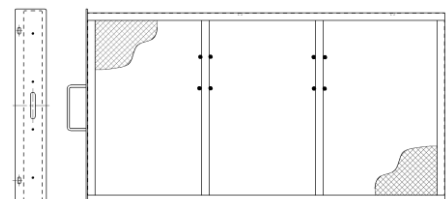
Screens and louvers should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.

- (b) If the motor is equipped with air filters, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. It is better to replace or recondition filters too often than not often enough. The Permanent type air filters can be cleaned with fresh water, make sure to let them dry before reinstalling.



Disposable type filter fitted into two filter supports.

Fig. 20



Permanent type filter.

Fig. 21

-
- (c) Totally enclosed air-to-air cooled and totally enclosed fan cooled motors require special cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fiber bristles (not wire of any type).

 - (d) It is important to keep the external surfaces of any motor clean and free from buildup of dirt and debris as this can function as an insulating blanket causing the motor to overheat drastically and could reducing the life of the motor. Methods of cleaning external surfaces are: Scraping, brushing, dry ice blasting etc.
-

5.5 Maintenance of anti-friction bearing

5.5.1 Frequency of relubrication

The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc. It is, therefore, impossible to be precise about replenishment intervals. However, for normal direct coupling transmission, the periods shown in Table 1 may be used as a guide.

Remarks :

- (a) The periods shown in Table 1 should be halved where bearings are used for belt drive and/or in dirty, high ambient temperature or high humidity environments.
- (b) Please refer to the lubrication nameplate, if attached to the motor.
- (c) For bearing numbers outside the range of Table 1, please contact TECO-Westinghouse.
- (d) If the periods referred to Table 1 for drive-end bearing and opposite drive-end bearing are different, for the convenience of maintenance operation, one could take the shorter one for re-greasing schedule.

5.5.2 Kinds of grease

ExxonMobil Polyrex EM grease is standard for TECO-Westinghouse motors except some special models for which special grease will be shown on the lubrication nameplate. Please use identical grease or its equivalents when maintaining.

ATTENTION !

Do not mix different kinds of grease.

Mixing grease with different types of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.

Table 1

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
62XX 63XX 72XX 73XX	6210										
	12									2000Hrs	
	13										
	14									1000Hrs	
	15										
	16									720 Hrs	
	17									2000Hrs	
	18	3000Hrs								500 Hrs	
	20										
	22										
	24									1500Hrs	
	26										
	28									2000Hrs	
	30									1000Hrs	
	32									500 Hrs	
	34									1500Hrs	
36											
38									2000Hrs		
										1000Hrs	

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM		
NU2XX NU3XX	NU214										
	15									2000Hrs	
	16										
	17										
	18	3000Hrs								1500Hrs	
	20										
	22									1000Hrs	
	24										
	26									2000Hrs	
	28									500 Hrs	
	30										
	32										
	34									2000Hrs	
	36									1000Hrs	
	38	2000Hrs									
	40										
44									1000Hrs		
48	1000Hrs								500 Hrs		

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM		
222XX 223XX	22220									300Hrs	
	22										
	24	1000Hrs								500 Hrs	
	26										
	28										
	30									300 Hrs	
	32									500 Hrs	
	34										
	36										
	38	500 Hrs									
	40									300 Hrs	
44											
48	300 Hrs										

5.5.3 Grease quantity

The amount of grease per replenishment depends on the type, size and construction of the bearings. The minimum amount for replenishment of each bearing is shown in Table 2.

Table 2

Bearing No.		Amount of replenishment	Bearing No.		Amount of replenishment
62XX	6210	30g	63XX	6310	40g
72XX	6212	40	73XX	6312	60
NU2XX	6213	50	NU3XX	6313	80
222XX	6214	50	223XX	6314	80
	6215	60		6315	100
	6216	60		6316	100
	6217	80		6317	120
	6218	80		6318	120
	6220	100		6320	160
	6222	120		6322	220
	6224	120		6324	270
	6226	140		6326	300
	6228	160		6328	400
	6230	180		6330	450
	6232	200		6332	500
	6234	250		6334	600
	6236	300		6336	700
	6238	350		6338	800
	6240	400		6340	900
	6244	450		6344	900
	6248	500		6348	900

Fill desirable however to regrease until it replaces and the old grease is entirely replaced. The temperature of the bearing will initially increase because of the excess grease. After a few hours, the excess grease will be expelled through the exit tube and the bearing temperature will return to normal.

5.5.4 Re-greasing



If relubrication is to be performed when the motor is running, stay clear of rotating parts.

It is advisable to re-grease while the motor is running to allow the new grease to be evenly distributed inside the bearing.

Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet or grease drain should be opened to allow the proper venting of old grease.

Use a grease gun to pump grease through grease nipple into bearings slowly. After re-greasing, operate the motor for 10-30 minutes to allow any excess grease to vent out.

5.5.5 Oil relubrication (For oil lubrication types only)

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing from clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, the oil level goes above the maximum shown on the sight gauge during operation, drain enough oil to bring the level back within the recommended operating range.

Do not permit the operating level to fall below the minimum shown on the sight gauge.

ATTENTION !

Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.

Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil.

Use only good quality, oxidation-corrosion-inhibiting turbine oils produced by reputable oil companies. The viscosity of the oil to be used depends upon the type and size of the bearing, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 3. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil. Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil metering hole is clear, and then dry the housing thoroughly before reassembly, and ensure all traces of cleaning solvent have been removed.

Table 3 oil viscosity for vertical motors**

Bearing Type	Oil viscosity	Range of pole
Angular contact ball (72XX , 73XX)	ISO VG32 (150 SSU/100°F)	2 pole
	ISO VG68 (300 SSU/100°F)	4 pole and above
Spherical roller (293XX , 294XX)	ISO VG68 (300 SSU/100°F)	4 pole
	ISO VG150 (700 SSU/100°F)	6 pole and above

**Note: Where a lubrication nameplate is attached to the motor, use the lubrication oil it stipulates.

5.5.6 Cleaning and installation of bearings

- (a) Apply the proper amount of grease to disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.
- (b) Bearing installation

ATTENTION !

Before installing the bearings, make sure that the shaft mounted parts behind the bearings are in place before installation.

Since the bearing is a high precision component, it is important to avoid ingress of dust and foreign matter and hammering during cleaning and installation. Be extremely careful and ensure clean conditions exist during installation and assembly.

ATTENTION !

The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be absolutely avoided.

The bearing should be heated in a bath of clean oil to a temperature of approx. 80°C or using an induction bearing heater with a temperature probe. After warming, slide the bearings in place quickly and nimbly so that it does not shrink onto the shaft before being fully in position. Take care to keep the bearing straight during installation and ensure it is properly seated against the shoulder. Maintain pressure against the shoulder for several seconds to ensure it does not slide back from the shoulder, or become “cocked” on the journal.

Grease the bearing after the temperature returns to normal, and then reassemble the motor.

5.6 Maintenance of sleeve bearing

5.6.1 Daily inspections

- (a) Ensure the volume and quality of lubricating oil are in compliance with specifications.

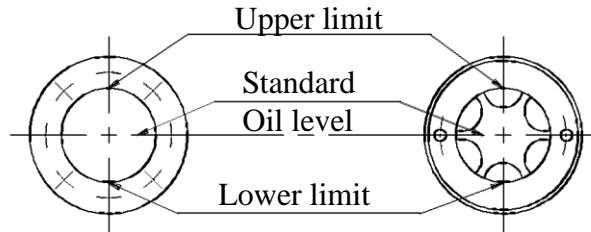


Fig. 22

- (b) Ensure there is motion of the oil ring and it is not clamped, but free to rotate.
- (c) The indicator of the shaft endplay should be restricted within the specified range of the red groove of the shaft or the $\pm 3\text{mm}$ range of the drive-end shaft shoulder. Otherwise the bearing will be destroyed.

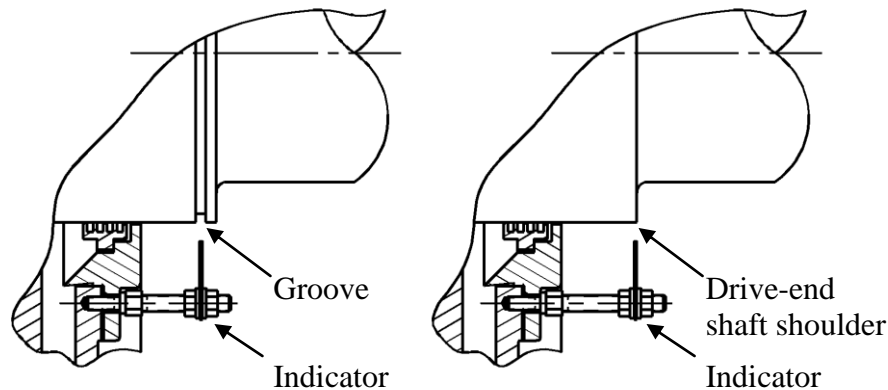


Fig. 23

5.6.2 Regular examination

- (a) Periodical change of oil

The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high-speed (3600-rpm) motors or if severe oil discoloration or contamination occurs. In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.

Refill the reservoir to the center of oil sight glass with a rust and oxidation inhibiting turbine grade oil. Refer to the outline and lubrication nameplate for the correct viscosity.

- (b) Quantity of lubrication oil

Please refer to the lubrication nameplate for oil quantity.

(c) Oil viscosity for horizontal motors with sleeve bearings

Table 4 oil viscosity for horizontal motors

Oil viscosity	Equivalents		Range of pole
	ESSO	MOBIL	
ISO VG32 (150 SSU/100°F)	TERESSO 32	DTE OIL LIGHT	2 pole
ISO VG46 (200 SSU/100°F)	TERESSO 46	DTE OIL MEDIUM	4 pole
ISO VG68 (300 SSU/100°F)	TERESSO 68	OIL HEAVY MEDIUM	6 pole & above

Note: Where a lubrication nameplate is attached to the motor, use the lubrication oil it stipulates.

5.6.3 Disassembly



Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated on larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

ATTENTION !

Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.

The following is the recommended procedure for removing the bearing sleeve:

- (a) Remove the oil drain plug in the housing bottom and drain the oil sump.
- (b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc.
- (c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.
- (d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive in the top bearing half.
- (e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up in parts or damage to the surface at the partings.

- (f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring, and then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.
- (g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive end, jacking or lifting can be done using eye bolts threaded into the tapped holes provided in the shaft end.
- (h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eye bolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.



Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and suddenly falls back to its bottom position. Serious personal injury could result.

- (i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.

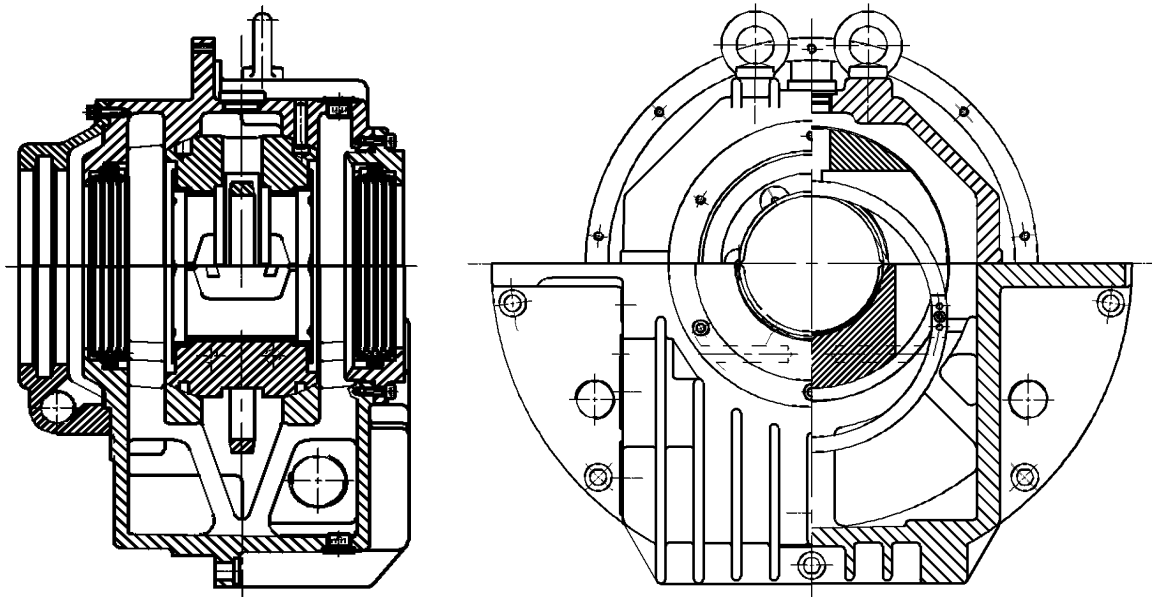


Fig. 24

5.6.4 Reassembly

Bearing reassembly is basically a reverse of the disassembly procedures outlined above, with the following suggestion:

- (a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.
- (b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.

- (c) All parts should be carefully inspected for nicks, scratches, etc., in any contact surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filing, etc., followed by thorough cleaning.
- (d) Before installing the halves of the floating labyrinth seal, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its internal face. These must be placed at the bottom toward the inside of the bearing. Only in this position the accumulated oil can drain back into the housing.
- (e) Put a bead of Curil-T around the seal half O.D.'s on both sides adjacent to the angular spring groove. This will prevent oil from by-passing the seal around its outside.
- (f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Curil-T around the O.D.'s on both sides adjacent to the garter spring groove on this half also.
- (g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance. Once assembled, the oil ring should be measured to ensure it is round, if it is not it should be repaired or replaced.
- (h) Some of the pipe plugs in the housing are metric thread type. These are identified as those which have a copper, lead, or similar material washer. If these plugs are removed, be careful not to lose the washers. Before reassembly, inspect the washers and replace them as required.
- (i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The "tab" must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

ATTENTION !

- (1) **Curil-T is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.**
- (2) **During the reassembly of the bearing parts, a thin layer of Curil-T should be applied to all gaskets and machined interface surface. This suggestion does not apply to the machined surfaces of the bearing liner halves.**
- (3) **When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure the split surfaces of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of the shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.**

5.6.5 Oil viscosity for vertical motors

Bearing Type	Oil viscosity	Range of pole
RENK Vertical Bearing Inserts Type EV or Kingsbury Type	ISO VG68 (300 SSU/100°F)	4 pole and above

5.7 Maintenance of slip ring (For Wound Rotor only)



Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.

5.7.1 Adjustment of carbon brush

(a) Brush pressure for normal operation :

- Electro-graphite brush
 $160 \text{ g/cm}^2 \pm 10\%$ (for slip ring with spiral groove)
 $200 \text{ g/cm}^2 \pm 10\%$ (for slip ring without groove)

When frequent vibrations are evident or the brush is small (area below 0.5 cm^2), the pressure should be greater than as shown.

(b) Adjustment of brush pressure :

The brush pressure should be adjusted to keep normal operation as it wears.

- The brush pressure may be reduced after use, so it is necessary to re-adjust. For adjustment, please turn adjusting screw, pressure adjusting pin or pressure adjusting plate as shown in Fig.25 to obtain the correct tension ($=0.23 \times \text{brush cross sectional area in cm}^2 \pm 10\% \text{ kg}$).

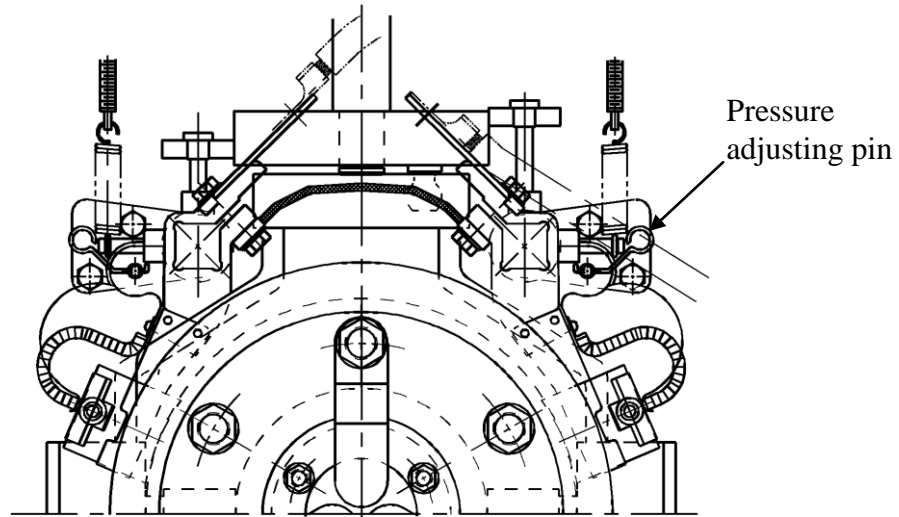


Fig. 25

(c) Brush pressure need not be adjusted if constant force spring is used as shown in Fig.26 and Fig. 27.

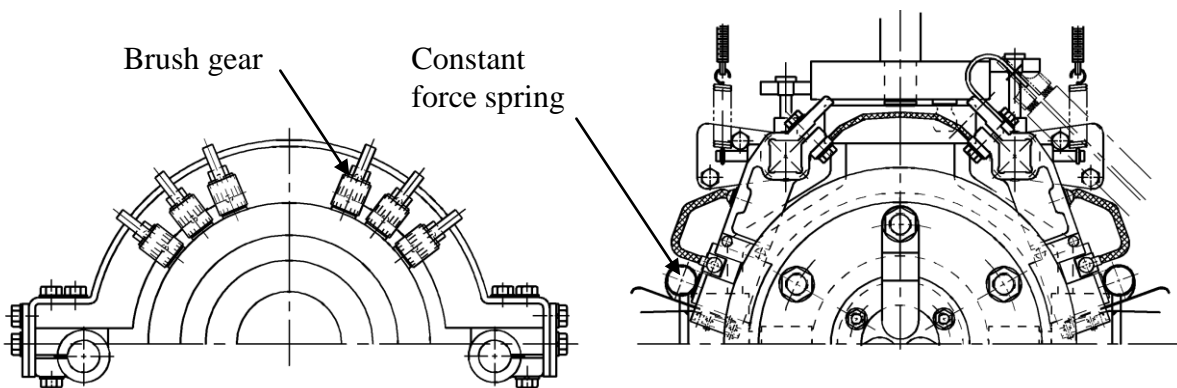


Fig. 26

Fig. 27

5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to 1/2~3/5 of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TECO-Westinghouse, and are listed on the nameplate of motor. It is important to know this when you replace the brush, only the recommended type and grade should be used.

(b) Dimensions

Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

ATTENTION !

The gap between a brush and its holder is important for good performance and safety of the motor.

(c) Adjustment of new brushes (Shown in Fig.28)

- (1) Polish the new brush with sandpaper until it assumes the appropriate contour of the slip ring which it touches.
- (2) Place sandpaper (JIS R6252 NO.40....50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
- (3) Repeat item 2 with fine sand-paper (JIS R6252 NO. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
- (4) Finally, clean the contaminated slip ring and brush with clean cloth or vacuum.

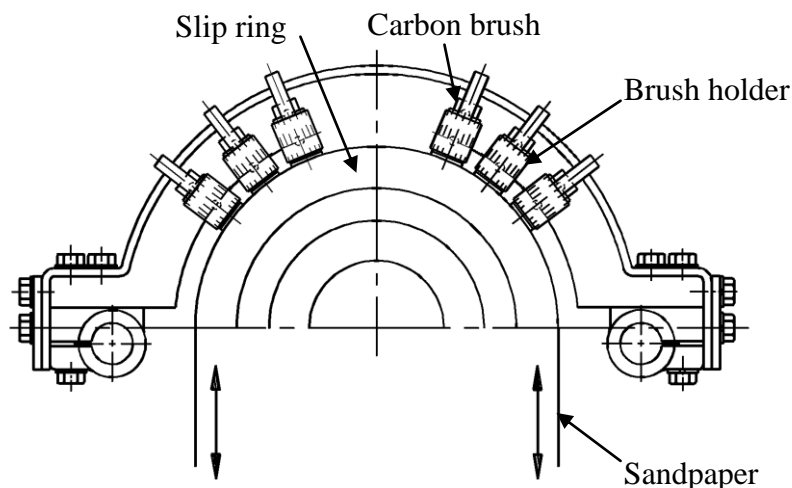


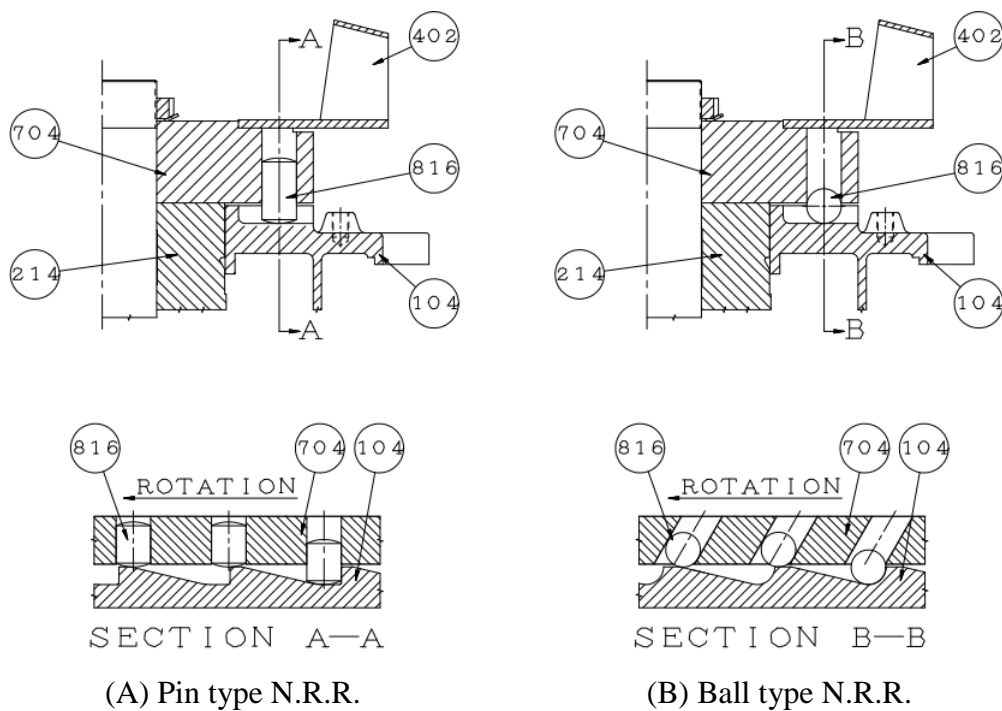
Fig. 28

5.8 Maintenance of non-reverse ratchet mechanism (For Vertical high Thrust Motor only)

5.8.1 Non-reverse ratchet mechanism

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive back pressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TECO-Westinghouse vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of N.R.R. mechanism is shown as Fig.29 below.



ITEM	NAME
104	RATCHET
214	BEARING SEAT
402	EXTERNAL FAN
704	RATCHET PIN CARRIER
816	RATCHET PIN(BALL)

Fig. 29

The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over speeding and damage to water-lubricated pump shaft bearings when, on shutdown, the falling water column tends to drive the pump in the reverse direction.

In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

5.8.2 Service life

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stop in application.

Over time the pins can become deformed due to this reverse shock load, causing the up and down motion of ratchet pins to become sluggish or jammed and unusual noises will arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period is to be halved.

ATTENTION !

The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.

5.9 Dismantling and Assembly Procedure

Please see the drawing in Appendix 4.

Brackets w/anti-friction bearing	Dismantling brackets	Assembly
TEFC	<ol style="list-style-type: none"> 1. Remove the fan cover & outer fan. 2. Remove securing bolts between the bearing cover-outer (22) and the bracket (18). 3. It may be necessary to remove any seals / grease flingers / temperature sensors etc attached to the shaft or housings. 4. Pull out the bearing cover-outer (22) very carefully. 5. Remove securing bolts hold between the bracket (18) and frame (12). 6. Pull out the bracket (18) gently. 	<ol style="list-style-type: none"> 1. Check the bearing assembly. Keep each part very clean. 2. Tighten securing bolts by reverse step of dismantling.

5.10 Records of operation and maintenance

5.10.1 Objective

- (a) Fully understand the purpose of the motors in operation and discover any abnormalities in advance.
- (b) Prevent negligence and omissions in maintenance.
- (c) Map pertinent maintenance plans after fully understanding the operation of the motor.
- (d) Assess the life of the depreciating parts to determine the amount of spare parts to be kept.
- (e) Plan the amount of spare motors and replacement parts to repair the motors in operation according to actual situation and schedule.

5.10.2 Records of operation

- (a) It is advisable to use a primed form with yes/no or right/wrong selections for the operator to easily fill out.
- (b) Principle contents :
 - (1) Serial number of machine.
 - (2) Load machine type.
 - (3) Models and specifications of motors.
 - (4) Three-phase voltage.
 - (5) Three-phase current.
 - (6) Temperature of a motor and bearings when in operation.
 - (7) Ambient temperature, humidity, weather, date and time.
 - (8) Time of start and stop.
 - (9) Special remarks.
 - (10) Operator's name.

5.10.3 Maintenance records

- (a) It is advisable to use a primed form with yes/no or right/wrong selections for the operator to easily fill out.
 - (b) Principle contents :
 - (1) Serial number of machine.
 - (2) Load machine type.
 - (3) Models and specifications of motors.
 - (4) Ordinary operating conditions and data.
 - (5) Cause, date and disposition measures at breakdown.
 - (6) Quantity and name of replaced spare parts.
 - (7) Date of maintenance and initial operation.
 - (8) Items and date of maintenance.
 - (9) Special remarks.
 - (10) Name of maintenance personnel.
-

6. FAULT FINDING AND RECOGNITION

Type of Breakdown	Symptoms	Possible causes	Remedies
Fail to start without load	Motionless and soundless	Power-off	Consult power company
		Switch-off	Switch-on
		No fuse	Install fuse
		Broken wiring	Check wiring and repair
		Broken lead	Check wiring and repair
		Broken windings	Check windings and repair
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)	Short circuit of circuit switches	Check circuit switches and replace
		Incorrect wiring	Check wiring according to nameplate
		Poor contact at terminals	Lock tightly
		Windings grounded	Factory repair
		Broken windings	Factory repair
		Poor contact of circuit switches	Check and repair
		Broken wiring	Check and repair
		Poor contact of starting switches	Check and repair
Short circuit of starting switches	Check and repair		
Incorrect connections of starting switches	Connect according to nameplate		
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits
		Overload	Lighten load
		High load at low voltage	Check circuit capacity and reduce load
	Overheating motor	Overload or intermittent overload	Lighten load
		Under-voltage	Check circuit capacity and power source
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the duct
		Ambient temperature exceeds 40°C	Correct insulation class F, or lower ambient temperature.
		Friction between rotor and stator	Factory repair
		Fuse blown (Single-phase rotating)	Install the specified fuse
		Poor contact of circuit switches	Check and repair
		Poor contact of circuit starting switches	Check and repair
		Unbalanced three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and power source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheat	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing overheating	Lack of oil	Add oil
		Lack of grease	Add grease
		Misalignment between motor and machine shafts	Re-align
		Over speed of bearing outer-ring	Adjust bracket
		High bearing noise	Replace the damaged bearing
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings Should be repaired at factory
	Bearing noise	Churning sound	May be normal noise from grease circulating through the bearing
		Rattling noise as result of poor lubrication	Add Grease
		Larger noise	Inspect cause -replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingress of foreign matters	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
		Induced by conveyance machine	Repair machine
	Vibration	Electromagnetic vibration	Short circuit of windings
Open circuit of rotor			Factory repair
Mechanical vibration		Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetrical centers between belt sheaves	Align central points
		Central points of couplings not in alignment	Adjust the alignment between motor and driven equipment
		Improper mounting installation	Check mounting and alignment
		Motor mounting bed is not strong enough	Reinforce mounting bed
		Mounting bed vibration caused by near machines	Eliminate the vibration source near motor

Remarks:

- (1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switch etc.
- (2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controllers etc.

7. RECYCLE

7.1 Introduction

TECO obey its environmental and protection policies. TECO has always been committed through the use of recyclable and life cycle analysis of the results to improve environmental protection products. Products, production processes or flow designs are all reflected the concept of environmental protection. TECO's environmental management system through the ISO 14001 certification is used to implement an environmental policy tool.

The following guidelines only deal with the suggestions of environmental treatment on the equipments. Customer shall be responsible for compliance with local regulations. This manual may not include some of the customer's specific content. Project document provides additional documentation.

7.2 Materials Average Content

When producing electrical equipments, the average material content used are as follows:

Material	Die-casting frame Induction machinery	Steel plate frame Induction Machinery
Steel	45 – 56 %	79 - 83 %
Copper	8 – 10 %	12 – 14 %
Cast iron	32 – 43 %	1 – 3 %
Aluminum	0 – 5 %	0 - 1 %
Insulation materials	1 - 2 %	2 – 4 %
Stainless steel	Below 1 %	Below 1 %
Other	Below 1 %	Below 1 %

7.3 Packing Materials Recycling

When the equipments arrived to the place, the packing materials should be removed.

- All wood-made packing materials can be burned.
- The packing materials used with impregnated wood at sea shipping for some country must be recycled according to local regulations.
- The plastic materials around equipments can be recycled.
- The anticorrosive agent covered on the surface of equipments can be cleaned by gasoline-based cleaner or wipers. Treating the wipers must be complied with local regulations.

7.4 Equipment of disassembling

Disassembling equipment is a basic operation because equipment is assembled by bolts. However, due to the heavy weight of equipment, the operator must be required to have received training in handling the transportation of heavy loads to avoid any danger.

7.5 Classification of different materials

7.5.1 Frame, Bracket (bearing housing), Cover and Fan

These parts are made of structural steel and can be recycled according to local regulations. All of auxiliary equipment, cables and bearings must be removed before melting.

7.5.2 Parts with electrical insulation

The stator and rotor are the main part of machinery included electrical materials. Some auxiliary parts also included similar materials and should be used the same methods to dispose. These materials include each insulator in outlet box, exciter, transformer with adjustable voltage and current function, cables, wires, corona discharger and capacitor. Some parts are used for synchronous machineries and some used for few equipments.

All of these parts are in an inert state when equipments were completed.

Some parts (especially the components into stator and rotor) including a large number of copper can be separated by appropriate heat treatment and the organic adhesive materials in insulation materials can be gasified. In order to ensure proper gas combustion, burner should provide an appropriate supplementary burner. In the combustion process of heat treatment, following conditions are recommended to minimize the material distributed processing:

Temperature of Heat treatment : 380- 420°C (716- 788°F)

Duration : Processing object should be kept at that temperature for at least 5 hours when reaching to 90% of target temperature.

Supplementary gas combustion temperature for adhesives smoke: 850-920 ° C (1562-1688 ° F)

Flow rate: adhesives smoke in the combustion chamber should be kept at least three seconds

Note: The distribution of substances include O₂, CO, CO₂, NO_x, C_xH_y gas and micro-particles.

User shall be responsible to ensure that the process comply with local regulations.

Note: You should pay particular attention to thermal processes and heat treatment equipment maintenance, so as not to bring fire or explosion hazard. Since this work will use a variety of devices, so TECO cannot provide a detailed maintenance guideline for treatment process or equipment, customers will be responsible for dealing with these issues.

7.5.3 Permanent Magnet

If permanent magnet synchronous machineries will be totally melted, it's no need to deal with the permanent magnets.

In order to achieve a more complete recovery and removal of equipment or if the rotor will be sent out after recovery, we suggest doing permanent magnet demagnetization. Rotor can be heated in the

furnace until the temperature of a permanent magnet reaches 300 °C (572 °F) to achieve degaussing purpose.



Open or disassemble permanent magnet synchronous machinery or remove the rotor of such equipment will produce stray magnetic fields. It may interfere with or damage to other electrical or electromagnetic devices and components, such as cardiac pacemakers, credit cards and more.

7.5.4 Hazardous Waste

The grease in oil lubrication system is hazardous waste and must be treated by local regulations.

7.5.5 Buried Waste

All insulation materials can be treated as landfill waste.

Appendix 1. Daily inspection

Checking point	Checking item	Description or inspection parts	Method	Criteria or notes
1. Bearing	Oil supply	Oil quantity	Check oil level from oil sight gauge.	In the middle of oil sight gauge.
		Oil pressure (forced oil lubrication only)	Check oil supply pressure gauge near inlet pipe or supply unit.	Within $\pm 20\%$ of specified pressure.
		Oil ring rotation (horizontal sleeve bearing only)	Check oil ring from window at 12 o'clock.	Rotating smoothly
	Oil leakage	Shaft 、 labyrinth seal 、 piping connection 、 parting line of housing	Inspect by eye and touch by hand.	Dampness around housing is normal. But oil accumulation on floor should be checked.
	Temperature	Bearing temperature detector	Check the value is the same as normal.	Recommendation : See 4.2.8
	End play	Axial fluctuation of shaft	Inspect by eye.	The shaft shoulder should not touch the liner.
		Magnetic center	Inspect the magnetic center pointer on drive end.	$\pm 3\text{mm}$
	Vibration	Ref to 4.2.9	If the vibration level is higher than normal, please measure the spectrum by instrument.	Analyze the spectrum.
Noise	Ref to 4.2.9	Listen for unusual noise	Assess noise , stop and inspect if necessary	
2. Stator	Temperature	Winding temperature detector	Check the value is the same as normal.	Recommendation : See 4.2.10
	Load	Voltage 、 current	Check the value from control panel	Voltage variation < 10% Current < rated current
3. Cooler	Water supply	Water quantity	Check the water flow relay or indicator & temperature.	The water flow rate and temperature limitations are shown on outline drawing.
4. Filter	Dust or pollution	Clean filter	Clean by fresh water	Clean filter
5. Others	Odor	Windings & Bearings	Check winding and bearing temperature monitors	Check load / cooling air flow, oil condition.

Appendix 2. Monthly inspection

Checking point	Checking item	Description or inspection parts	Method	Criteria or notes
1. Bearing	Oil supply	Oil quantity	Check oil level from oil gauge.	In the middle of oil gauge. If the oil quantity is low , please add oil and check for leaks
	Oil leakage	Shaft 、 labyrinth seal 、 piping connection 、 parting line of housing	Inspect by eye and touch by hand.	If oil is leaking, it is important to find the root cause.
2. Stator	Temperature	Winding temperature detector	Check the value if the same as normal.	Recommendation : See 4.2.10
	Appearance	Bolts/nuts for bracket or frame etc.	Inspect by eye and touch by hand.	Re-tighten all loose.
	Resistance	Winding	500VDC/1000VDC megger. Once every three months at least.	Ref to “Operation” 4.1.2 measurement of insulation resistance.
3. Cooler	Water supply	Water quantity	Check the water flow relay or indicator & temperature.	The water flow rate and temperature limitations are shown on outline drawing.
4. Coupling	Appearance	Bolts/nuts	Inspect by eye and touch by hand.	Re-tighten all loose bolts.
5. Space heater	Resistance	Heater wire	500VDC megger.	Ref to “Operation” 4.1.2 measurement of insulation resistance.

Appendix 3. Regular Inspection

item	Checking point	Description	Regular inspection			
			In situ Exterior surface inspection	In situ Open inspection	Removed for Disassembly inspection	
1. Inspection before disassembly	(1)	Vibration	Measure and record the vibration levels for reference	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(2)	Temperature	Record bearing, winding & ambient temperature for reference.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(3)	Coupling	Measure the mounting and shaft end dimensions. Check if any bolts are loose. Check if there are any mounting hole, key & keyway deformation.			<input type="radio"/>
	(4)	Alignment	Check and record the alignment for reference			<input type="radio"/>
	(5)	Anchor bolt, mounting bolt & nut	Check if there are any parts loose. Check condition of all nuts , bolts, Replace if defective.		<input type="radio"/>	<input type="radio"/>
	(6)	Adjusting shims	Check if rusty, damaged and replace if damaged.			<input type="radio"/>
	(7)	Shaft vibration	Measure the shaft vibration value and record.			<input type="radio"/>
	(8)	Foundation level	Check for any deformation that may have occurred.			<input type="radio"/>
	(9)	Air gap	Measure this value and record in 3 places at least for each end.			<input type="radio"/>
2. Sleeve bearing inspection	Sleeve bearing	According to RENK "Instructions for Maintenance and Inspection".		<input type="radio"/>	<input type="radio"/>	
3. Stator inspection	(1)	Winding resistance	Use 500VDC/1000VDC megger to measure and record results.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(2)	Winding appearance	Check if any dust or oil contamination on winding coil			<input type="radio"/>
	(3)	Coil end	Check coils for loose blocking, lashings, end rings.			<input type="radio"/>
	(4)	Coil insulation	Check coil insulation material for wear, discolouration or damage			<input type="radio"/>
	(5)	Cable lead	Check if lead insulation broken, cracked or damaged.			<input type="radio"/>
	(6)	Terminal lug	Check for loose or damaged lugs or terminals.			<input type="radio"/>
	(7)	Coil wedge	Check for loose or damaged slot wedges.			<input type="radio"/>
	(8)	Air guide	Check each bolt & nut to see if any is loose.			<input type="radio"/>

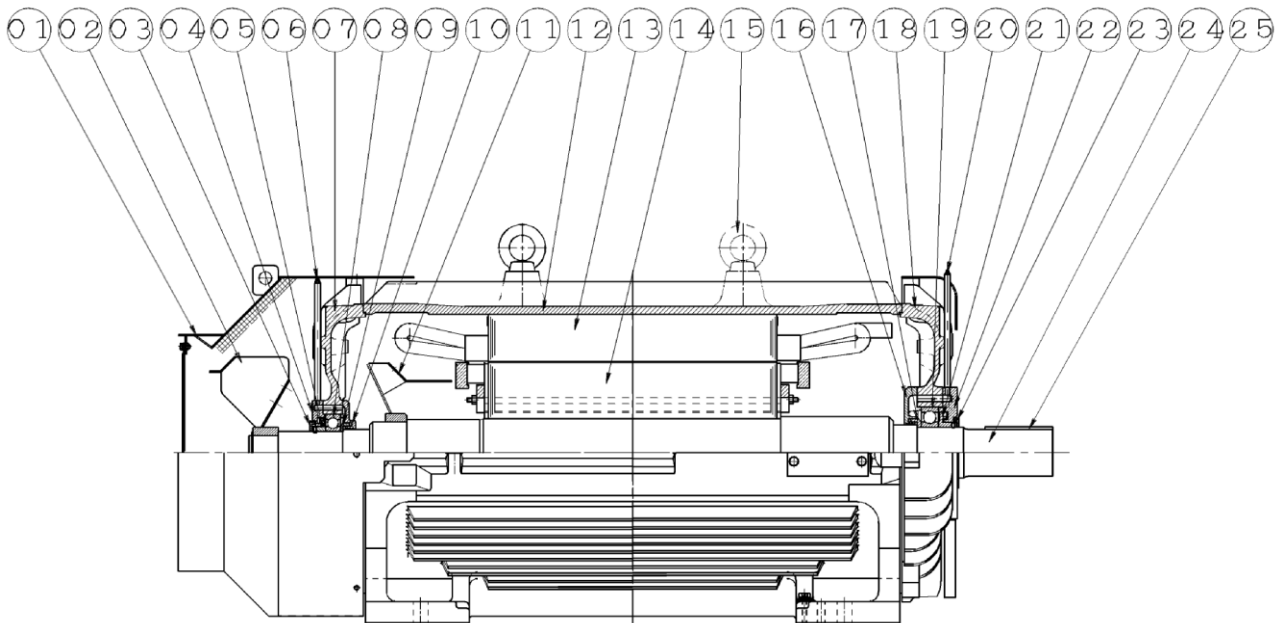
Appendix 3. Regular Inspection (continue)

item	Checking point	Description	Regular inspection		
			In situ Exterior surface inspection	In situ Open inspection	Removed for Disassembly inspection
4. Rotor inspection	(1) Rotor appearance	Check if any dust or oil contamination is on rotor.			○
	(2) Rotor bar	Check for loose or damaged bars Check rotor bar end ring welds.			○
	(3) Rotor core	Check for loose or damaged laminations.		○	○
5. Fan	Fan	Check welded portions for cracks, bolts & nuts, any built up dirt or rust.			○
6. Inspection before operation	(1) Winding resistance	Use 500VDC/1000VDC megger to measure, record results.	○	○	○
	(2) Supply lead connection	Check all incoming supply leads correctly connected.		○	○
	(3) Protection relay	Check protection relay in normal operation.	○	○	○
	(4) Lubrication oil	Oil level at the middle of oil gauge. Oil inlet pressure correct and oil drains smoothly.	○	○	○
	(5) Alignment	Check and record the alignment.			○
	(6) Anchor bolt & mounting bolt	Check all mounting bolts are securely tightened.		○	○
	(7) Driven equipment	Check if all driven equipment is ready for operation.	○	○	○
	(8) Cooling water	Check cooling water flow rate & quantity.	○	○	○
7. Inspection before starting	(1) Rotational direction	Check rotational direction.	○	○	○
	(2) Oil ring	Check if oil ring runs smoothly.	○	○	○
	(3) Noise	Check there is no abnormal noise.	○	○	○
	(4) Vibration	Check if vibration is normal.	○	○	○
	(5) Bearing temperature	For test run, please keep monitoring for 2hrs at least.	○	○	○
	(6) Oil level	Check oil level.	○	○	○
	(7) Current	Make sure current is below rated value shown on nameplate.	○	○	○

Note :

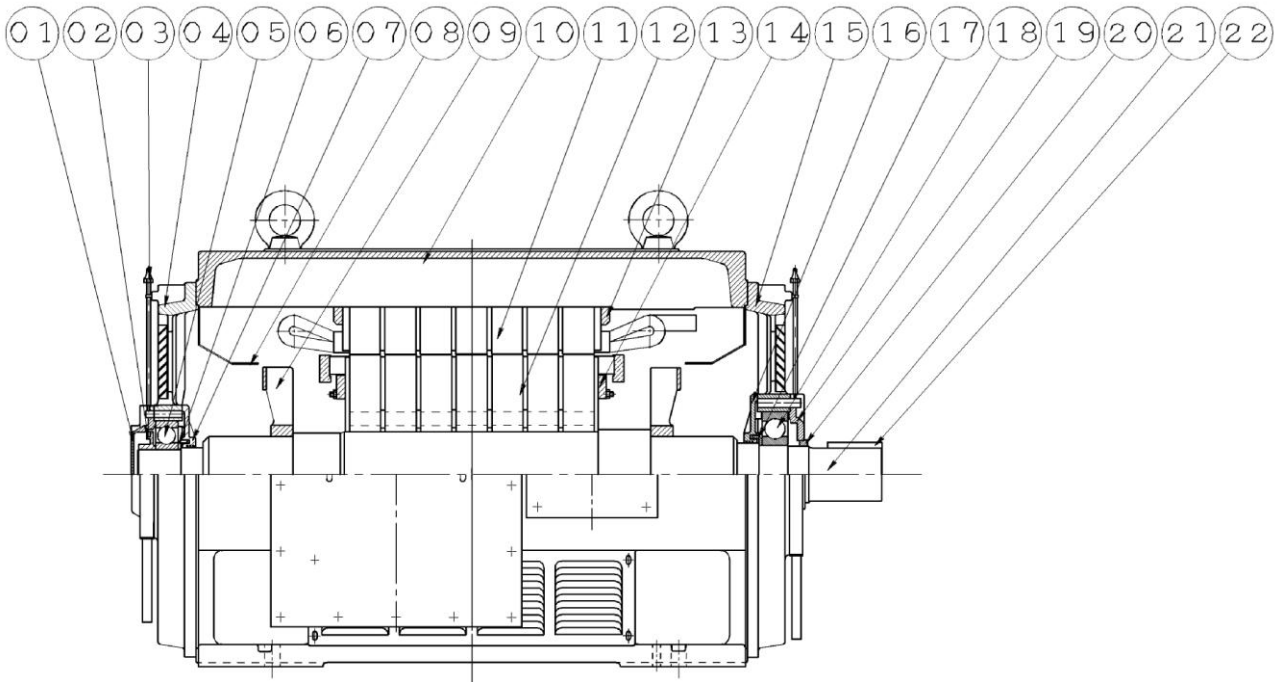
- (a) Disassembly inspection : removing the rotor to inspect the stator & rotor.
Recommendation : every four (4) years, but depends on operation environment conditions & machine type.
 - (b) Open inspection : inspect the maximum possible portions without removing rotor.
Recommendation : every two (2) years, but depends on operation environment conditions & machine type.
 - (c) Exterior surface inspection
Recommendation : every year.
-

Appendix 4. Typical motor cross sectional drawings: SCIM, TEFC



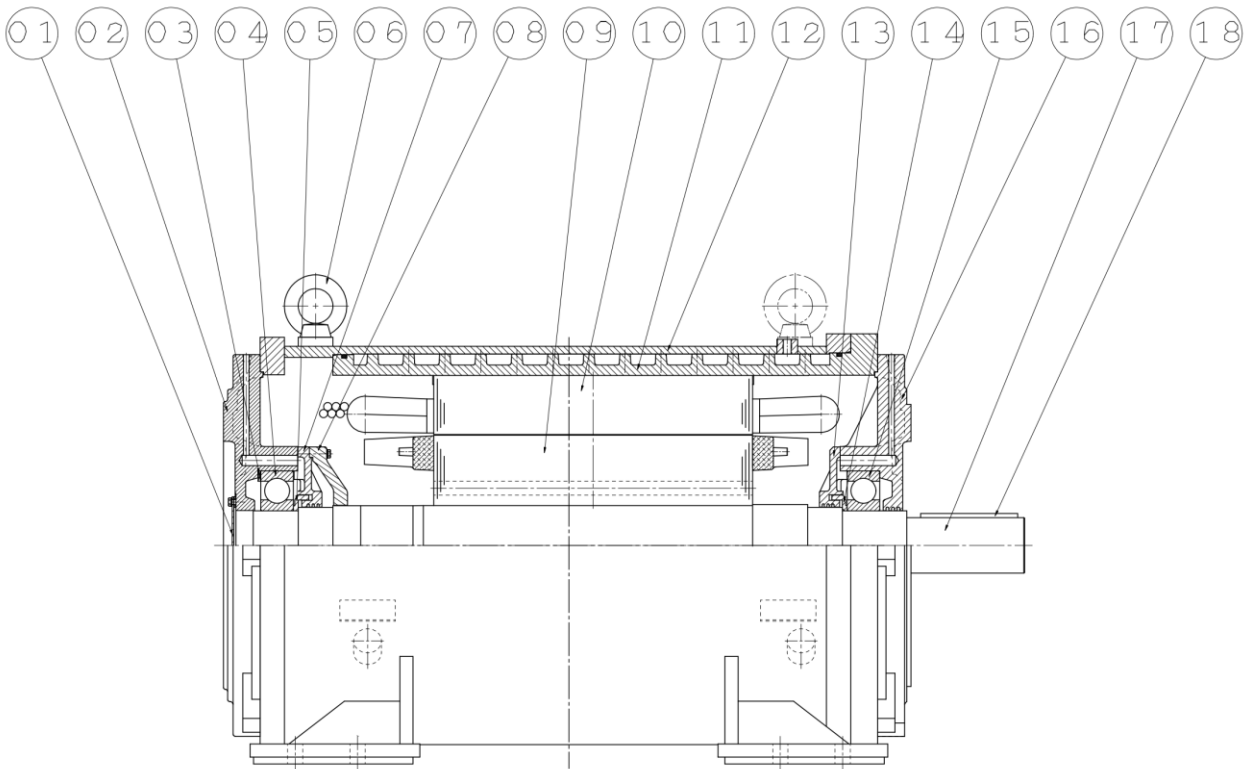
Item	Name	Item	Name
01	FAN COVER(N.D.E)	14	ROTOR
02	EXTERRAL FAN	15	EYE BOLT
03	DUST FLINGER	16	BEARING COVER-INNER
04	BEARING COVER-OUTER	17	GREASE FLINGER
05	GREASE FLINGER	18	END BRACKET
06	GREASE NIPPLE	19	BEARING
07	END BRACKET	20	GREASE NIPPLE
08	BEARING	21	GREASE FLINGER
09	GREASE FLINGER	22	BEARING COVER-OUTER
10	BEARING COVER-INNER	23	DUST FLINGER
11	INNER FAN	24	SHAFT
12	FRAME	25	SHIFT END KEY
13	STATOR		

Appendix 5. Typical motor cross sectional drawings: ODP



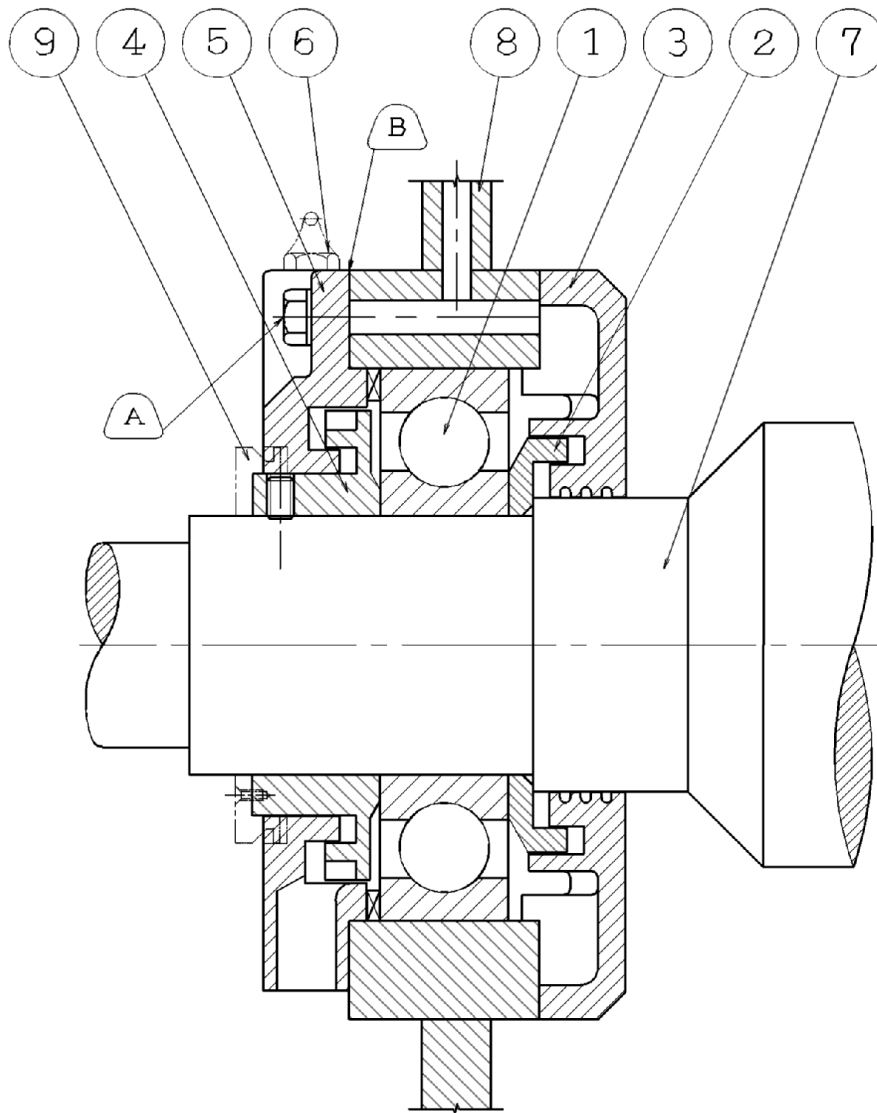
Item	Name	Item	Name
01	BEARING COVER-OUTER	12	R CORE
02	GREASE FLINGER	13	RETAINER RING-S
03	GREASE NIPPLE	14	RETAINER RING-R
04	BRACKET	15	BRACKET
05	BEARING	16	BEARING COVER-INNER
06	STOP RING-BEARING	17	STOP RING-BEARING
07	BEARING COVER-INNER	18	BEARING
08	AIR GUIDE	19	BEARING COVER-OUTER
09	INNER FAN	20	INPRO SEAL
10	FRAME	21	SHAFT
11	S CORE	22	KEY

Appendix 6. Typical motor cross sectional drawings: SCIM, TEWC



Item	Name	Item	Name
01	COVER	10	S CORE
02	FLANGE-BRACKET	11	FRAME-INNER
03	PRE-LOAD SPRING	12	FRAME-OUTER
04	BEARING	13	BEARING COVER-INNER
05	GREASE FLINGER	14	GREASE FLINGER
06	EYE BOLT	15	BEARING
07	BEARING COVER-INNER	16	FLANGE BRACKET
08	BEARING COVER-INNER	17	SHAFT
09	ROTOR	18	KEY

Appendix 7. Typical ball bearing construction drawing

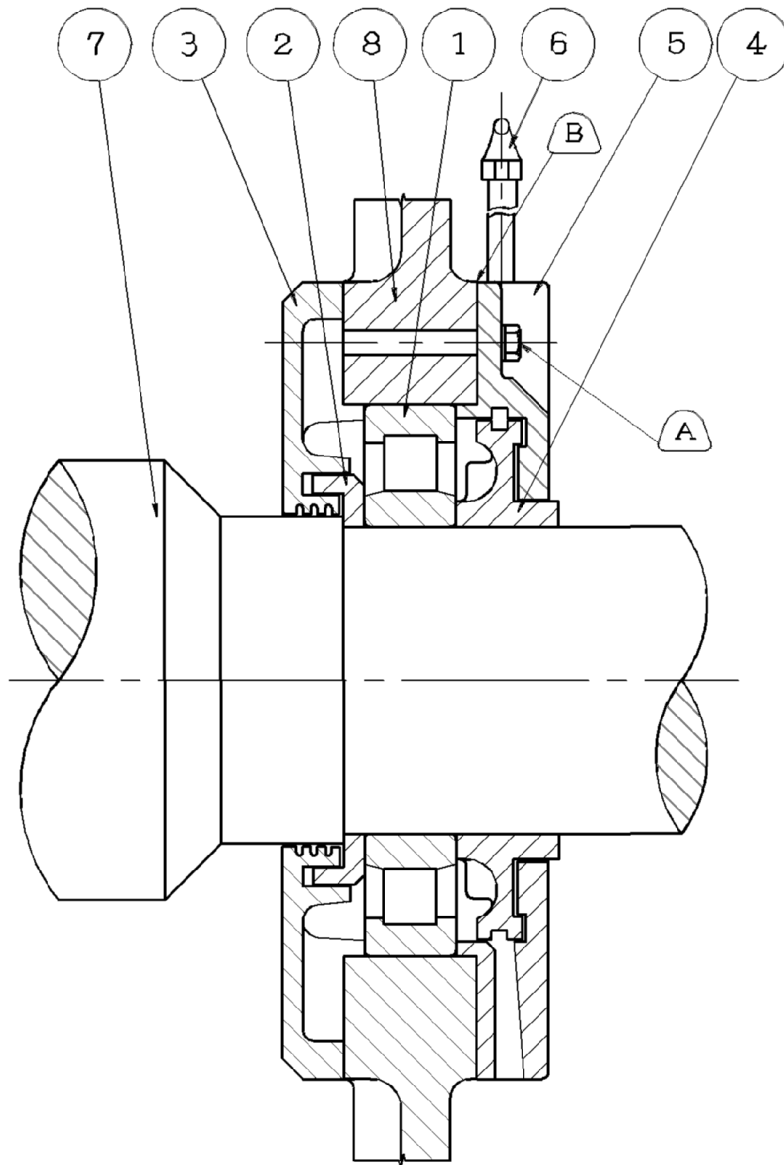


Item	Name	Item	Name
1	Ball Bearing	6	Grease Nipple & Pipe
2	Grease Flinger-Inner	7	Shaft
3	Bearing Cover-Inner	8	Bracket
4	Grease Flinger-Outer	9	Dust Flinger
5	Bearing Cover-Outer		

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

Appendix 8. Typical roller bearing construction drawing

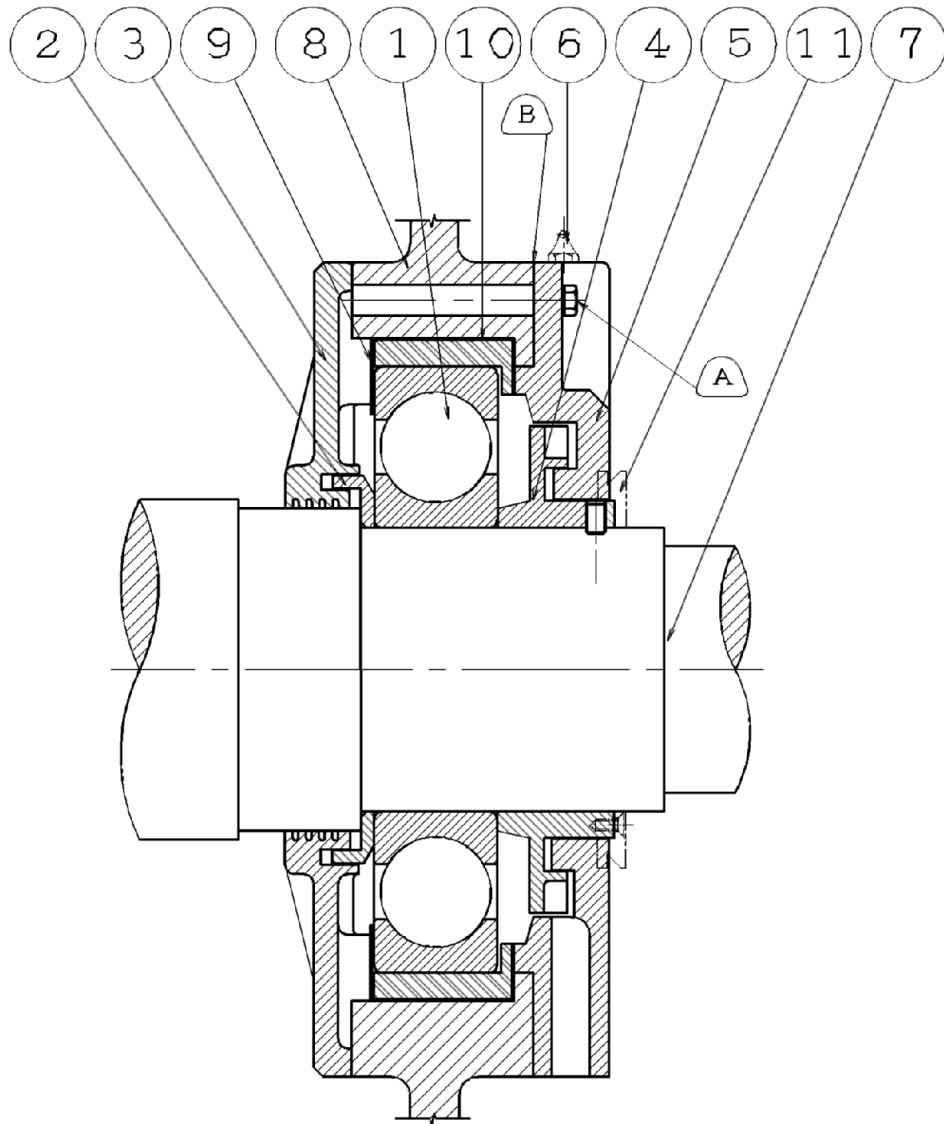


Item	Name	Item	Name
1	Roller Bearing	5	Bearing Cover-Outer
2	Grease Flinger-Inner	6	Grease Nipple & Pipe
3	Bearing Cover-Inner	7	Shaft
4	Grease Flinger-Outer	8	Bracket

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

Appendix 9. Typical ball bearing with insulation bushing construction drawing

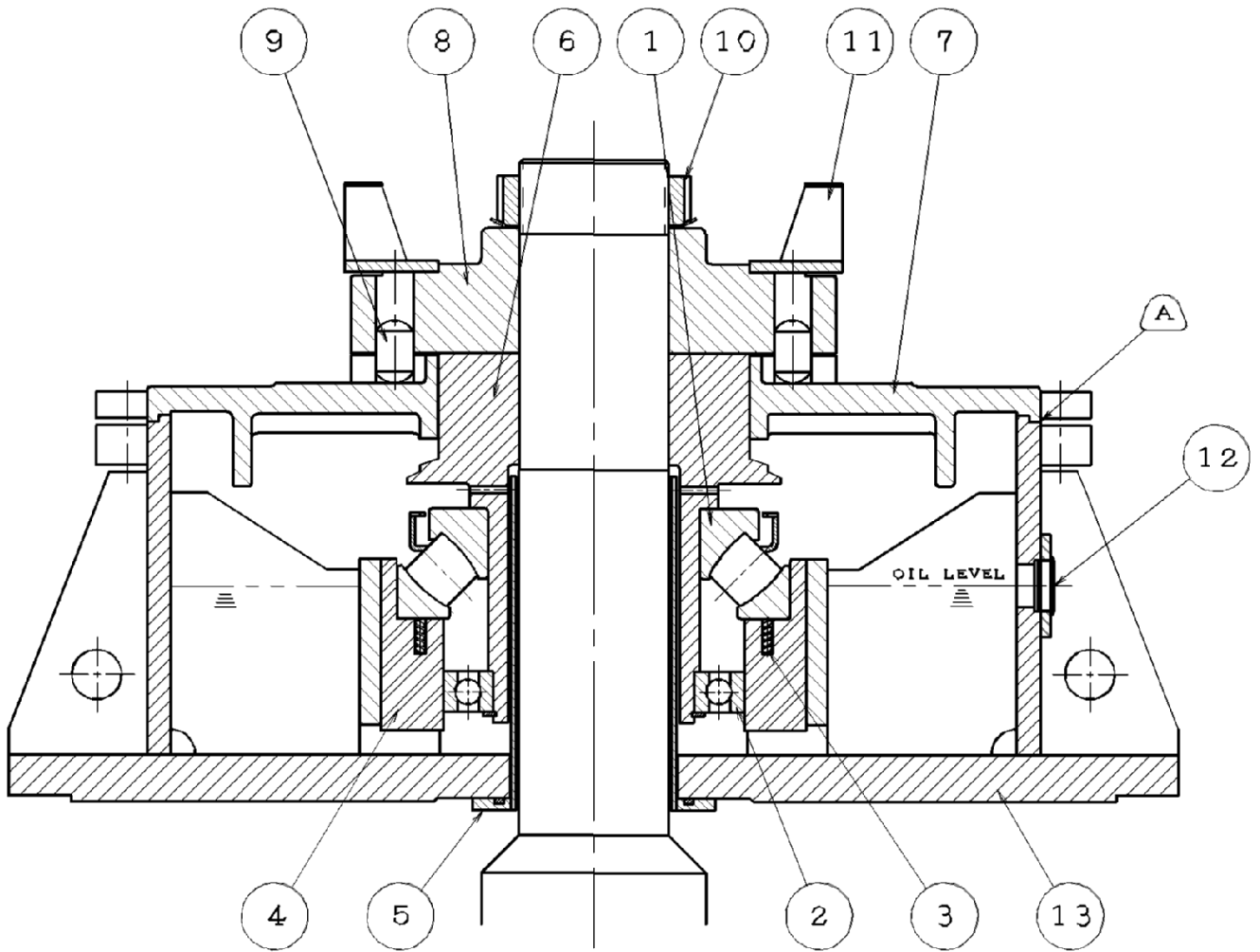


Item	Name	Item	Name
1	Ball Bearing	7	Shaft
2	Grease Flinger-Inner	8	Bracket
3	Bearing Cover-Inner	9	Insulation Plate
4	Grease Flinger-Outer	10	Insulation Bushing
5	Bearing Cover-Outer	11	Dust Flinger
6	Grease Nipple & Pipe		

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

Appendix 10. Typical thrust bearing assembly drawing (vertical machine)

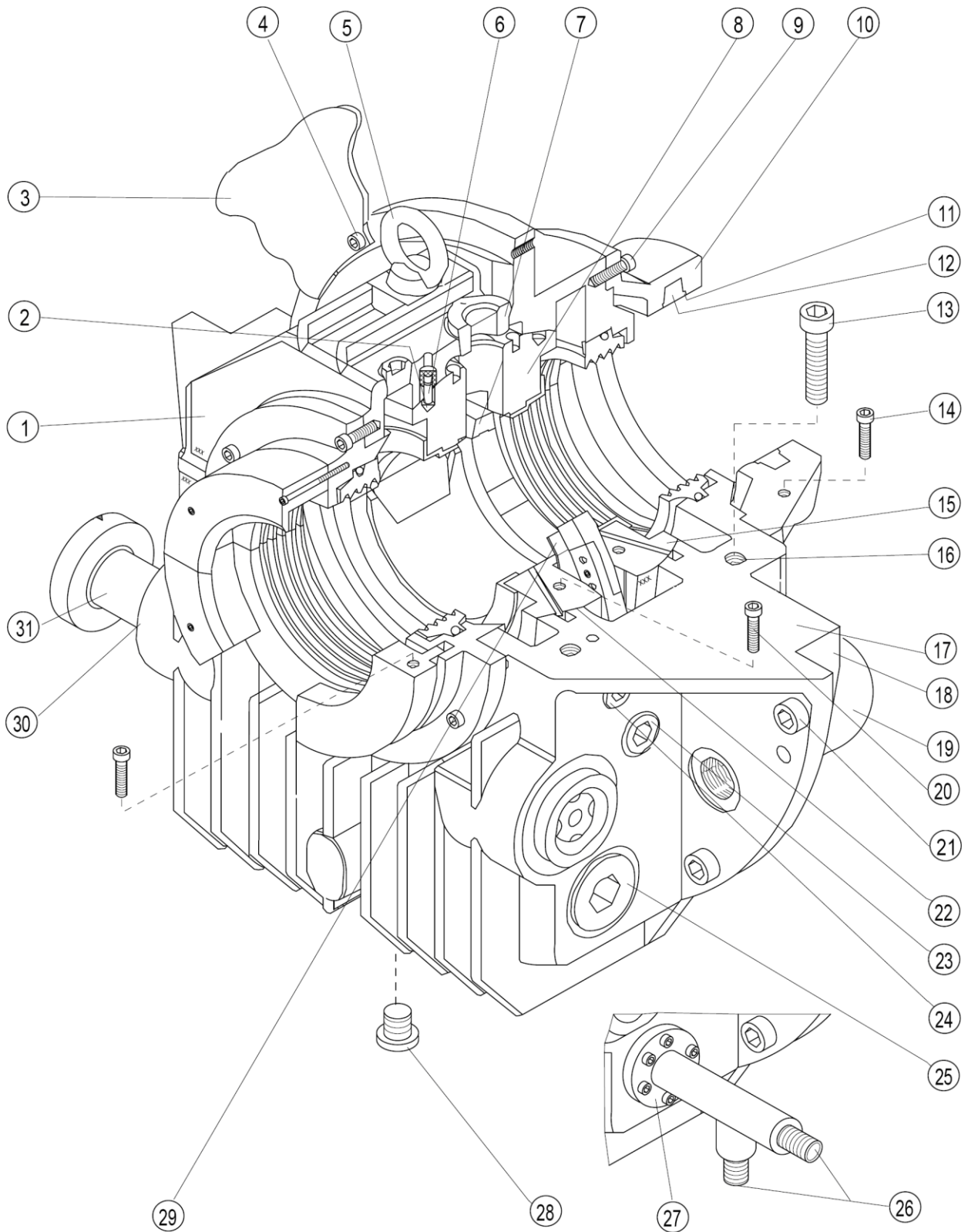


Item	Name	Item	Name
1	Thrust Bearing	8	Ratchet Pin Carrier
2	Ball Bearing	9	Ratchet Pin
3	Spring	10	Lock Nut
4	Insulation Bushing	11	External Fan
5	Oil Standpipe	12	Oil Lever Gauge
6	Upper Bearing Runner	13	Upper Bracket
7	Non-Reverse Ratchet		

Please be noted :

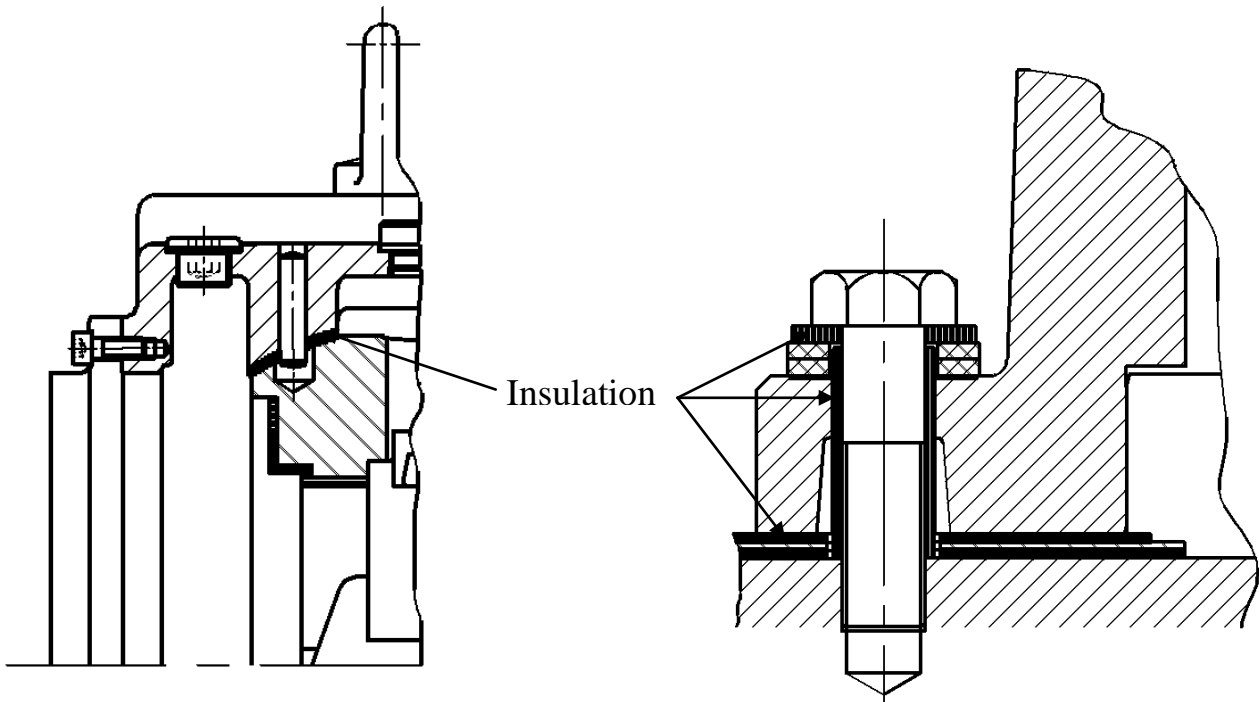
Use sealing compound on spigot of oil tank (A), between non-reverse ratchet (item 7) and upper bracket (item 13).

Appendix 11. Sleeve bearing construction



Item	Name	Item	Name
1	Top half of the housing	2	Positioning pin nut
3	Plate (Assembly opening)	4	Screw
5	Eye bolt	6	Positioning pin
7	Top sight glass	8	Top half of the shell
9	Screw	10	Machine seal
11	Hemp packing seal groove	12	Hemp packing
13	Screw(split line of the housing)		
14	Screw (split line of the machine seal)		
15	Bottom half of the shell	16	Tapped hole
17	Bottom half of the housing	18	Recess
19	Pressure equalizing hose	20	Screw (split line of the shell)
21	Screw	22	Spherical seating
23	Tapped hole for temperature measurement of the journal part		
24	Oil inlet connection hole		
25	Tapped hole for the oil sump temperature measurement		
26	Outlet/Inlet cooling water (optional)		
27	Cooler (optional)		
28	Hexagon head plug (Oil drain plug)		
29	Metal tabs (optional for EMZL.)		
30	Oil outlet connection hole		
31	Oil outlet pipe		

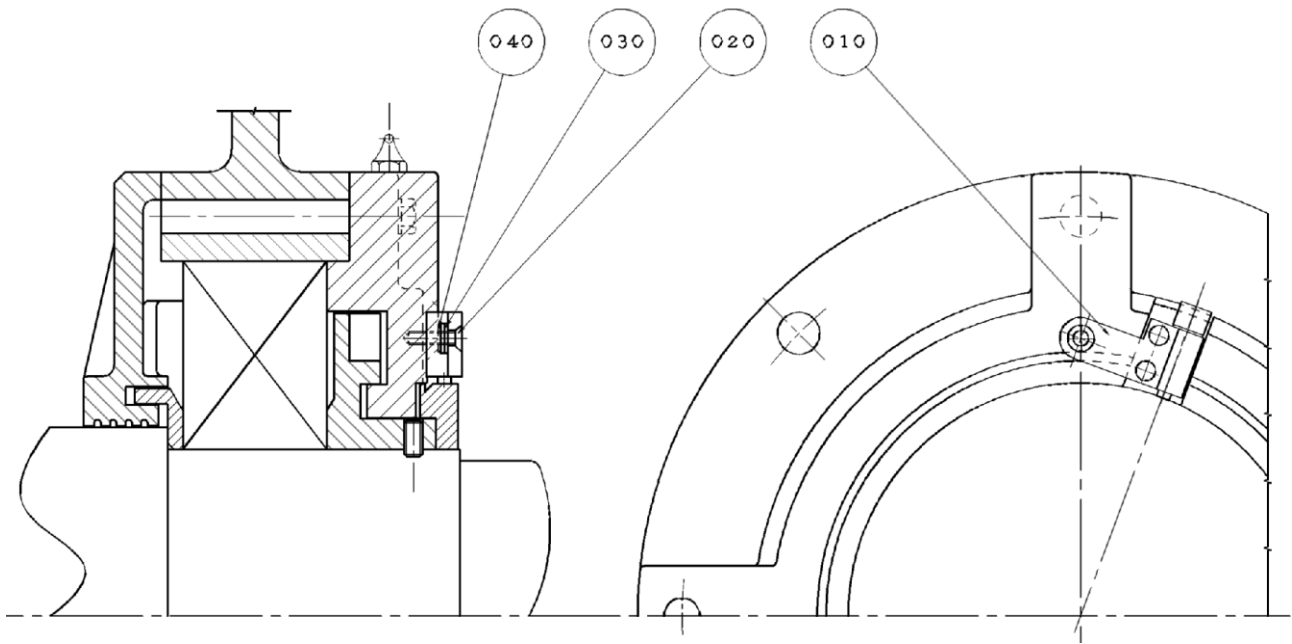
Appendix 12. Mounting of Insulated Sleeve Bearings



Please be noted :

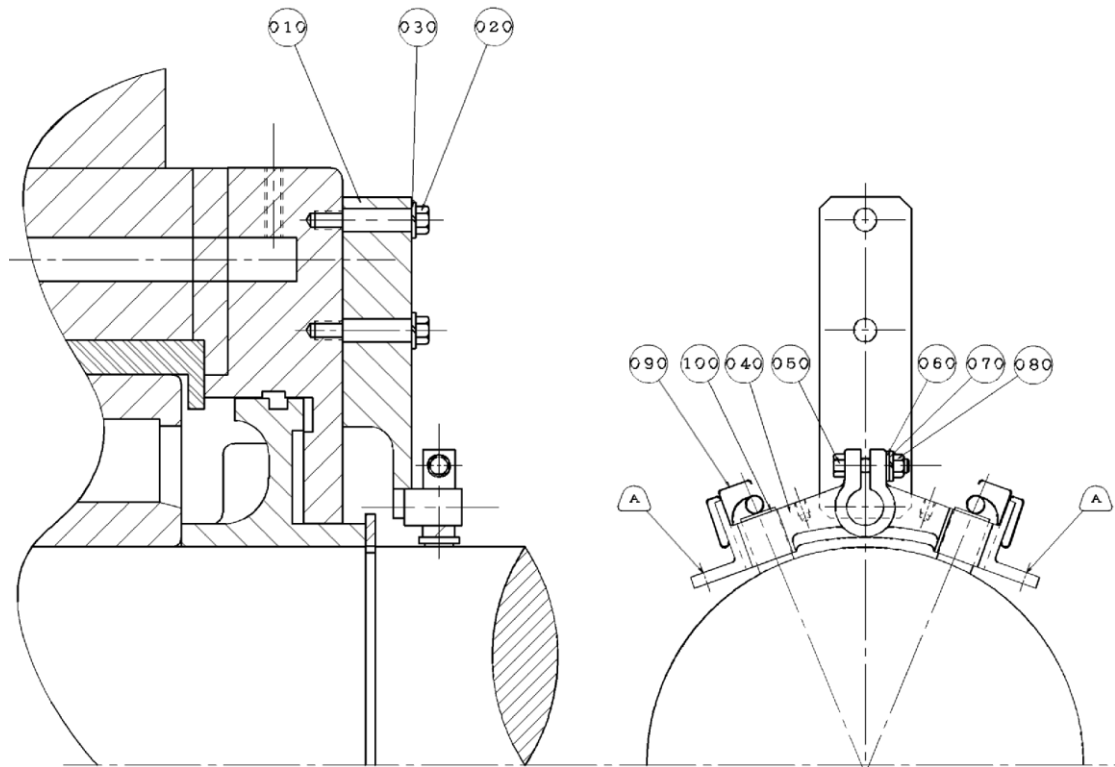
Generally, a pedestal bearing is insulated by means of insulating washers or insulating bushes. (Right hand side of drawing)

Upon request insulated E bearings can be supplied. In this case the spherical seating which accommodates the bearing shell is covered with a non-conductive plastic foil. (Left hand side of drawing)

Appendix 13. Shaft earth brush assembly drawing (TAC)

Item	Name	Item	Name
010	Brush	030	Plain Washer
020	CR C SCREW	040	T Lock Washer

Appendix 14. Shaft earth brush assembly drawing (TECO)



Item	Name	Item	Name
010	Support	060	Plain Washer
020	Hex Bolt	070	S Washer
030	S Washer	080	Hex Nut
040	Brush Holder	090	Brush Spring Assembly
050	Hex Bolt	100	Brush

Please be noted :

Directly connect grounding by a separate wire between one of M6 tap holes (A) on brush holder (item 040) and earth is highly recommended.

Appendix 15. Bolt Torque (kg-cm)

BOLD SIZE	THREAD PITCH	MILD STEEL (property class 4.6 or 4.8)		BRASS
		WITHOUT SPRING WASHER	WITH SPRING WASHER	WITHOUT SPRING WASHER
M4	0.7	25~34	10~13	8.4~11.3
M5	0.8	38~52	20~25	16.2~22.0
M6	1.0	68~97	40~50	28~38
M8	1.25	161~230	90~110	68~91
M10	1.5	288~416	180~230	125~183
M12	1.75	462~660	320~400	230~310
M16	2.0	1010~1440	800~1000	560~760
M20	2.5	2100~3000	1600~2000	1090~1470
M24	3.0	3800~5400	2800~3500	1870~2500
M30	3.5	8000~11500	5800~7250	3800~5100
M36	4.0	14000~20000	10000~12500	6500~8800

Appendix 16. TECO Worldwide Operations

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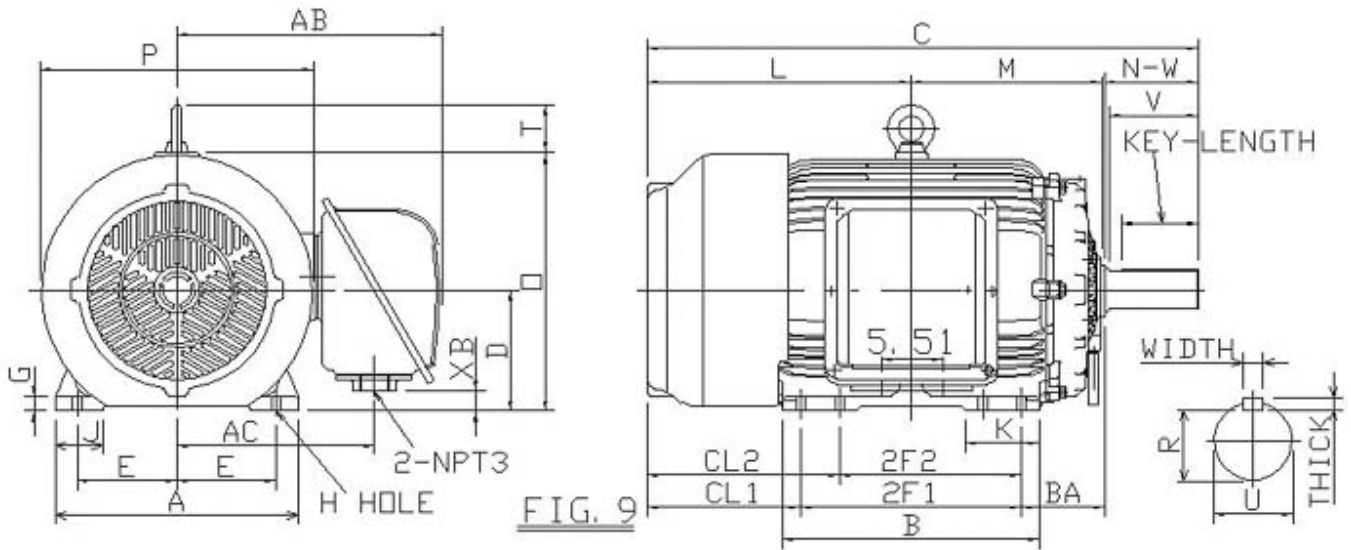


For more information, please contact your local agent
or branch office of TECO-Westinghouse.

3A057D874E REV.04
2010. Dec.

Dimensional Drawing

Catalogue	Type	HP	RPM	Voltage	Hz	Frame Size
PDH2004	AEHH8N	200	1800	460	60	447T



Mounting					A	B	C	CL1	CL2	D	G
E	2F1	2F2	H	BA							
9	20		0.81	7.5	22.05	23.25	49.9			11	1.4

J	K	L	M	O	P	T
4.35		23.9	17.15	23.52	24.76	4.33

Terminal Housing			
AA	AB	AC	XB
2-3	24.02	17.91	1.83

Shaft Extension			Key			Keyseat
N-W	U	V	Width	Thick	Length	R
8.5	3.375	8	0.875	0.875	6.93	2.88

Bearings		Weight Lbs	Drive Method	Dimensions
DE	NDE			
6320	6316	2004	Direct Coupling / Belt Drive	Inches



3. Cooler

TABLE OF CONTENTS

GENERAL-Introduction and Operation	2
EQUIPMENT DELIVERY AND SITING	2
UNLOADING & HANDLING	3
PRIOR TO RUN-IN & START UP.....	4
HYDROSTATIC TEST.....	4
BEARINGS.....	4
LUBRICATION GUIDE.....	4
FANS	4
LOUVERS/SHUTTERS.....	5
V-BELTS	5
GEAR BOX.....	5
VIBRATION SWITCH.....	5
PROCESS START UP	5
HEADER ACCESS PLUGS.....	5
LONG TERM MAINTENANCE	6
FIN CLEANING	6
TUBE CLEANING.....	6
LEAKING TUBES.....	6
WINTER OPERATION (FAN PITCH)	7
AIR DENSITY CHART	7
INSTALLATION OF TAPER TUBE SEALING PINS.....	8
INSPECTION	9
RECOMMENDED SPARE PARTS.....	9
WARRANTY	10

air-x-hemphill

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INTRODUCTION

This manual has been prepared for the purpose of providing general information and recommendations for the operation and maintenance of your air-cooled heat exchanger in order to insure that it will continue to provide you maximum performance in future years under a variety of operating conditions

Normal maintenance items and light repairs as outlined can be achieved with basic mechanics tools. These include adjusting v-belt tension, checking and adjusting fan blade pitch angle, lubrication of bearings, setting of vibration switches and the periodic cleaning of fin tubes, both externally and internally. For more specific and detailed information please refer to the individual manufacturers maintenance instructions for the specific item or component in questions (i.e. motors, fans, bearings, and controls). The Table of Contents indicates the appropriate section where this information is contained.

Naturally, prudent judgement should always be exercised when repairing, replacing or particularly modifying any original parts to make certain that they are equivalent to the original design. Most standard parts and components are maintained in factory stock at *air-x-hemphill* and are available on a 24 hour emergency basis if necessary.

RECEIPT OF EQUIPMENT & SITING

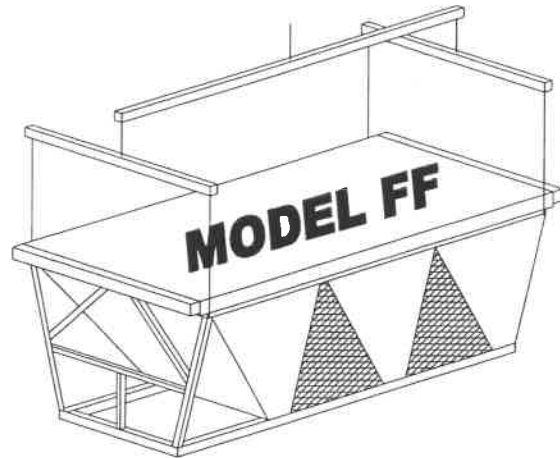
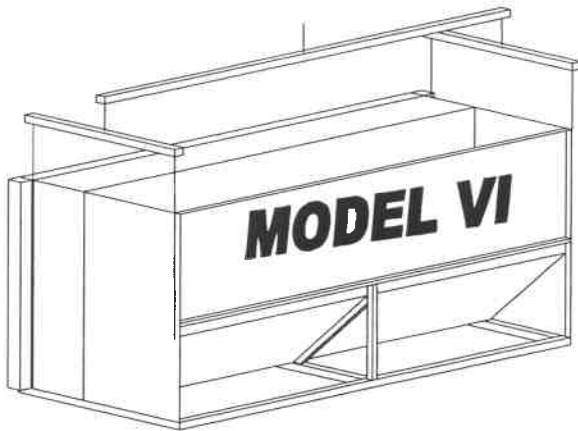
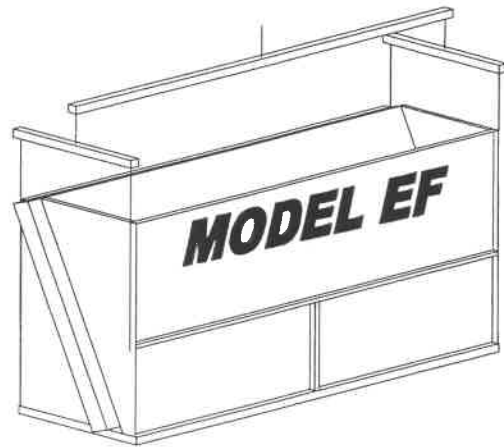
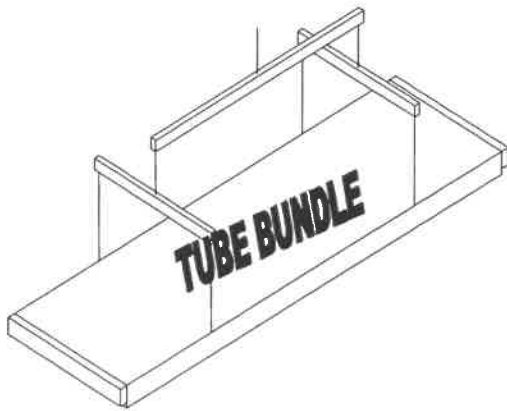
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges, crushed fins, damaged controls are among other items that should be described on the bill of lading document and presented by the carrier. Prompt reporting will expedite filing of claims and will expedite resolution and compensation from the responsible party.

Installation or siting of cooler(s) is the responsibility of the purchaser or contractor who must insure that the cooler intake areas are free from obstructions and provide adequate airflow. Spacing of air coolers should be adequate to avoid hot air recirculation (and the affects of other coolers). The impact of grouping coolers closely together may be compensated for by either elevating and/or separating them.

The cooler is normally completely shop assembled and no field assembly at the job-site is required. However, occasionally optional or special accessories may require disassembly to meet transportation height or width limitations. In the event some assembly of the unit is required, the appropriate assembly instructions will accompany the shipment. The packing list should be checked carefully to see that all parts shipped with the cooler are on hand. These parts may be shipped separately, secured to the skid base (if so designed) or inside the plenum area.

UNLOADING & HANDLING COOLERS

Spreader bars should be used for lifting when the cooler width is over eight (8) feet. The cooler is normally supplied with multiple lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some recommended ways of lifting. Please refer to the illustration below that resembles the type of *air-x-hemphill* cooler to be handled and use it as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e.. EF, VI, FF, ZF, etc.)



PRIOR TO RUN-IN & START UP

HYDROSTATIC TEST

Air-x-hemphill tube bundles (sections) are hydrostatically tested to 1.3 times the design pressure as required by ASME before being released for shipment. To ensure that no damage has been done during shipment and/or installation, it is good practice to hydro test the entire system, including piping, heat exchangers, pumps, etc., prior to start up.

BEARINGS

Check bearings for lubrication. **Caution: DO NOT OVER GREASE.** The manufacturer has greased the bearings and no additional grease is necessary at start up. Remote lubrication lines, when provided, should be loosened at the bearing end, and checked to be sure they are filled with grease from the fitting end. This will ensure that the lube lines are full of grease and free of air and any debris. During high-speed operation too much grease will cause overheating. When dust and water are present bearings should contain as much grease as the operating speed will permit since a full bearing with very slight leakage is the best protection against the entrance of foreign material. Under normal conditions refer to the following table as a general guideline, although certain conditions may require a change of lubrication periods other than those described. Bearing mounting bolts and set screws should be checked for tightness. See bearing manufacturer recommended lubrication chart for recommended maintenance schedule and type of grease.

FANS

Check fan blade bolts and hub bushing set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan blades should be checked for adequate tip clearance and blade pitch angle. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to the section on fans. If the fan is found not to be centered in the fan ring, slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the fan ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from *air-x-hemphill*). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis. Refer to fan manufactures information for proper location and *air-x-hemphill* parts list for design angle. Using a mallet, tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Occasionally coolers may be equipped with an auto-variable type fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied to the fan before starting to check for proper operation. **Before starting, any electric motor should be "bumped" to check for proper direction of fan rotation and air flow.** This will also insure that the motor is in proper working order.

LOUVERS/SHUTTERS

Check all mounting brackets and bolts for tightness. To insure that the linkage is adjusted properly on manually operated louvers, operate blades from a fully open to a fully closed position. On automatic louvers with air motors (optional) air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. For further information on air motors see attached manufacture maintenance instructions.

CAUTION: DO NOT WALK ON LOUVERS OR USE THEM AS A LADDER

V-BELT DRIVES

Check V-Belt tension in accordance with V-Belt tensioning section of this manual.

GEAR BOX

When supplied, check gearbox for oil. Gears are shipped without oil and must be filled and serviced in accordance with the instructions contained later in this operating manual.

VIBRATION SWITCH (OPTIONAL)

For Murphy switches, after the switch has been installed, adjust it by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see the specific manufacture's information.

PROCESS START-UP

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and/or low heat load duty should also be avoided, especially during start up.

HEADER ACCESS PLUGS

Header plugs opposite each tube are installed at room temperature. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. **WARNING: DO NOT** tighten plugs while bundle is under pressure. If any plugs are removed, the soft iron gasket (shoulder plugs only) should always be replaced. Replacement gaskets are in stock and may be ordered from *air-x-hemphill*. When installing the plugs, a thread lubricant and/or anti-galling compound should be used.

WINTER OPERATION – FANS

It is highly recommended that during winter or cold weather operation, when the daily ambient high temperature is below approx 60°F, that the fan pitch be reset to one-half of the summer design pitch. This applies to constant speed applications, i.e. engine drive coolers. Note: The design fan pitch is shown on the Parts List, G/A Drawing and Specification Sheet. Specific instructions for adjusting the fan pitch are contained in the fan section of the IOM.

Reducing air flow (fan pitch) during cold weather offers multiple benefits:

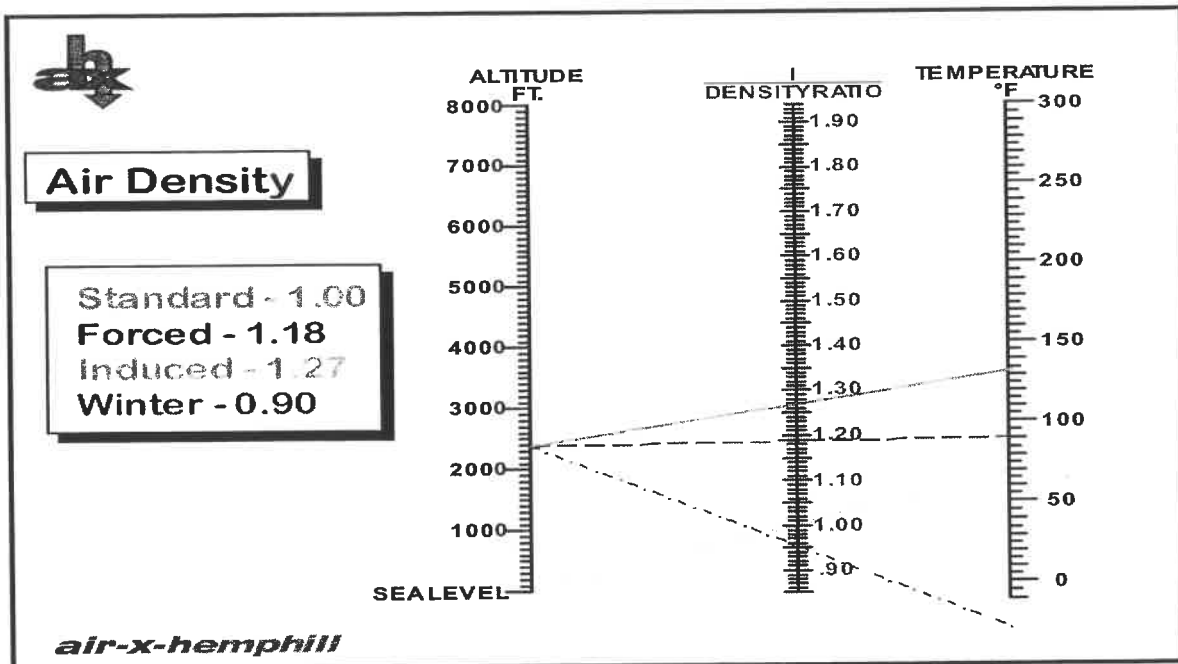
1. It significantly reduces the parasite fan hp and enables more hp to be used for compression.
2. It will result in much improved temperature control for process services and will reduce the chance for over cooling and potential hydrate formation (freeze up).
3. It will significantly reduce stress and blade load on the fan and prevent possible cavitation, overload and stall conditions from occurring when louvers are closed.

The following fan laws apply:

Air Flow - Varies as a *Direct* ratio of fan speed.

Static Pressure - Varies as the *Square* of the change in air flow.

Fan Horsepower - Varies as the *Cube* of change in fan speed and varies *Directly* with air density.



LONG TERM MAINTENANCE

FIN CLEANING

Fins should be kept free of dirt and lint. Bug and lint screens are an available option that will greatly assist in keeping tube bundles clean. Fin tubes can be cleaned by directing compressed air perpendicular to the tubes in a direction OPPOSITE to the normal airflow. Caution should be when using steam or chemicals to clean fins. DO NOT clean or spray water when the section/bundle is hot.

TUBE CLEANING

The internal cleaning of tubes can be done in several different ways:

1. **Mechanical Cleaning** - This consists of using a drill, (or wire brushes), on long rods, and rotating them with air or electric motors. This is normally followed by a treated water or chemical wash or air purge.
2. **Chemical Cleaning** - This consists of circulating chemical solutions through the tubes. The solution should contain inhibitors to avoid corrosion of the tube walls.
3. **High Pressure Water Sprays** - This consists of placing a high-pressure water jet head at the end of hollow rods and pushing through the individual tubes.

NOTE: The last two processes will not work on tubes that have been "plugged" with sealing pins.

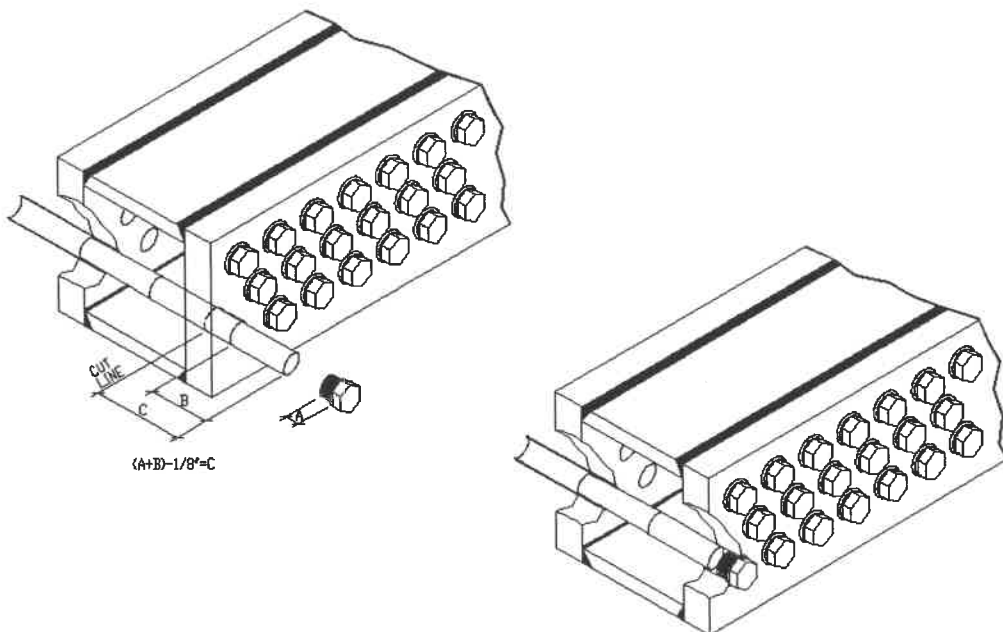
LEAKING TUBES

Tube leaks are generally of two types: 1) leaks through the tube wall itself, and more commonly 2) leaks in the tube end attachment in the header (tube sheet). In the first case it is desirable to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is adversely affected and will vary with each specific application. When cooling performance falls below acceptable limits, the tube bundle may be re-tubed. If leaks develop in the tube end attachment at the tube sheet, re-rolling of the tube may be necessary. Care must be taken in selecting the proper tube expander for the tube size (dia) and gauge of tube to be rolled. When rolling a tube, excess or "over-rolling" must be avoided. Consult the factory for further information on taper sealing pins to plug the tubes and tube roller sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING TUBES

- 1.) Remove header access plug from one end of leaking tube (do not switch plugs in holes) and replace with new gaskets whenever possible.
- 2.) Insert taper sealing pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
- 3.) Measure plug to determine the depth it was originally screwed into header plug sheet. (Dimension A)
- 4.) Measure the distance that the taper pin protrudes from the header plug sheet in "seated" position. (Dimension B)
- 3.) Add the distance measured in Steps 3 and 4 and subtract 1/8". This will be the length which should be cut off the large end of the taper sealing pin. ($A+B-1/8" = \text{Dimension C}$)
- 4.) Remove the taper pin from the end of the tube.
- 5.) Cut the end off the large end of the taper pin to the length calculated in Step 5. CAUTION: Do not cut the pin too short.
- 6.) Re-insert the taper sealing pin in the tube and drive securely into place.
- 7.) Lubricate the access plug and replace it in plug sheet and run in tightly. The plug should now seat tightly and hold taper pin in place.
- 8.) Repeat operation on other end of tube.
- 9.) Hydro-test section to insure proper pressure seal without leaks.

NOTE: If the access plug that was removed does not seal properly, replace it along with the gasket if it is a shoulder type plug.



INSPECTION

TUBES

Tubes should be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity and type of service and atmosphere that the tubes are operating in. Inspection of the tubes should be performed every six months to one year intervals. Tube wall thickness can be checked externally using an ultrasonic technique.

FANS

Fans should be inspected for wear or loose bolts (cracks, pitting and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque. (See fan section of manual).

BEARINGS

In addition to checking bearings as recommended by the manufacture, the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six months.

STRUCTURE

A general inspection of the structure should be performed every six months to a year. This inspection should include checks for corrosion, damaged members, sheeting guards and for loose bolts.

HEADERS

Headers should be inspected for corrosion periodically . This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the individual job specification data sheet.

RECOMMENDED SPARE PARTS

We suggest that one each of the parts that are designated by an asterisk (*) on the individual job parts list contained in the Table of Contents be carried in a stock of spare parts or be readily available. The down time caused by waiting for delivery of a spare part may cost far more in lost production or service than the cost of the item itself.

Spare parts orders should be specified in accordance with the parts list description and always include the *air-x-hemphill* model and Job number of the cooler.

WARRANTY

Air-x-hemphill warrants that the equipment it *manufactures* is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment that has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgment it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AIR-X-HEMPHILL HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

LIMITATION OF LIABILITY

The remedies set forth herein are exclusive. Air-x-hemphill shall not be liable, in excess of the purchase price of the equipment, for any damages, whether in contract, in tort or on any other basis, sustained by the customer or any other person arising from or related to the delivery, use or failure of the equipment or for any delay, special, incidental, consequential, indirect or commercial damages whether due to lost profits or otherwise resulting from the delivery, use or failure of the equipment. If it is ever necessary to contact our plant for service or replacement parts, it is essential that our job number and other identifying data be obtained from the metal nameplate attached to the cooler, or the nameplate attached to the tube bundle header box, which also contains the design pressure, temperature, and serial number.

air-x-hemphill

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airxhemphill.com



401 E. Lowry Road Phone (918) 283-9200
 Claremore, OK 74017 Fax (918) 283-9229
info@axh.com www.axh.com

Proposal / Job No. CK57912F
Date 6/9/2021
Page 1 OF 1

1	Purchaser	NEXT COMPRESSION	Ultimate User	
2	Inquiry / PO#		Destination	200HP STOCK
3	# Units	1	Model	60VI
4	Assembly	PACKAGED	Draft	INDUCED
			Est. Overall Size, Ft	SEE DRAWING
			Est. Wt.	3,950 LBS

THERMAL & MECHANICAL DESIGN

5	Service	EJW	TAW/CW
6	Flow	7.5GPM	7.5GPM
7	Fluid	50%GLY	50%GLY
8	Temp. In / Out, °F	179.0 / 120.7	167.5 / 108.7
9	Pressure, PSI		
10	Pressure Drop, PSI	.2	.4
11	Heat Load, BTU/HR	202950	202950
12	True LMTD	48.4	36.6
13	Overall Rate, U	59.1	59.4
14	Fouling Factor	.0005	.0005
15	Surface, Tube / Total, Sq Ft	72 / 1141	95 / 1510
16	Sections, #	(1) - COMBINED	(1) - COMBINED
17	Design Temp, °F Max / Min	300 / -20	300 / -20
18	MWP / Test Press, PSIG	* 14 / 75	* 14 / 75
19	Pass Arrangement	CROSSFLOW	CROSSFLOW
20	# Tube Rows	3	3
21	# Tube Passes	4	6
22	Tubes, OD x BWG	5/8X16	5/8X16
23	Material	SA214 STEEL	SA214 STEEL
24	# Per Section / Length, Ft	65 / 7	86 / 7
25	Turbulators		
26	Accelerators		
27	Fins, Type	HI-EFF	HI-EFF
28	Material	AL	AL
29	Nozzles, Rating / Type	CPLG	CPLG
30	Material	SA105	SA105
31	#-Inlets / Size In	(1) 2	(1) 2
32	#-Outlets / Size In	(1) 2	(1) 2
33	Headers, Type	REC TUBE	REC TUBE
34	Material	A500	A500
35	Corrosion Allow, In		
36	Grooved Tubesheet	SGL	SGL
37	Plugs, Type	TAPER	TAPER
38	Plugs Material	STEEL	STEEL
39	PWHT		
40	ASME Code & Nat'l Board		
41	CRN		
42	Add'l Specs & Options		
43	API		
44	Louvers / Hail Screen		
45	Inspection / NDT		

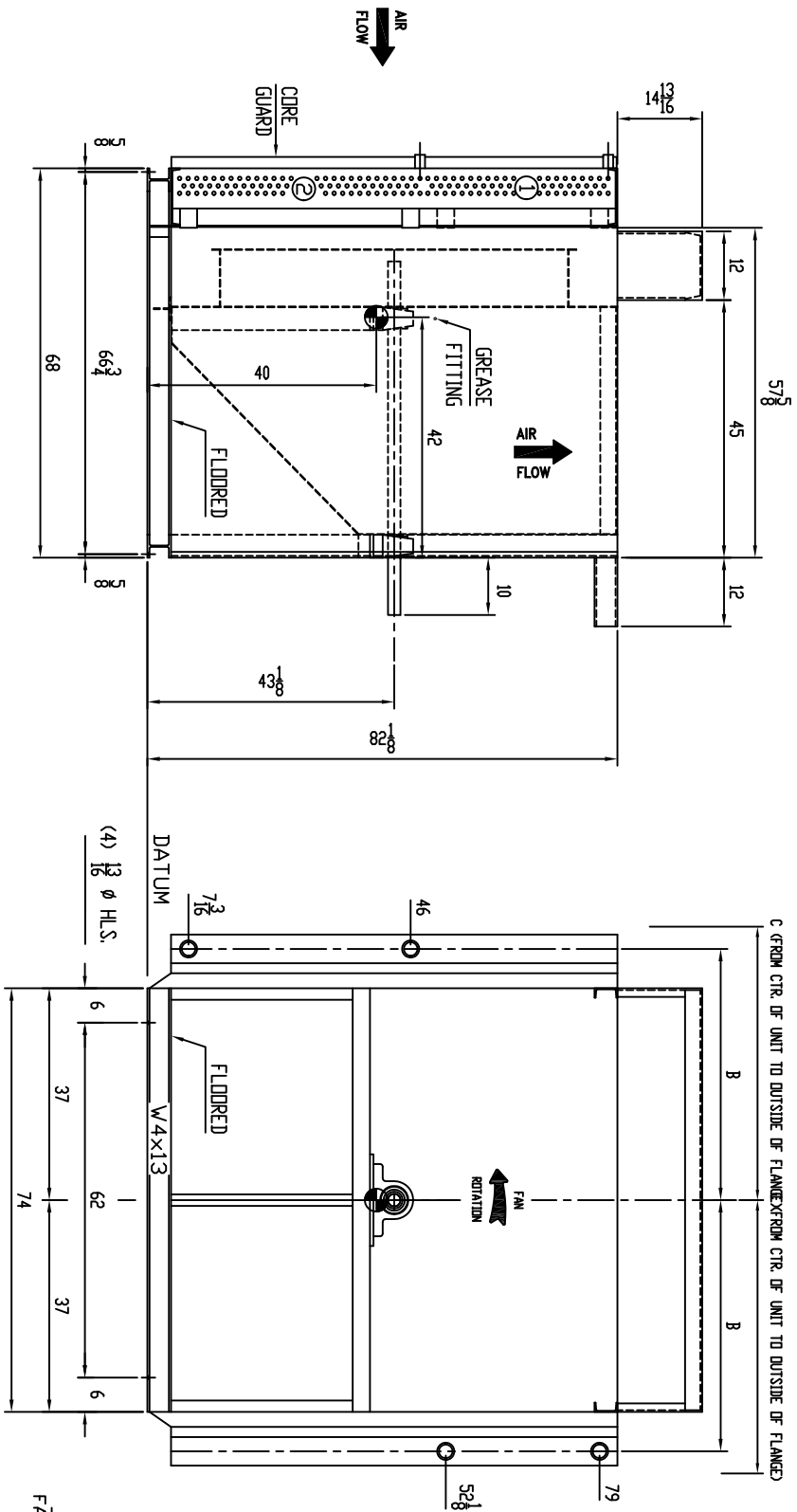
AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA		STRUCTURAL	
46	Ambient Air Temp, In °F	90	Fan(s)	(1) MOORE-S27-5KVT	Type	Guards	CORE
47	Elevation, Ft	2500	Blade Material	ALUMINUM	V-BELT BY OTHERS		
48	Air Flow, SCFM	30,966	HP / Fan	9.3			
49	Outlet Air Temp, °F	101.6	Dia, In / # Blades	60 / 4			
50	Min Air Temp, °F	-20	RPM	640			
51			Tipspeed, FPM	10053			
52	Est. Noise Data:	84 dBA @1m, 64 dBA @ 15m	Pitch, Deg	9			

53 **Additional Info.** *-BUILT TO STANDARD 50# DESIGN BUT DESIGNATED 14# TO AVOID THE NEED FOR PROVINCIAL REGISTRATION

54	
55	
56	
57	
58	

NDT Legend	FX= 100% X-Ray of all header & nozzle butt welds with UT of attachment welds.	BX = 100% X-Ray of all nozzle butt welds.
	SX= Spot X-Ray of 1 long seam & 1 end closure, per header.	H = Hardness testing.
	UT = 100% UT of all header seam and nozzle attachment welds.	

ITEM	SERVICE	MAWP	CODE	NOZZLES		COUPLING REF. DIMENSION			LOUVERS	BUG SCREEN	DRIVE	FAN	FINISH
				INLET	OUTLET	VENT	B	C					
1	EJW (COMBINED) 11.5 GALS	14 PSI @ 300/-20F	NONE	2 - CPLG	2 - CPLG	1-3000	43.88	-	NONE	NONE	ENGINE DRIVE SHAFTS, BELTS, AND GUARDS BY OTHERS	60# MOORE 5K, S27 ED VT 4-BLADE 9.0" PA LH ROTATION 640 RPM @ 9.3 HP REQD	STRUCTURE STD PRIMER W/ COVERDALE L426 DESERT TAN ENAMEL TOP COAT
2	TAW/CW (COMBINED) 15.5 GALS	14 PSI @ 300/-20F	NONE	2 - CPLG	2 - CPLG	1-3000	43.88	-	NONE	NONE	Ø2.1875 FAN DRIVE SHAFT WITH .5 x .25 KNY	Ø2.1875 BORE WITH .5 x .25 KNY.	



RELEASED
FABRICATION OF THIS
ORDER HAS BEGUN

FOR: CONCEPT COMPRESSION		ESTIMATED DRY WEIGHT 3,950#	
P.O. NO:	3141		
TAG NUM:	100418 THRU 100421		
USER:	STOCK 200 HP		
JOB SITE:	AB, CANADA		
JOB NO.:	57912 ABCD		
WORK ORDER:	-		
DR: LES	DATE: 03/05/05	DRG. NO. 57912-CRT	REV 1
CK: M.B.	DATE: 03/05/05	SCALE: FULL	DATE: 03/05/05
BY: MIKE	L.W.	MOVED FAN BEARINGS	
CK:		REVISION DESCRIPTION	



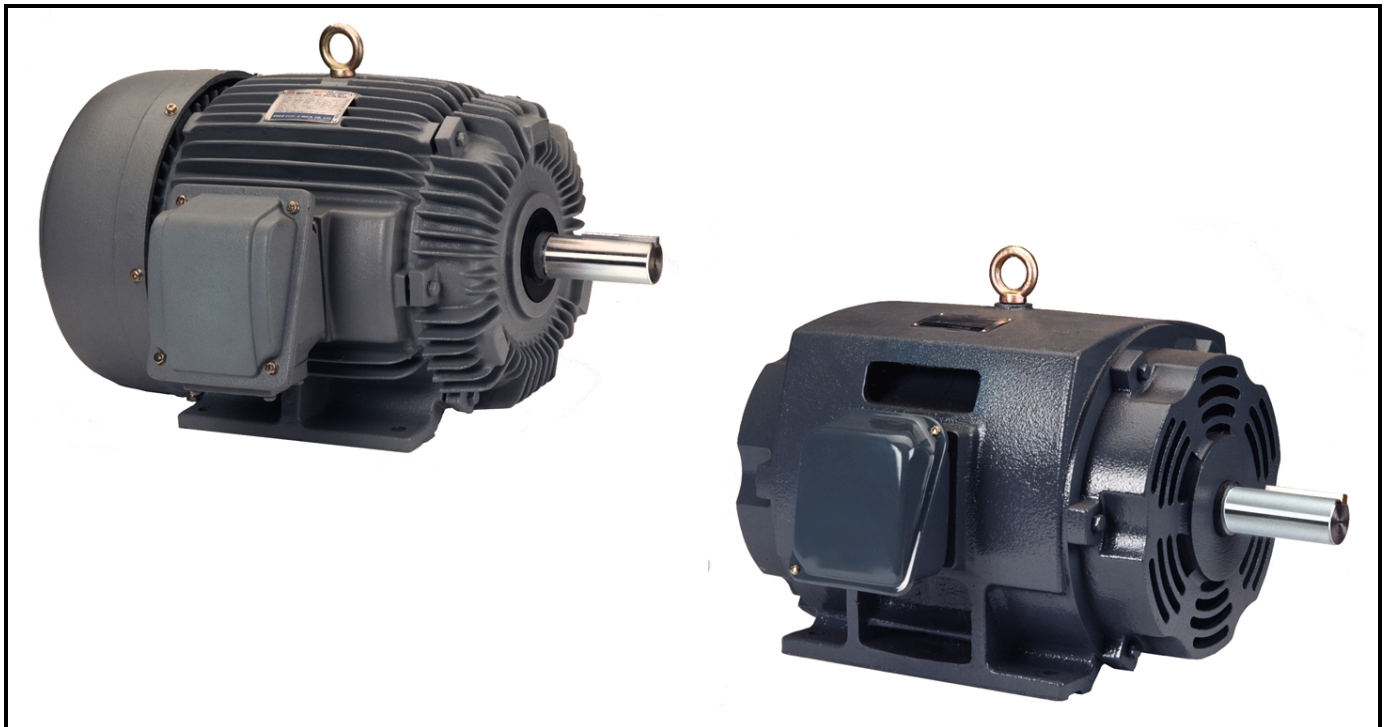
CERTIFIED DRAWING FOR:
MODEL 60 VI QUANTITY: 4

TECO Westinghouse

M O T O R S (C A N A D A) I N C .

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR THREE PHASE INDUCTION MOTORS

Frames 143T - 445T



18060 -109 Ave Edmonton, AB T5S 2K2
Phone: 800-661-4023 780-444-8933 Fax: 888-873-8964

RECEIVING

1. Check nameplate data.
2. Check whether any damage has occurred during transportation.
3. After removal of shaft clamp, turn shaft by hand to check that it turns freely.
4. If motor is to be reshipped (alone or installed to another piece of equipment) the shaft must again be clamped to prevent axial movement.

Note: Remove the bearing clamp before turning the shaft on 284T-449T frame motors.

WARNING

THE FOLLOWING SAFETY PRECAUTIONS MUST BE OBSERVED:

1. Electric rotating machinery and high voltage can cause serious or fatal injury if improperly installed, operated or maintained. Responsible personnel should be familiarized with NEMA MG2; Safety Standards for Construction and Guide Selection. Installation and Use of Electric Motors and Generators; National Electric Code and all local safety requirements.
2. When servicing, all power sources to the motor and to the accessory devices should be de-energized and disconnected and all rotating parts should be at standstill.
3. Lifting means, when supplied, are intended for lifting the motor only. When two lifting devices are supplied with the motor a dual chain must be used.
4. Suitable protection must be used when working near machinery with high noise levels.
5. Safeguard or protective devices must not be by-passed or rendered inoperative.
6. The frame of this machine must be grounded in accordance with the National Electric Code and applicable local codes.
7. A suitable enclosure should be provided to prevent access to the motor by other than authorized personnel. Extra caution should be observed around motors that are automatically or have automatic re-setting relays as they may restart unexpectedly.
8. Shaft key must be fully captive or removed before motor is started.
9. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving overhauling loads.
10. Explosion proof motors are constructed to comply with the label service procedure manual, repair of these motors must be made by TECO-Westinghouse or CSA/UL Listed service center in order to maintain CSA/UL Listing.

LOCATION

1. Drip-proof motors are intended for use where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. Totally enclosed motors may be installed where dirt, moisture, or dust are present and in outdoor locations.
3. Explosion-proof motors are built for use in hazardous locations as indicated by Underwriters label on the motor.
4. Chemical duty enclosed motors are designed for installation in high corrosion or excessive moisture locations.

Note: in all cases, no surrounding structure should obstruct normal flow or ventilating air through or over the motor.

MOUNTING

1. Mount motor securely on a firm, flat base. All ball bearing normal thrust motors up to and including 256T frame size may be side-wall or ceiling mounted; all others check nearest TECO-Westinghouse office for mounting recommendations.
2. Align motor accurately, using a flexible coupling if possible. For drive recommendations, consult with drive or equipment manufacturer, or TECO-Westinghouse.
3. Mounting bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. The recommended tightening torque s for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head, are:

Bolt Size	Recommended Torque (Ft-lb.)	
	Minimum	Maximum
2/8	25	37
1/2	60	90
5/8	120	180
3/4	210	320

4. V-belts Sheave Pitch Diameters should not be less than those shown in Table 1 (NEMA recommended values)
5. Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 ft. per min.

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number					V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	Horsepower at				Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
	Synchronous Speed, RPM							
3600	1800	1200	900					
143T	1.5	1	.75	.5	2.2	4.25	2.2	2.25
145T	2-3	1.5-2	1	.75	2.4	4.25	2.4	2.25
182T	3	3	1.5	1	2.4	5.25	2.4	2.75
182T	5				2.6	5.25	2.4	2.75
184T			2	1.5	2.4	5.25	2.4	2.75
184T	5				2.6	5.25	2.4	2.75
184T	7.5	5			3.0	5.25	3.0	2.75
213T	7.5-10	7.5	3	2	3.0	6.5	3.0	3.375
215T	10		5	3	3.0	6.5	3.0	3.375
215T	15	10			3.8	6.5	3.8	3.375
254T	15		7.5	5	3.8	7.75	3.8	4
254T	20	15			4.4	7.75	4.4	4
256T	20-25		10	7.5	4.4	7.75	4.4	4
256T		20			4.6	7.75	4.4	4
284T			15	10	4.6	9	4.4	4.625
284T		25			5.0	9	4.4	4.625
286T		30	20	15	5.4	9	5.2	4.625

TABLE 1. V-Belt Sheave Pitch Diameters (MG1-14.42)

Frame Number					V-Belt Sheave			
					Conventional A, B, C, D AND E		Narrow 3V, 5V, AND 8V	
	Horsepower at				Minimum Pitch Diameter Inches	*Maximum Width Inches	Minimum Outside Diameter Inches	**Maximum Width Inches
	Synchronous Speed, RPM							
3600	1800	1200	900					
324T		40	25	20	6.0	10.25	6.0	5.25
326T		50	30	25	6.8	10.25	6.8	5.25
364T			40	30	6.8	11.5	6.8	5
364T		60			7.4	11.5	7.4	5.785
365T			50	40	8.2	11.5	8.2	5.785
365T		75			9.0	11.5	8.6	5.785
404T			60		9.0	14.25	8.0	7.25
404T				50	9.0	14.25	8.4	7.25
404T		100			10.0	14.25	8.6	7.25
405T			75	60	10.0	14.25	10.0	7.25
405T		100			10.0	14.25	8.6	7.25
405T		125			11.5	14.25	10.5	7.25
444T			100		11.0	16.75	10.0	8.5
444T				75	10.5	16.75	9.5	8.5
444T		125			11.0	16.75	9.5	8.5
444T		150				16.75	10.5	8.5
445T			125		12.5	16.75	12.0	8.5
445T				100	12.5	16.75	12.0	8.5
445T		150				16.75	10.5	8.5

*Max. Sheave width = 2(N-W) - .25

**Max Sheave width = N-W

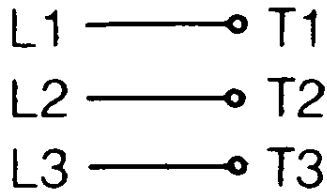
***Sheave ratios greater than 5:1 and center-to-center distance less than the diameter of the large sheave should be referred to TECO-Westinghouse.

POWER SUPPLY & CONNECTIONS

1. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and all local safety requirements.
2. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within -10% of nameplate voltage; or frequency with -5% and with a combined variation not to exceed -10%. 230-volt motors can be used on 208-volt network systems, but with slightly modified performance characteristics as shown on the nameplate.
3. Dual voltage and single voltage motors can be connected for the desired voltage by following connection diagram shown on the nameplate or inside of the conduit box.
4. All Explosion Proof motors have Temperature Limiting Devices in the motor enclosure to prevent excessive external surface temperature of the motor in accordance with CSA/UL standards. Terminals of thermal protectors (P1 & P2) should be connected to the motor control equipment, according to the connection diagram inside of the conduit box.
5. Standard connection diagram for three phase, not thermally protected, dual rotation motors are shown in diagrams A through E.

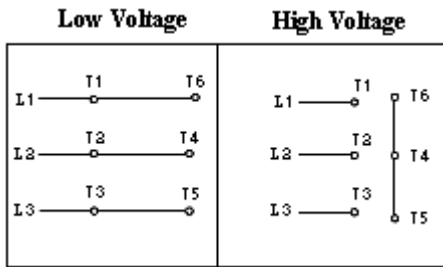
(Note: To change rotation, interchange any two line leads)

A. 3 Lead, Single Voltage

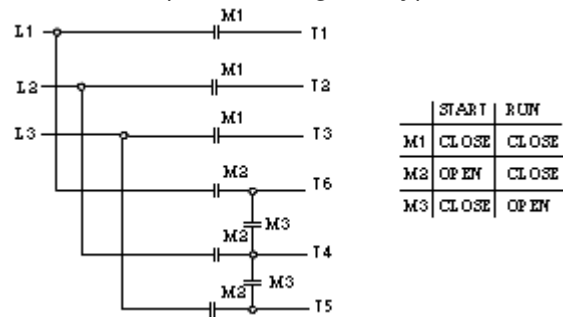


B. 6 Lead, Dual Voltage & Voltage Ratio 1 to 3

B-1 Across the Line Start & Run

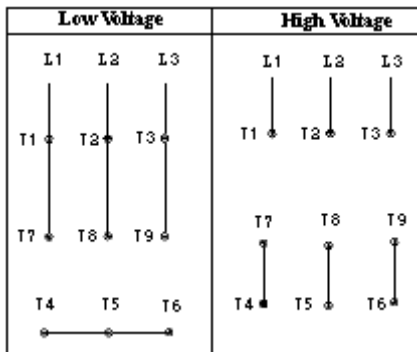


B-2 Wye Start & Delta Run
(Low Voltage only)

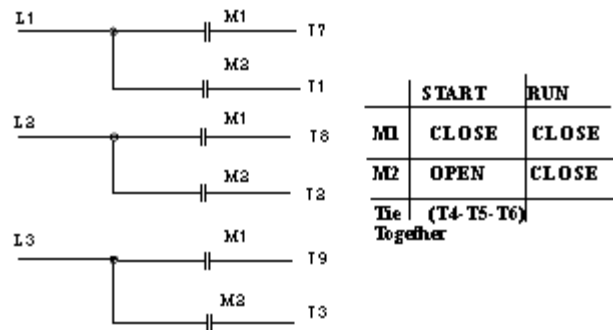


C. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Wye Connected

C-1 Across the Line Start & Run

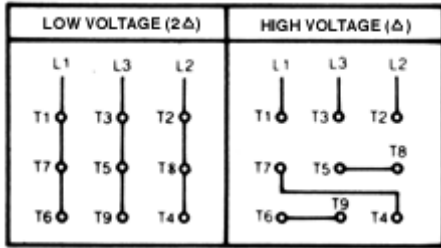


C-2 Part Winding Start
(Low Voltage only)

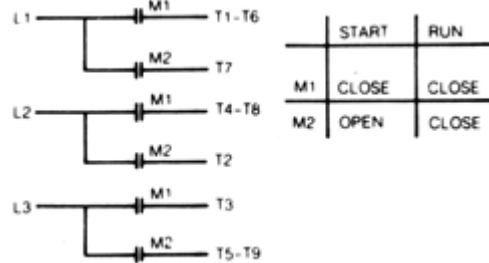


D. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Delta Connected

D-1 Across the Line Start & Run

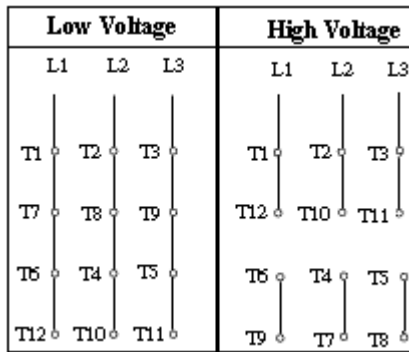


D-2 Part Winding Start (Low Voltage only)

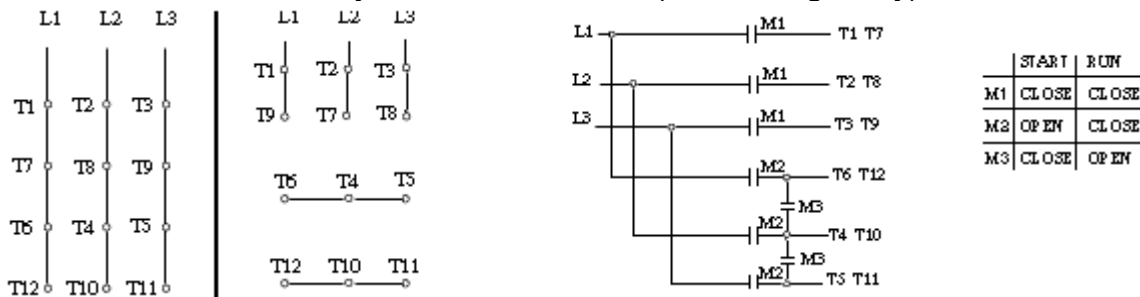


E. 12 Leads, Dual Voltage

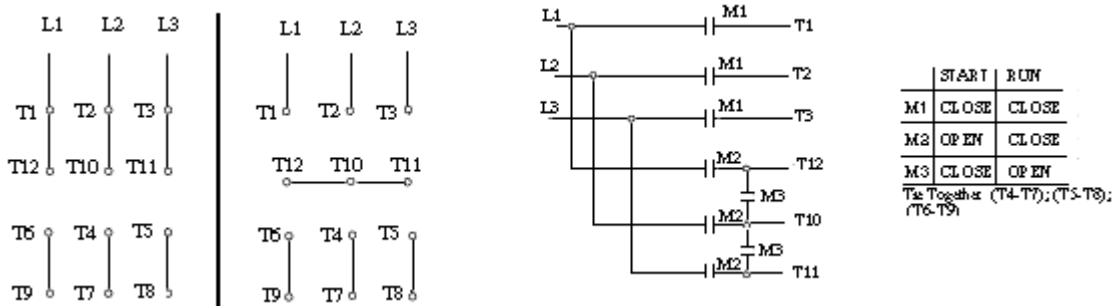
E-1 Across the Line Start & Run



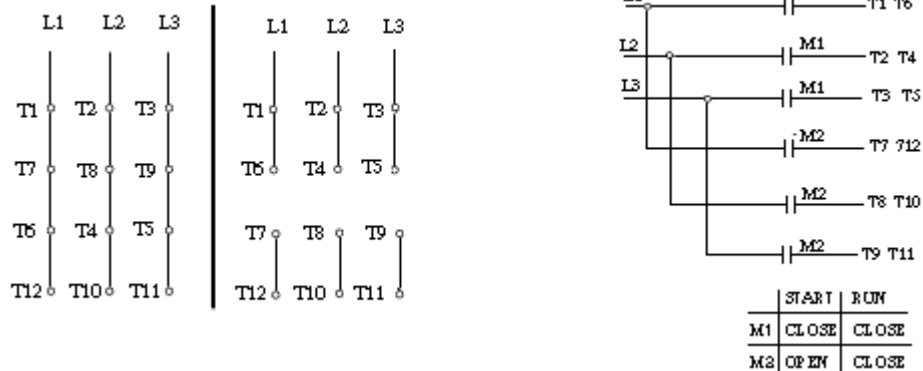
E-2-1 Wye Start & Delta Run (Low Voltage only)



E-2-2 Wye Start & Delta Run (High Voltage only)



E-3 Part Winding Start (Low Voltage only)



*Important: For Part Winding Start, M2 contactor should be closed within two (2) seconds after M1 contactor is closed.
Only 4 pole and above (e.g., 6P, 8P) motors are satisfactory for Part Winding Start at low voltage.

START UP

1. Disconnect load and start motor. Check direction of rotation. If rotation must be changed, ALLOW THE MOTOR TO STOP COMPLETELY. Interchange any two leads of a three-phase motor.
2. Connect load. The motor should start quickly and run smoothly. If no, shut power off at once. Recheck the assembly including all connections before restarting.
3. If excessive vibration is noted, check for loose mounting bolts too flexible motor support structure or transmitted vibration from adjacent machinery. Periodic vibration checks should be made; foundations often settle.
4. Operate under load for short period of time and check operating current against nameplate.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmmeter. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings.

If the resistance is lower than one megohm the windings should be dried in one of the following two ways:

1. Bake in oven at temperatures not exceeding 90°C (194°F) until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase the current through windings until temperature measured with a thermometer reaches 90°C (194°F). Do not exceed this temperature.

MAINTENANCE

INSPECTION

Inspect motor at regular intervals. Keep motor clean and ventilation openings clear.

LUBRICATION

1. Frame 143T-256T: Double shielded and pre-lubricated ball-bearing motors without grease fittings and don't need relubrication, except on Advantage Plus products which have regreasable features.
2. Frames 280TS, 320-449T(TS): Motors having grease fittings and grease discharge devices at brackets. Motors are shipped with grease for initial running. It is necessary to relubricate anti-friction bearing motors periodically, depending on size and type of service. See Table 2 to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

TABLE 2

Horsepower	Standard Conditions	Severe Conditions	Extreme Conditions
1 Thru 30 Hp, 1800 rpm and below	7 years	3 years	180 days
40 Thru 75 Hp, 1800 rpm and below	210 days	70 days	30 days
100 Thru 150 Hp, 1800 rpm and below	90 days	30 days	15 days
1 Thru 20 Hp, 3600 rpm	5 years	2 years	90 days
25 Thru 75 Hp, 3600 rpm	180 days	60 days	30 days
100 Thru 150 Hp, 3600 rpm	90 days	30 days	15 days

Note:

- A. Standard conditions: 8 hours operation per day, normal or light loading, clear and 40°C ambient conditions.
 - B. Severe conditions: 24-hour operation per day or light shock loading, vibration or in dirty or dusty conditions.
 - C. Extreme conditions: With heavy shock loading or vibration or dusty conditions.
 - D. For double shielded bearings, above data (lubrication frequency) means that the bearing must be replaced.
3. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease discharge hole.
 4. Use ExxonMobil Polyrex EM grease or equivalent polyurea based grease unless special grease is specified on the nameplate.
 5. If relubrication is to be performed with the motor running, stay clear of rotating parts. After regreasing, allow the motor to run for ten to thirty minutes.

RENEWAL PARTS

1. Use only genuine TECO-Westinghouse renewal parts or as recommended by TECO-Westinghouse.
2. When you order renewal parts please specify complete information to TECO-Westinghouse office/agent such as type, frame no., poles, horsepower, voltage, series no., quantity, etc.

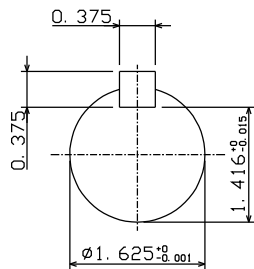
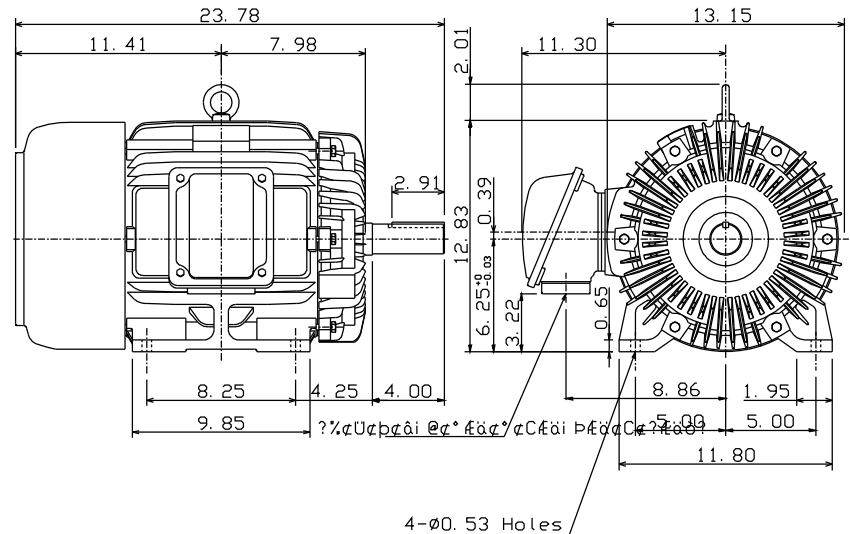
**FOR FURTHER INFORMATION PLEASE CONTACT
TECO-WESTINGHOUSE MOTORS (CANADA) INC.**

TEC Westinghouse		OUTLINE DIMENSIONS		MOTOR TYPE: AEHH8N-44-	
DATE		3-PHASE INDUCTION MOTOR		FRAME NO. 254T	

Pole	HP	kW	Hz	VOLT	r/min(rpm)
4	15	11	60	230/460	1800

Ins	Rating	Dimension in	Approx Weight	Bearings	
F	CONT.	inch	303 lbs	DE: 6309ZZ	NDE: 6307ZZ

Totally Enclosed Fan Cooled Squirrel Cage Rotor.



⊙		?	D
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DWG.	??	??	TEC Westinghouse	DWG NO.	31057M088190
CHKD.	??	??			
APPD.	??	??			

8 7 6 5 4 3 2 1

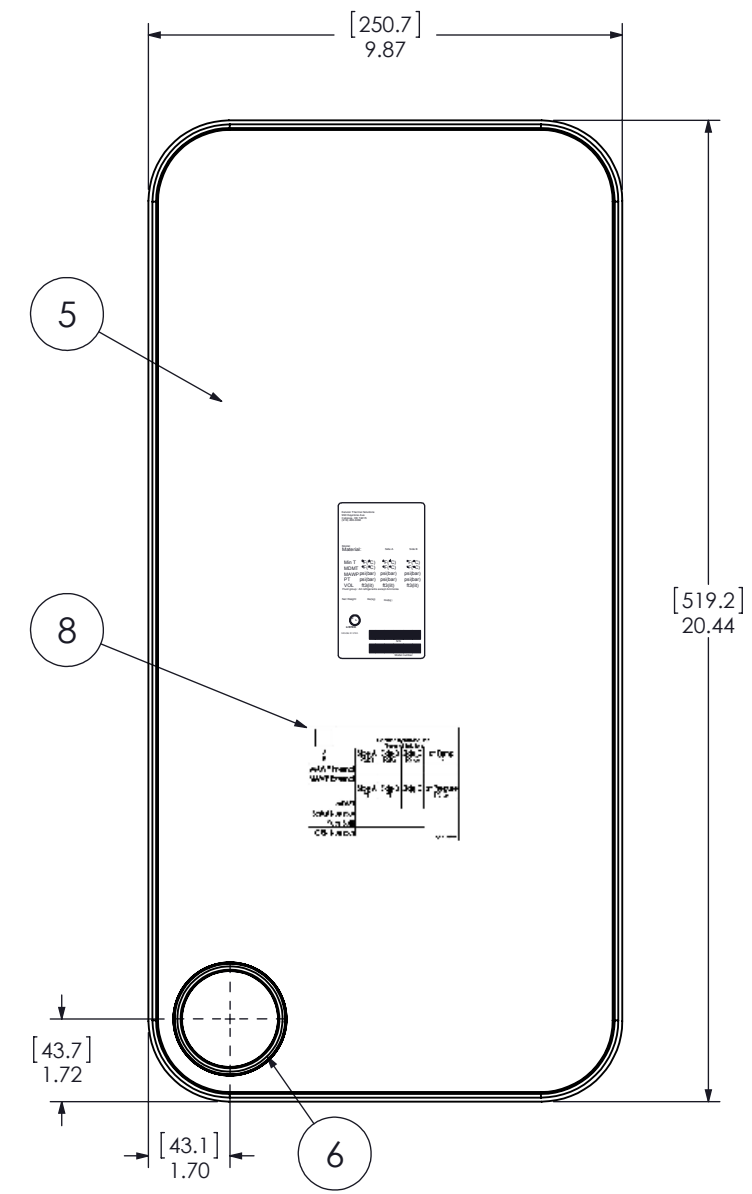
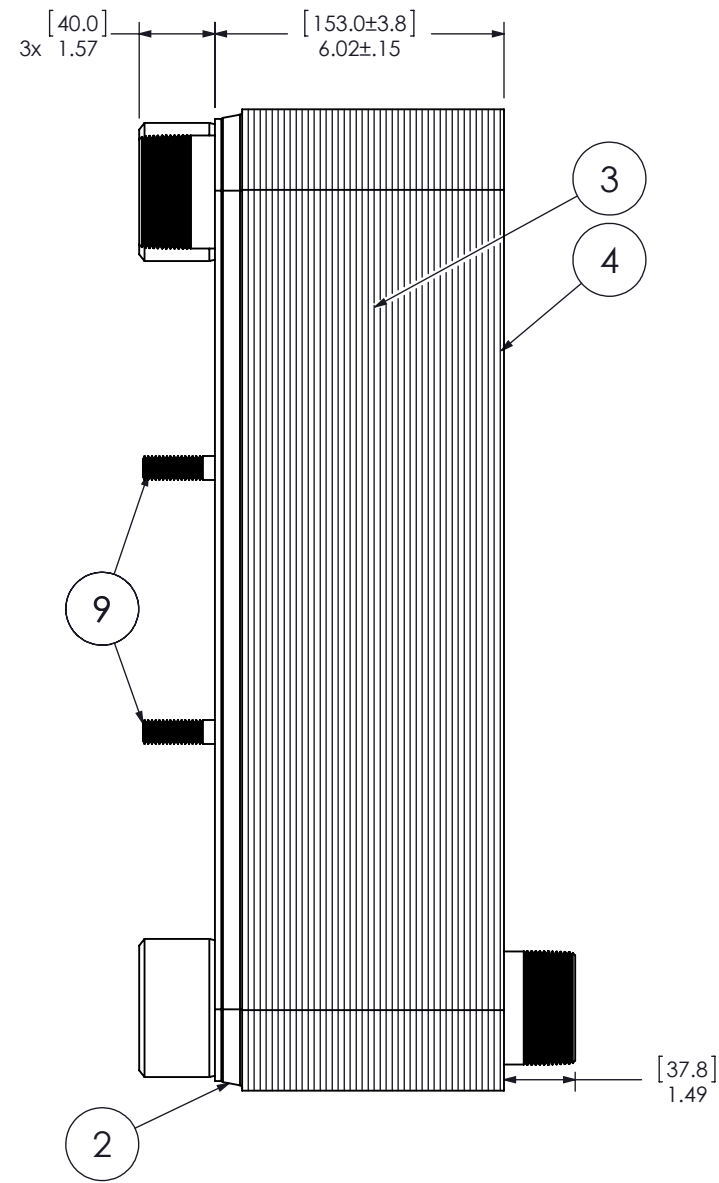
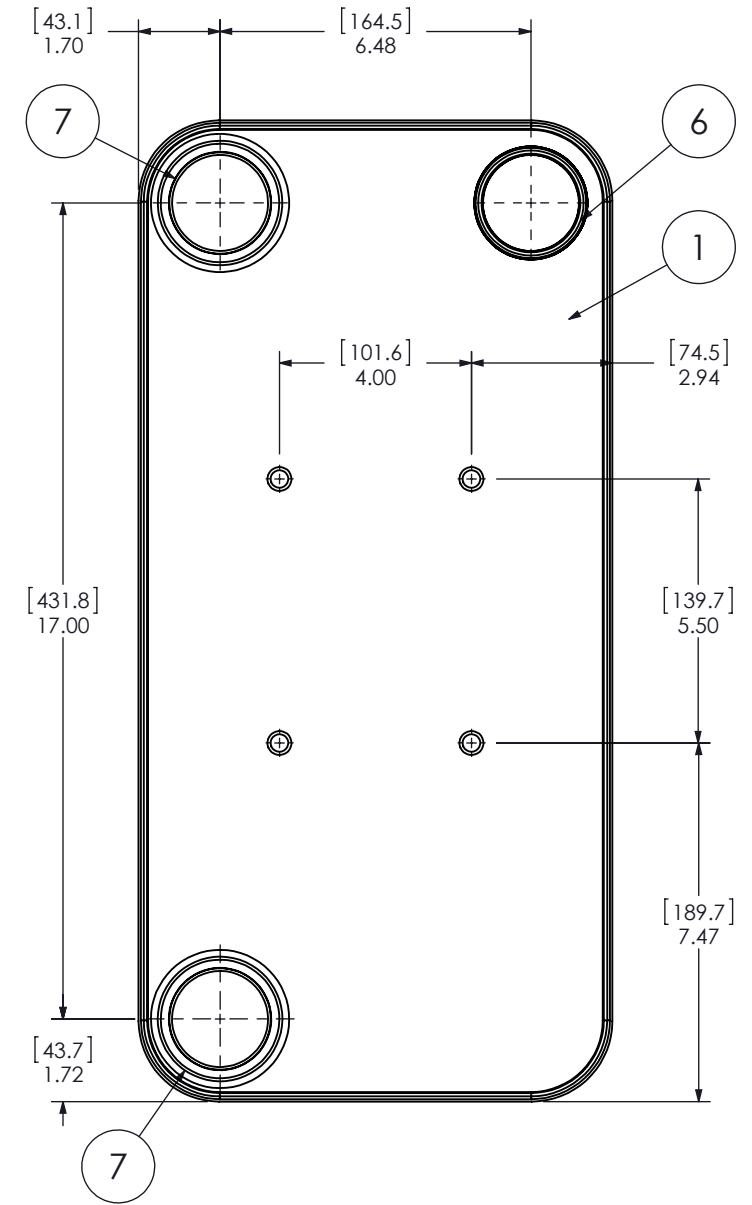
Note:
1. For welding fitting on back, see BPHE-WIM-001

Bill Of Material			
Item	Description	Material	QTY
1	RP 1020 (2.087,2.087,2.087,-)7GA	SA-240 304	1
2	TOP SEAL PLATE, 10X20 0.016" THICK	SA-240 316/316L	1
3	MAIN PLATE/BSP, 10X20L (O,O,O,O) 316L-CU 0.016" THICK	SA-240 316/316L	59
4	MAIN PLATE/BSP, 10X20L (X,X,X,O) 316L-CU 0.016" THICK	SA-240 316/316L	1
5	RP 1020 (2.087,-,-,-)7GA	SA-240 304	1
6	2" MALE NPT FITTING	SA-312, SA-479, SA-249 304	2
7	2-1/2" BUTT WELD FITTING	SA-312, SA-479, SA-249 304	2
8	NAME PLATE LABEL BPHE ASME+CRN	Stainless Steel 304	1
9	100105091-FLASH ARC WELD STUD 1/2"-13X1.5"	Stainless Steel 304	4

D

C

B



D

C

B

Customer Approval Drawing

Model Nomenclature: FP10X20L-60/13284 ASME+CRN
Material #:

Customer:
Customer Item #:
Customer Approval: **APPROVED**
Approval Date: *By Kevin Huartson at 3:40 pm, Oct 23, 2018*

Pressure, Temperature and Codes:
Maximum Allowable Working Pressure: 450 psig (31 bar)
Maximum Allowable Working Temperature: 350°F (177°C)
Minimum Design Metal Temperature (MDMT): -320°F (-196°C)
Test Pressure 535psig (36.9 bar)
Corrosion Allowance: 0.00"
Code Approvals:
UL listed (U.S. A. and Canada)
CRN
NBN
ASME Section VIII Division I 2017 Edition
Braze Alloy: Copper
Manufactured 100% in the U.S.A. by Kelvion Thermal Solutions, Catoosa, OK

Rev. Lev.	Date	Description	ECN #	Dr.	Ck.
0	10/18/18	NEW DRAWING	-	JTD	MP

Dimensional Notes:
Dimensions are in inches (mm), for reference only.
Tolerances are ± 0.06 (1.5) unless otherwise noted.

Kelvion Thermal Solutions proprietary information.
All rights reserved. This drawing may not be copied, and no information or data contained within the drawing may be disclosed without the express written release by Kelvion Thermal Solutions.
Kelvion
Catoosa, OK 74015

Drawing No.	Shop Dwg No.	Date	Scale
CUS4727	13284	10/18/2018	1:4

Sheet: 1 of 1
Dwn: JTD Appr: MP

8 7 6 5 4 3 2 1



4. Instrumentation / Auxiliary Equipment

3-Way Pilot Valves

Models 4057D & 4457A

Typical applications

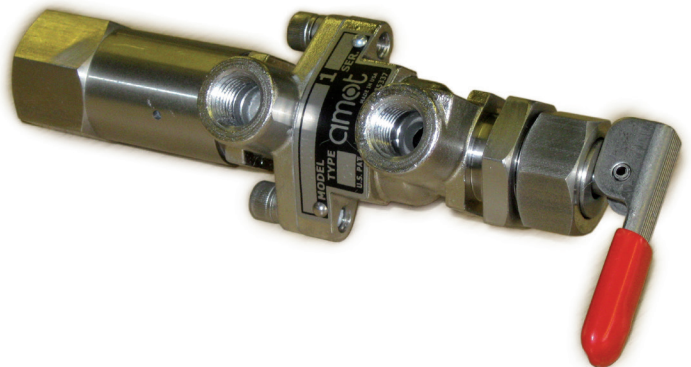
- Developed for use in manual and automatic control systems:
 - Hydraulic fluid control
 - Actuator control
 - Pneumatic panel systems
 - Safety control systems

Key features and benefits

- Suitable for use on many types of fluids:
 - Clean air
 - Natural gas
 - LP gases
 - Petroleum base lubricants
 - Hydraulic oils
 - Many other fluids
- Balanced force design
 - Pressure can be applied to any port
 - Simplified system design
- Can be panel or bracket mounted
 - Simple, flexible and low cost installation
- Uses the AMOT patented "Tad Pole" seal
 - Provides lower friction and longer cycle life than conventional o-ring seals




**Model 4057D
(Aluminum)**



**Model 4457A
(Stainless steel)**

Accreditations available

- PED Suitable for Group 1 & 2 liquids & gases (Ensure materials are compatible)
- ATEX  II 3G TX X
- CE 4057D Complies with all relevant EU directives

amot

www.amot.com

3-Way Pilot Valves - Models 4057D/4457A

Contents

Overview	3
Operation	3
Installation	3
Valve Characteristics	3
Operator, finish and thread	3
Options	4
How to Order	4
Specification	4
Dimensions	5
Maintenance and Service Parts	6
How to order service kits	6
Service kit model number structure	7
Service parts	7
Contact	9

3-Way Pilot Valves - Models 4057D/4457A

Overview

AMOT Models 4057 and 4457 3-way valves have been developed for use in manual and automatic hydraulic or pneumatic control systems.

They offer versatility in operating requirements and allowable pressure limits. For a ¼" size control valve, they offer exceptional flow capacity.

Operation

The 3-way pilot valves feature modular construction and incorporate a sliding spool. The standard spool has a small center dead spot position and no valve port overlap. With the spool fully to the left (rest position), Port 2 is open to Port 3 and Port 1 is closed. With the spool moved to the right (actuated position), Port 2 is open to Port 1 and Port 3 is closed.

The valves are available with a variety of manual and pressure operators and with manual, pressure or spring returns. See the valve types table below for the standard variations which are available.

Installation

- All connections are made with ¼" pipe thread fittings.
- Apply a quality thread sealant such as Loctite™ Pipe Sealant to pipe thread connections, but do not permit it to enter the valve passages.
- Teflon thread sealing tape may be used but must be applied so that shreds of the tape do not enter the valve.
- Avoid over-tightening fittings on the valve port bosses as they may be cracked, especially when Teflon thread sealing tape is used.
- All 4057D/4457A valves may be bracket mounted; most are also suitable for panel mounting.

Valve Characteristics

Operator, finish and thread

Operator, finish and thread (B) ¹		Valve type (see page 6)	Description
4057D Gulf-proofed NPT	4457A Stainless steel NPT		
019F	001F	CA	Manual operated - 2.2 kg (5 lbs) force required
020F	002F	CB	Manual pull spring return - 6.8 kg (15 lbs) force required
022H	004H	CD	Manual or pressure operated manual return - 0.69 bar (10 psi) pressure or 2.72 kg (6 lbs) force required
023H	005H	CE	Manual or pressure operated spring return - 1.79 bar (26 psi) pressure or 7.27 kg (16 lbs) force required
032J	014J	CF	Double pilot operated - 0.69 bar (10 psi) pressure required
031H	013H	CG	Pressure operated spring return - 1.79 bar (26 psi) pressure required
025H	007H	CP	Manual latch or pressure operated spring return when released - 1.8 bar (26 psi) pressure required
029K	-	CT	Adjustable pressure operated spring return - Adjustable from 0.3 - 1.03 bar (5 - 15 psi) pressure required
035J	-	C2	Double pilot operated spring return in one direction - 0.69 bar (10 psi) and 1.79 bar (26 psi) pressure required
027K	-	SB	Manual latch or pressure operated spring return when released - 0.9 bar (13 psi) pressure required

NOTES:

¹ If your operator, finish and thread code does not correspond with the given values, please contact the facility to confirm your operator, finish and thread code.

3-Way Pilot Valves - Models 4057D/4457A

Valve Characteristics Continued

Options


- All valves may be bracket mounted; most are also suitable for panel mounting.
- A satin chrome nut, part number: 3496L001 is available as an option, and it substitutes for the standard nut to improve the appearance for the front of a panel mounting.
- Red knob: part number 681L001 is available for types CA, CB, CD or CE as a substitute for the standard black knob.

How to Order

Use the table below to select the unique specification of your 4057/4457 3-Way Pilot Valves.

Examples	4057D	019F	1	-AA	Code description	Comments
	4457A	001F	1	-AA		
Basic model (A)						
Basic model (A)	4057D				Anodized aluminum	
	4457A				Stainless steel	
Operator, Finish & Thread (B)						
Operator, finish and thread (B)		*			For operator, finish and threads available, refer to the operator, finish and thread table on page 3.	
Spool (C)						
Spool (C)			1		Standard center dead spot	ALL valve types EXCEPT SB
			2		Valve port overlap	
			5		Standard center dead spot	4057D - SB ONLY
			6		Valve port overlap	
Customer special requirements (D)						
Customer special requirements (D)				-AA	Standard	May be omitted
				-***	Customer special code	

Specification

	4057D		4457A	
	Metric units	English units	Metric units	English units
Body material	Anodized aluminum		Stainless steel	
Standard spool and internal materials	Anodized aluminum		Anodized aluminum	
Standard seal materials	Viton		Viton	
Maximum temperature	120°C	248°F	120°C	248°F
Flow coefficient	Kv = 1.04	Cv = 1.2	Kv = 1.04	Cv = 1.2
Maximum pressure at ports 1, 2 or 3	8.62 bar	125 psi	8.62 bar	125 psi
Maximum pressure at ports A or B	10.3 bar	150 psi	10.3 bar	150 psi
Maximum pressure at port C (types CT & SB ONLY)	8.62 bar	125 psi	Not available	
Net weight	0.3-0.9 kg	0.6-2 lbs	0.8-2.6 kg	1.7-5.7 lbs
Accreditations available	PED		Suitable for Group 1 & 2 liquids & gases (Ensure materials are compatible)	
	ATEX		II 3G TX X	
	CE	4057D Complies with all relevant EU directives		

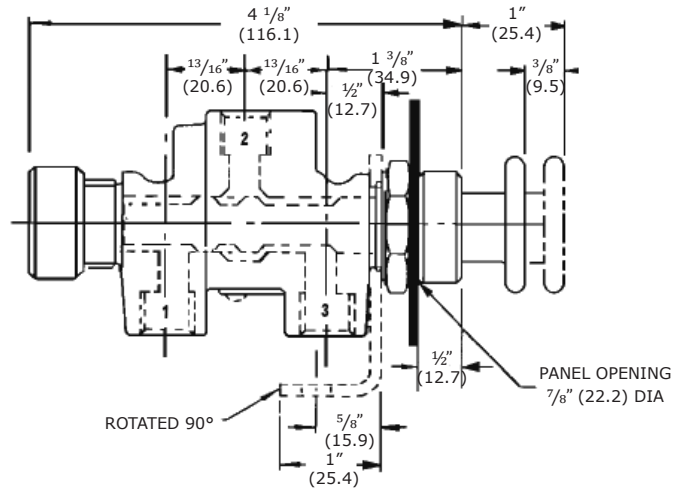
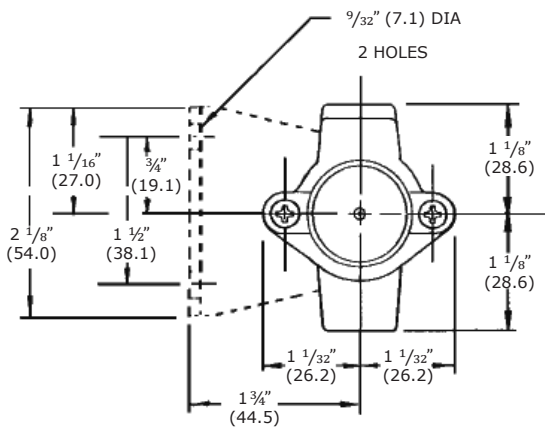
3-Way Pilot Valves - Models 4057D/4457A

Dimensions

Type CA: Manual operated - 2.27 kg (5 lbs) force required

Type CB: Manual pull spring return - 6.8 kg (15 lbs) force required

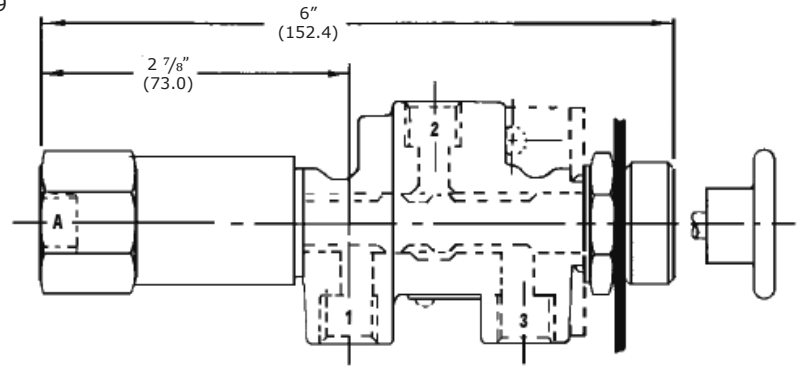
Dimensions - inches (mm)



Type CD: Manual or pressure operated manual return - 0.69 bar (10 psi) pressure or 2.72 kg (6 lbs) force required

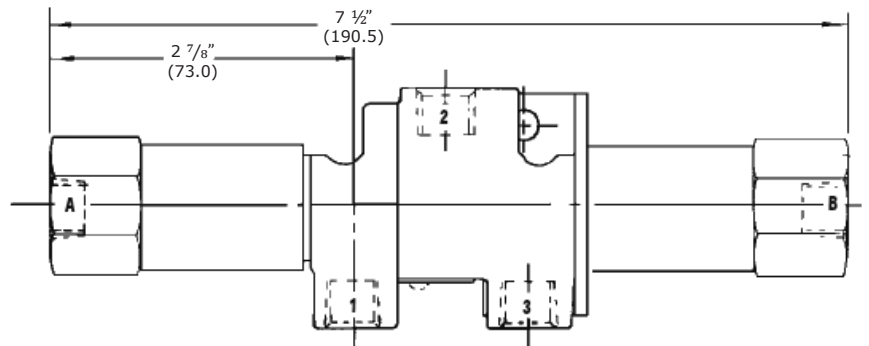
Type CE: Manual or pressure operated spring return - 1.79 bar (26 psi) pressure or 7.26 kg (16 lbs) force required

Type CG: Pressure operated spring return - 1.79 bar (26 psi) pressure required



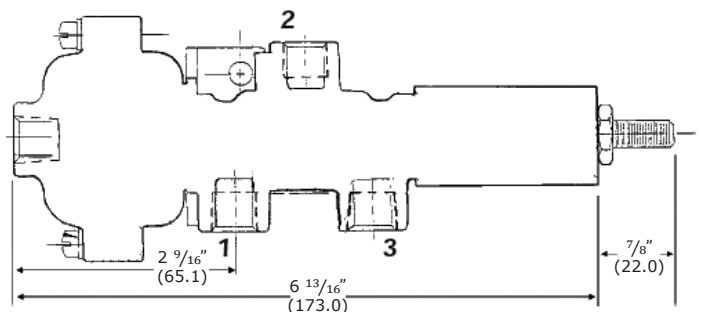
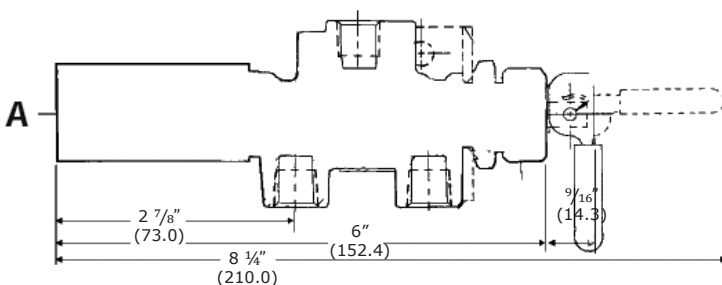
Type CF: Double pilot operated - 0.69 bar (10 psi) pressure required

Type C2: Double pilot operated spring return in one direction - 0.69 bar (10 psi) and 1.79 bar (26 psi) pressure required



Type CP: Manual latch or pressure operated spring return when released - 1.8 bar (26 psi) pressure required

Type CT: Adjustable pressure operated spring return - Adjustable from 0.3 to 1.03 bar (5 to 15 psi) pressure required

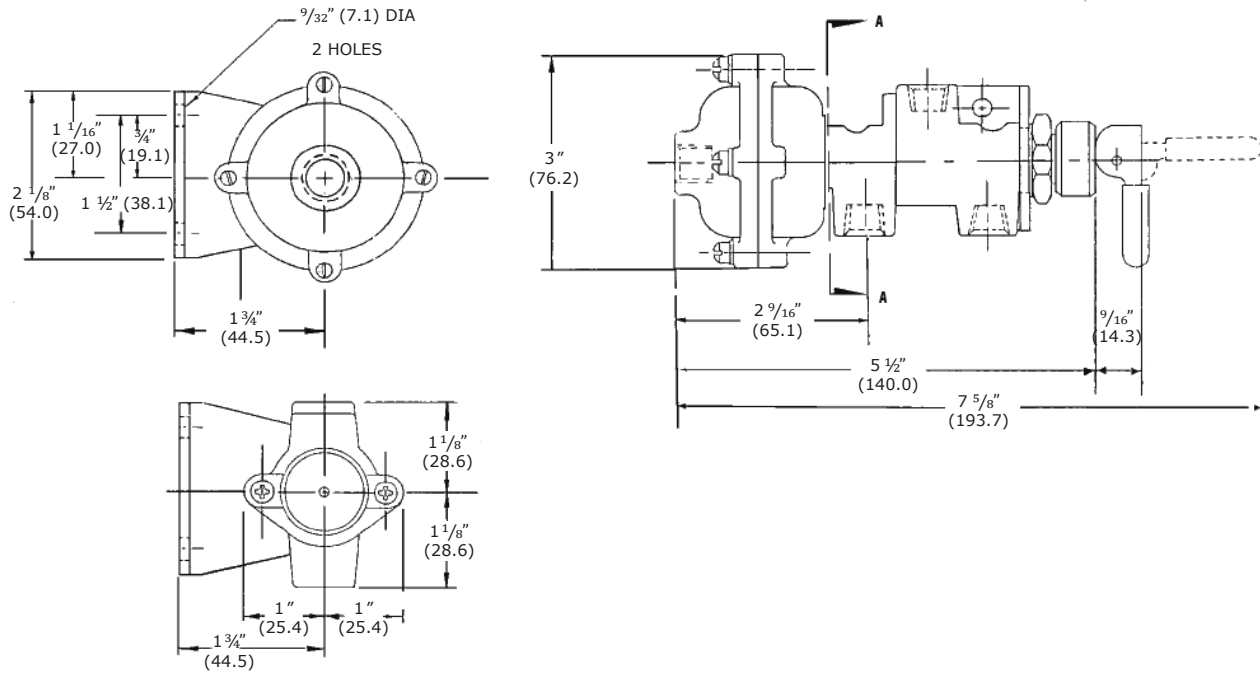


3-Way Pilot Valves - Models 4057D/4457A

Dimensions Continued

Dimensions - inches (mm)

Type SB: Manual latch or pressure operated spring return when released - 0.9 bar (13 psi) pressure required



Maintenance and Service Parts

Over time, exposure to foreign chemicals and particulate matter as well as prolonged operation at extreme conditions may reduce the effectiveness of the valve. At such time, AMOT Pilot Valves can be restored to original performance simply by installing an AMOT pilot valve service kit. Service kits include all new seals and diaphragm required for normal maintenance.

When these valves are used in safety control systems, it is recommended that the system be checked MONTHLY for proper functioning. The unit must be kept clean and free of dust. The end cap is to be regularly inspected for signs of damage or rust and replaced if necessary.

How to order service kits

Service kits are available with seals and diaphragm required to service the valve. Order service kits by the service kit model number which is identified by the basic valve model and operator, finish and thread code found in the AMOT valve part number.

Ensure that regular inspections of the valve and end cap are carried out to ensure that it is kept clean and free from wear, damage or rust. If the valve shows signs of process fluid leakage, examine the seals. If the valve is subjected to prolonged periods of high vibration at low temperatures, it is possible that wear may occur to the disc assembly and it is recommended that the valve is isolated and safely removed from the system, and returned to AMOT for examination.

AMOT designs and tests all its products to ensure that high quality standards are met. For good product life, carefully follow AMOT's installation and maintenance instructions; failure to do so could result in damage to the equipment being protected or controlled.

Refer to the AMOT valve part number printed on the valve nameplate and the AMOT valve part number structure in the how to order section on page 4.

3-Way Pilot Valves - Models 4057D/4457A

Maintenance and Service Parts Continued

Service kit model number structure

- 1) Identify the basic valve model, located in the Basic model (A) section of the AMOT valve part number.
- 2) Identify the operator, finish and thread code, located in the Operator, finish and thread (B) section of the AMOT valve part number.
- 3) Use those codes in the service kit identification table below to identify the proper service kit needed to service the valve. Two examples are shown in the table below.

Service kit identification				
Basic model (A)	Operator, finish and thread (B) ¹			Service kit model number
4457A	001F			9113X001
	002F			
	004H			
	005H			
	007H			
	013H			
	014J			
4057D	019F			
	020F			
	022H			
	023H			
	025H			
	031H			
	032J			
	035J			
	027K			
	029K			9128X001
Examples				
Valve part number			Service kit model number	
4057D	029K	2		9128X001
4457A	001F	1	-AA	9113X001

Service parts *(refer to diagrams on page 8)*

Ref no.	Service kit parts		Description
	Qty. ²		
	9113X001	9128X001	
3	4	4	Spool seals
4	2	-	Piston seals
47	-	1	Diaphragm
48	-	1	Thread seal

NOTES:

¹ If your operator, finish and thread code does not correspond with the given values, please contact the facility to confirm your operator, finish and thread code.

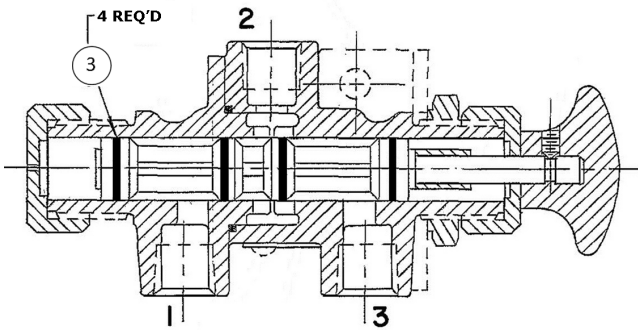
² Service kit 9113X001 contains extra parts when used with valve types CA, CB, CD, CE, CG and CP. Please discard of any extra parts.

3-Way Pilot Valves - Models 4057D/4457A

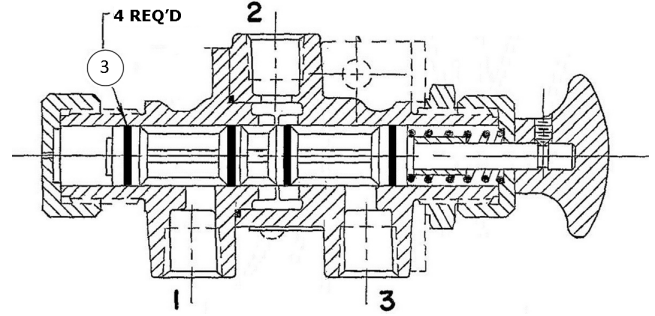
Maintenance and Service Parts Continued

Service parts continued

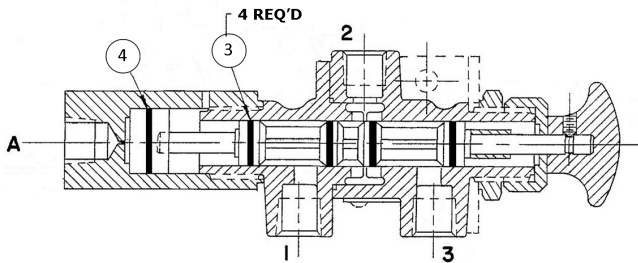
Type CA



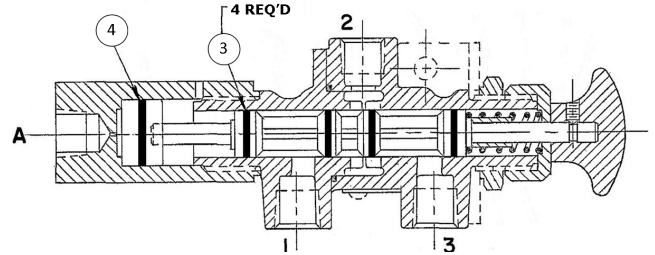
Type CB



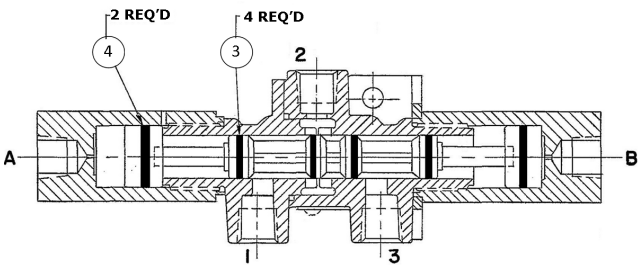
Type CD



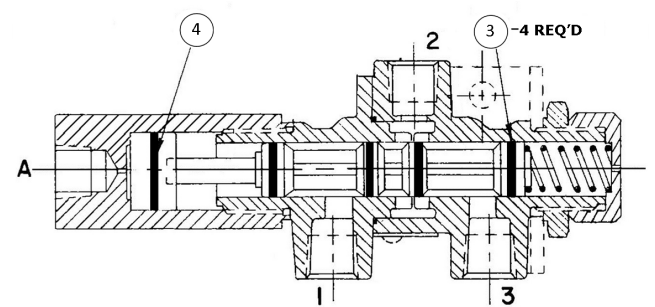
Type CE



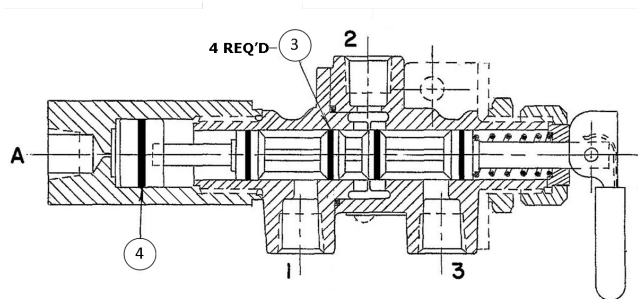
Type CF



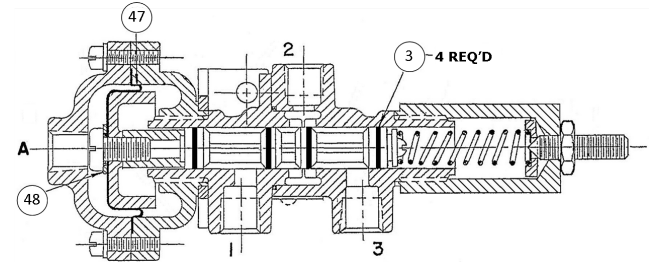
Type CG



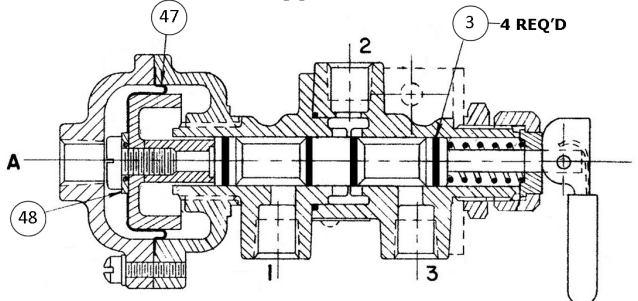
Type CP



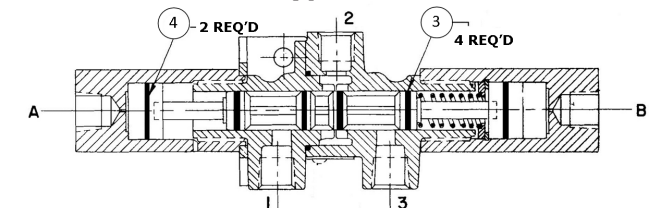
Type CT



Type SB



Type C2



3-Way Pilot Valves - Models 4057D/4457A

Contact

Americas

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Houston, TX 77064
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Tel: +1 (281) 940 1800
Fax: +1 (713) 559 9419
Email: customer.service@amot.com

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Email: info@amot.com

AMOT Germany
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Germany

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Email: germany@amot.com

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Shanghai 201801
China

Tel: +86 21 5910 4052
Fax: +86 21 5237 8560
Email: shanghai@amot.com



WARNING

This product can expose you to chemicals including Lead, which is known to the state of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.



Dual Chamber Orifice Fitting Datasheet

6759 - 65th Avenue, Red Deer, Alberta T4P 1X5
 Ph:(403)342-4494 Fax:(403)346-7110
 Email: canalta@canaltaflow.com

General	1	Tag No.	
	2	Line No.	
	3	Line Size/Schedule	2" SCH80 (XS)
	4	Inside Diameter	1.939 "
	5	Measurement Standard	AGA2016 Ed.
	6	Quantity	1
	7	Paint	Canalta Standard Ship Coat
Orifice Plate	1	Orifice Plates	Qty Provided (per): 1 <input checked="" type="checkbox"/> Installed
	2	Material	316 SS
	3	Thickness(Inches)	0.125
	4	Beta(b) = d/D (installed)	0.52
	5	Bore Diameter (d) (Inches)	1.000
	6	Max Allowable Beta (b) = d/D	0.75
	7	Max Allow. Orifice Bore Diam. (d) (Inches)	1.375
	8	Vent Drain	
	9	Seal Assembly	K-Style 316SS, HNBR, 85D
	10	Plate Holder	Standard, CF8MStainless
Orifice Fitting	1	Body Material	A216WCB (NACE)
	2	Body Size / Rating	2" 600
	3	Body Connections	Up:Weld Down:RF Dwl Pin: <input type="checkbox"/>
	4	Seal Gap	.56200
	5	Trim Material	NACE MR-01-75 (CS)
	6	Seat Style	Grease
	7	Tap Hole Diameter	0.375
	8	Body Stud Bolt/Nut Special Coating	S: A193 B7M N: A194 2HM Special Coating: None
	9	Engineering Design Standard	ASME B16.34-2017
	10	Tap Location	1.000" from plate face
	11	Tap Connection Style	1/2" NPT
	12	Sets of Taps	4
	13	Shaft Orientation	Left
	14	Valve Lockout Mechanism	None
Meter Tube	1	Tube Material	A106B
	2	Pipe Grade	Cold Drawn
	3	Pipe (Outer) Connection Types	Up:RF Down:RF
	4	Pipe Connection Size / Rating	2" 600
	5	Flange Material	A105N
	6	Stud Bolt / Nut Material	S: A193 B7M N: A194 2HM Special Coating: None
	7	Gasket	316 Spiral Wound Flex CG
	8	Pipe Measurement Standard	AGA2016 Catch All
	9	Engineering Design Standard	ASME B31.3-2018
Flow Conditioner	1	Flow Conditioner Type	Contour
	2	Material	AISI 316SS
	3	Spacer	Included: <input type="checkbox"/>
	4	Connection Style	RF Dwl Pin: <input type="checkbox"/>

Customer:	Next Compression
Customer PO#:	
Reff#:	
Sales Quote:	SQ039277 Line: 610000
Sales Order:	Line:
Sales Contact:	Gord Gentner

Drawing Name:
 Dimensions (Inches)
 OAL: 57 N1: 12
 UL1: 15 N2: 8
 UL2: 16 N3:
 N4:
 DL: 26 N5:
 FC1: N6:
 N7:
 N8:

Overall Length Tolerance +/- 1/4"
 Weld Bevels: 37.5° +/- 15°

Non-Destructive Testing

- Fitting Radiography Testing (Critical Locations)
- Fitting Radiography Testing (Weldneck Only)
- Weld Radiography Testing: 10% by shop rate
ASME B31.3 - Normal
- MPI
- Liquid Penetrant
- Hardness 10%
- PWHT
- Ultrasonic
- Ferrite

Seat Test:	1650 PSIG
Hydro Test:	1 Hour(s) @ 2225 PSIG
Corr. Allow.:	1/16
CWP:	1480 PSIG @ -20°F to 100°F

Weld Procedures

- GMAW, FCAW, or SAW
(CCL5 may also be used on outlets of large runs)
- CCL-1N Rev 1(RT/LT-FCAW)
- CCL8 (STAINLESS-GMAW(RMD)/FCAW)
- CCL5 (RT/LT-SMAW)
- CCL-10N/11N (RT/LT-MCAW)
- CCL-14N (GTAW-PED)
- Subcontractor (refer to attachment)

Branch Connection Details

	N1	N2	N3	N4	N5	N6	N7	N8
Style	TOL	TOL	---	---	---	---	---	---
Size (Inches)	1	3/4	---	---	---	---	---	---
Schedules	---	---	---	---	---	---	---	---
Rating	3000	3000	---	---	---	---	---	---
Orientation	0	0	---	---	---	---	---	---
Material	A105N	A105N	---	---	---	---	---	---

Other Applicable Customer Specifications

Rev	Description	By	Date
0	Issued for quotation	GG	06/14/2021
1	CL 600 option added	GG	06/14/2021

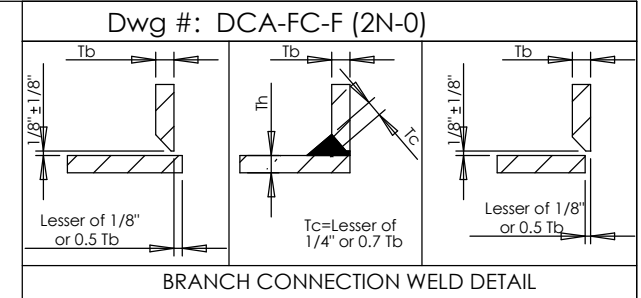
Customer Approval

Signature

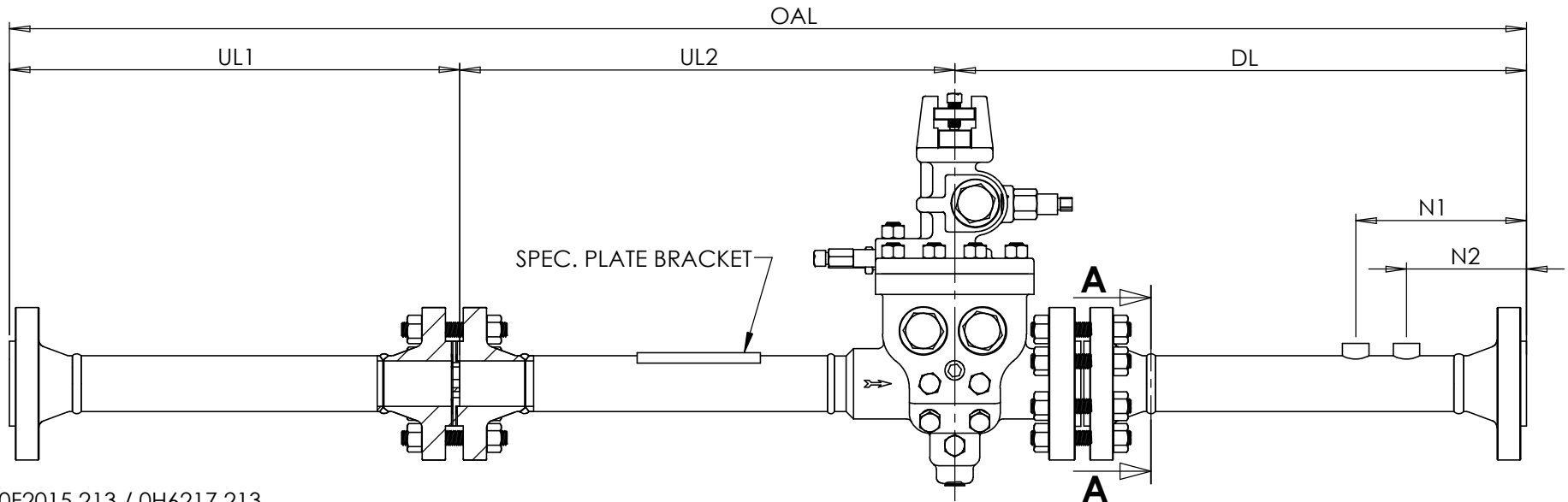
Printed Name:



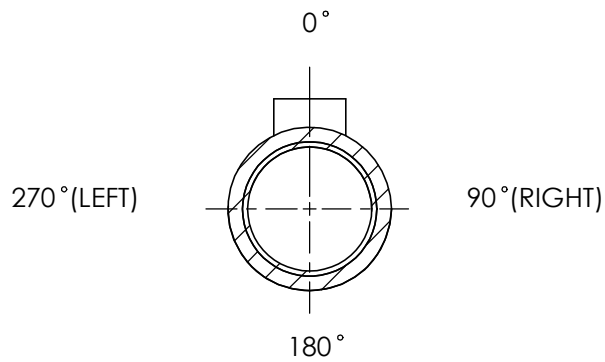
Canalta Controls Ltd.
DC Orifice Fitting 2" - 16"
150 - 1500 ANSI
Flanged Flow Conditioner



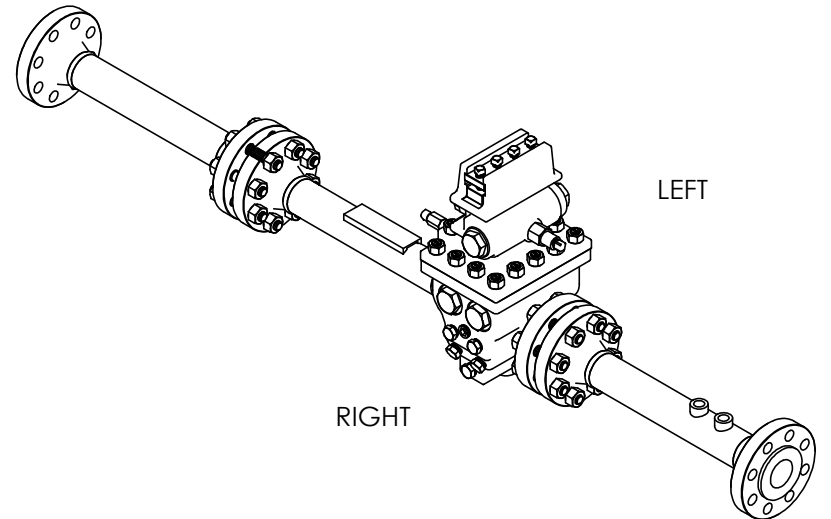
Refer to datasheet for specifications



CRN: OF2015.213 / OH6217.213



SECTION A-A
T.O.L. ORIENTATION



REV 0-OCT 21, 2011

	BY	DATE
DWN	SAN	OCT21-2011
APP'D	SAN	OCT21-2011

CATA-DYNE™ HEATER

STANDARD HEATER APPLICATIONS

INSTALLATION & OPERATION INSTRUCTIONS

WARNING: Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.



The Cata-Dyne™ heater can be used in all industrial indoor locations where a source of infrared radiant heat is required, providing adequate ventilation is available.

CERTIFICATION

Model WX (Series X) Cata-Dyne™ Explosion-proof, flameless infrared catalytic gas heaters are certified by the Canadian Standards Association (CSA) for use in Class I, Divisions 1 and 2, Group D hazardous (classified) locations and Factory Mutual Global (FM), for use in Class I, Division 1, Group D hazardous (classified) locations, temperature code T2C at an ambient temperature of 40°C (104°F).

The Model BX (Series G) Cata-Dyne™ heater is certified by CSA and FM for use in general industrial non-hazardous locations. The MKII model (Series X) Explosion-proof, flameless infrared catalytic gas heater is certified by CSA for use in Class I, Divisions 1 and 2, Group D hazardous (classified) locations. Models listed are certified for industrial use only, for either natural gas or propane gas. CSA approved models are equipped for high altitudes: 0 - 4,500 ft. (0-1,370 m) above sea level.

INSTALLATION

To ensure maximum efficiency of your Cata-Dyne™ heater, it should be installed with the heating surface positioned plus or minus 45° from the vertical plane at a height of no more than 8 ft. (2.44 m). All heaters must be installed in accordance with the latest revisions of the codes described in the table below and in accordance with any local codes and regulations. Before installing the heater, all information on the heater

Cata-Dyne™ Heater - Models Available

WX Model (Series X)					
Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA					
Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW		Max. Btu/hr	Max. kW
WX 6 x 6	1,000 Btu/hr	0.299 kW	WX 18 x 24	12,000 Btu/hr	3.514 kW
WX 6 x 12	2,000 Btu/hr	0.588 kW	WX 18 x 30	15,000 Btu/hr	4.393 kW
WX 6 x 24	4,000 Btu/hr	1.171 kW	WX 18 x 36	18,000 Btu/hr	5.272 kW
WX 8 x 60	10,000 Btu/hr	2.929 kW	WX 18 x 48	24,000 Btu/hr	7.029 kW
WX 8 x 8	1,778 Btu/hr	0.521 kW	WX 18 x 60	30,000 Btu/hr	8.786 kW
WX 10 x 12	3,333 Btu/hr	0.976 kW	WX 18 x 72	36,000 Btu/hr	10.543 kW
WX 12 x 12	4,000 Btu/hr	1.171 kW	WX 24 x 24	16,000 Btu/hr	4.686 kW
WX 12 x 24	8,000 Btu/hr	2.343 kW	WX 24 x 30	20,000 Btu/hr	5.857 kW
WX 12 x 36	12,000 Btu/hr	3.514 kW	WX 24 x 36	24,000 Btu/hr	7.029 kW
WX 12 x 48	16,000 Btu/hr	4.686 kW	WX 24 x 48	32,000 Btu/hr	9.372 kW
WX 12 x 60	20,000 Btu/hr	5.857 kW	WX 24 x 60	40,000 Btu/hr	11.715 kW
WX 12 x 72	24,000 Btu/hr	7.029 kW	WX 24 x 72	48,000 Btu/hr	14.068 kW

BX Model (Series G)					
Approved for use in general industrial non-hazardous locations by both FM and CSA					
Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW		Max. Btu/hr	Max. kW
BX 6 x 6	1,500 Btu/hr	0.4 kW	BX 18 x 24	18,000 Btu/hr	5.3 kW
BX 6 x 12	3,000 Btu/hr	0.9 kW	BX 18 x 30	22,500 Btu/hr	6.6 kW
BX 6 x 24	6,000 Btu/hr	1.8 kW	BX 18 x 36	27,000 Btu/hr	7.9 kW
BX 8 x 8	3,500 Btu/hr	1.0 kW	BX 18 x 48	36,000 Btu/hr	10.5 kW
BX 10 x 12	5,000 Btu/hr	1.5 kW	BX 18 x 60	45,000 Btu/hr	13.2 kW
BX 12 x 12	6,000 Btu/hr	1.8 kW	BX 18 x 72	54,000 Btu/hr	15.8 kW
BX 12 x 24	12,000 Btu/hr	3.5 kW	BX 24 x 24	24,000 Btu/hr	7.0 kW
BX 12 x 36	18,000 Btu/hr	5.3 kW	BX 24 x 30	30,000 Btu/hr	8.8 kW
BX 12 x 48	24,000 Btu/hr	7.0 kW	BX 24 x 36	36,000 Btu/hr	10.5 kW
BX 12 x 60	30,000 Btu/hr	8.8 kW	BX 24 x 48	48,000 Btu/hr	14.1 kW
BX 12 x 72	36,000 Btu/hr	10.5 kW	BX 24 x 60	60,000 Btu/hr	17.5 kW
			BX 24 x 72	72,000 Btu/hr	21.0 kW

MKII Model (Series X)		
Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA		
Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW
MKII 12 x 12	4,000 Btu/hr	1.171 kW
MKII 12 x 24	8,000 Btu/hr	2.343 kW
MKII 18 x 24	12,000 Btu/hr	3.514 kW
MKII 24 x 24	16,000 Btu/hr	4.686 kW

Model WX Series Heaters are certified for use in Class I, Division 1 and 2, Group D hazardous locations by both FM and CSA/CBA

The WX Series Cata-Dyne™ features an improved efficiency catalyst pad that requires 1/3 less fuel to generate the same heat value as our BX Series Cata-Dyne™ heater.



Head Office & Factory:
 5918 Roper Road, Edmonton, Alberta, Canada T6B 3E1
 Telephone: (780) 466-3178 Fax: (780) 468-5904
 Toll Free: 1-800-661-8529

E-mail: info@ccithermal.com

www.ccithermal.com

Date of issue: July 2003

nameplate must be carefully reviewed. The nameplate lists all the fuel and electrical requirements for the heater.

All Cata-Dyne™ Heaters Installed in Canada	All Cata-Dyne™ Heaters Installed in the United States
CSA/CAN – C22.1-02, Canadian Electrical Code	NFPA 70, National Electrical Code
CSA/CAN – B149.1-00, Natural Gas and Propane Installation Code	NFPA 54, National Fuel Gas Code

SPECIFICATIONS

Clearances

Appropriate clearances from the heating surface must be observed during the installation of the Cata-Dyne™ heaters (See Figure 1). Maintain nameplate clearances from combustible materials such as wood, cloth, paper, etc.

Fuels

The Cata-Dyne™ flameless gas heater is designed to operate on clean, dry natural or propane gas as specified

on the heater nameplate.

Natural Gas – these heaters are designed to use natural gas (1000 Btu/ft³, 37 MJ/m³) at 7 in. w.c. (1.73 kPa), 4.5 in. w.c. (1.12 kPa), or 3.5 in. w.c. (0.86 kPa).

Propane – these heaters are designed to use propane gas (2500 Btu/ft³, 88 MJ/m³) at 11 in. w.c. (2.72 kPa).

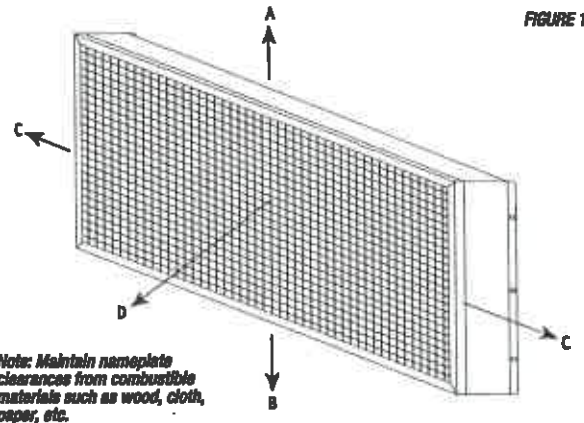


FIGURE 1

Note: Maintain nameplate clearances from combustible materials such as wood, cloth, paper, etc.

HEATER CLEARANCE										
	Radiant Surface			Sides	Top			Bottom		
Radiant Surface Position	Heaters Up To 12,000 Btu/hr	Over 12,000 Up To 48,000 Btu/hr	Over 48,000 Up To 72,000 Btu/hr	All Heaters Up To 72,000 Btu/hr	Heaters Up To 12,000 Btu/hr	Over 12,000 Up To 48,000 Btu/hr	Over 48,000 Up To 72,000 Btu/hr	Heaters Up To 12,000 Btu/hr	Over 12,000 Up To 48,000 Btu/hr	Over 48,000 Up To 72,000 Btu/hr
Vertical (0°)	28 in.	42 in.	60 in.	12 in.	18 in.	18 in.	42 in.	7 in.	12 in.	18 in.
0-45° up	28 in.	42 in.	60 in.	12 in.	18 in.	32 in.	54 in.	0 in.	12 in.	18 in.
0-45° down	28 in.	42 in.	60 in.	12 in.	18 in.	18 in.	18 in.	22 in.	24 in.	42 in.

Piping

1. A main shut-off valve must be installed upstream of all auxiliary heater controls.
2. The 100% safety shut-off valve and appliance regulator (natural gas heaters only) must be installed in the upright position.
3. The thermostatic temperature controller should be installed with the dial shaft in the horizontal position.
4. The maximum inlet pressure to the 100% safety shut-off valve, thermostatic temperature controller and appliance regulator is 1/2 psi (3.4 kPa). If the inlet pressure is higher than this, a low-pressure service regulator must be installed upstream of these components.
5. The maximum inlet pressure to the low-pressure service regulator is 250 psi (1.7 MPa). If the inlet pressure is higher than this, a high-pressure regulator must be installed upstream.
6. All components should be installed as indicated in Figure 2 (WX and BX models only) or Figure 3 (MKII model only).

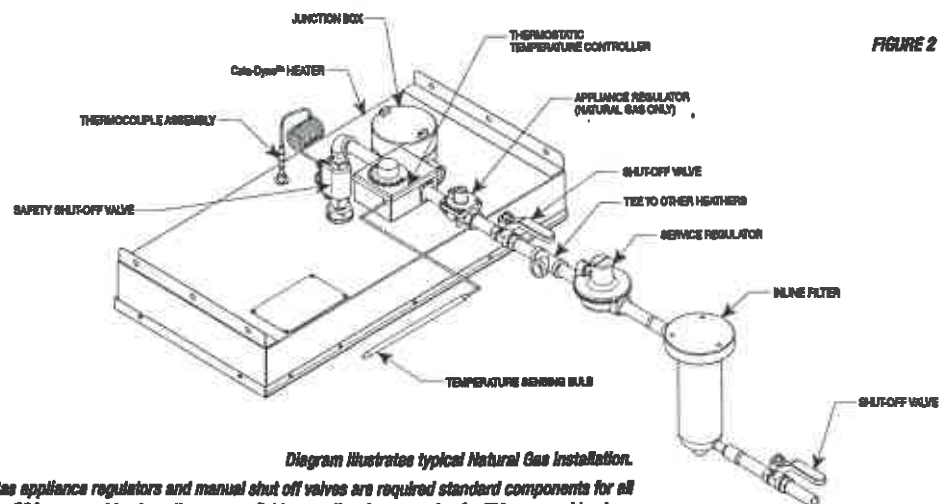


FIGURE 2

Diagram illustrates typical Natural Gas Installation. Gas appliance regulators and manual shut off valves are required standard components for all CSA approved heaters; they are available as optional accessories for FM approved heaters.

Electrical

1. All wiring is to be installed in accordance with the latest revisions of the Canadian Electrical Code (CEC) and/or any applicable local codes.
2. It is desirable to install an indicating light on all starting systems. This will reduce the possibility of the power being left on once the heater is started, which can severely reduce the lifespan of the heater.
3. Ground connections for 120 V and above heaters are required as indicated in Figures 4 and 5.
4. The number of terminals in the junction box can be two or four depending on the number of elements used in the fabrication of the heater. All MKII models incorporate a single element and therefore have only two terminals. The connection procedure for the different combinations is as described in Figures 4 and 5:

Ventilation

The catalytic reaction in Cata-Dyne™ heaters occurs when natural gas or propane reacts with oxygen to produce water vapor, carbon dioxide and infrared energy. Ventilation must be provided to allow an adequate supply of oxygen for the reaction.

For every 1.0 ft² (0.093 m²) of heater surface, 40 ft³/hr (1.13 m³/hr) of air supply is required. For example, a WX 24 x 24 heater (16,000 Btu/hr / 4.686 kW) would require 160 ft³/hr (4.53 m³) of air to ensure proper operation of the Cata-Dyne™ heater.

To reduce the carbon dioxide and water vapor concentrations in the building, a vent hood assembly can be installed to provide positive ventilation from the heater (See Figure 6).

FIGURE 4

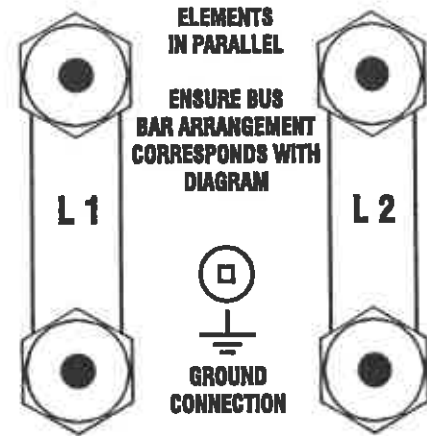


FIGURE 5

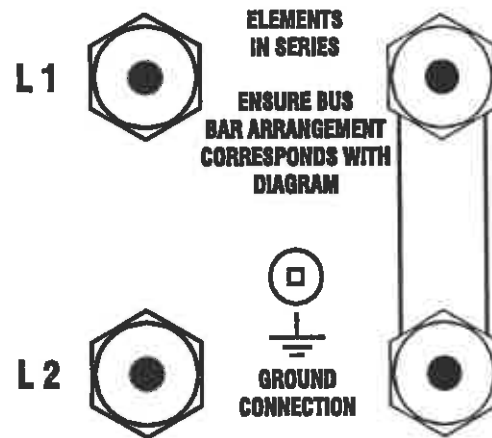


FIGURE 3

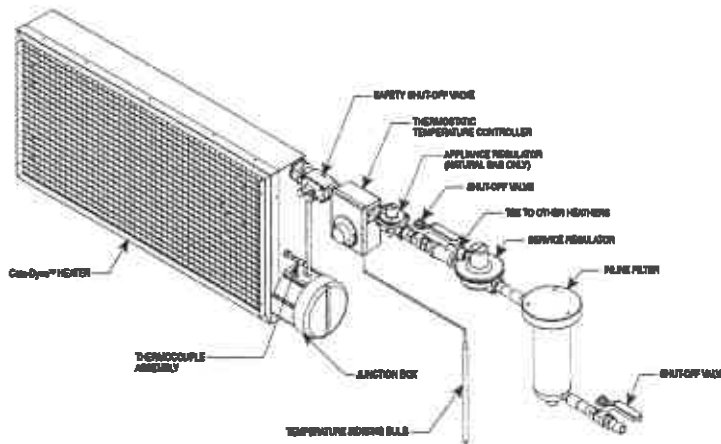
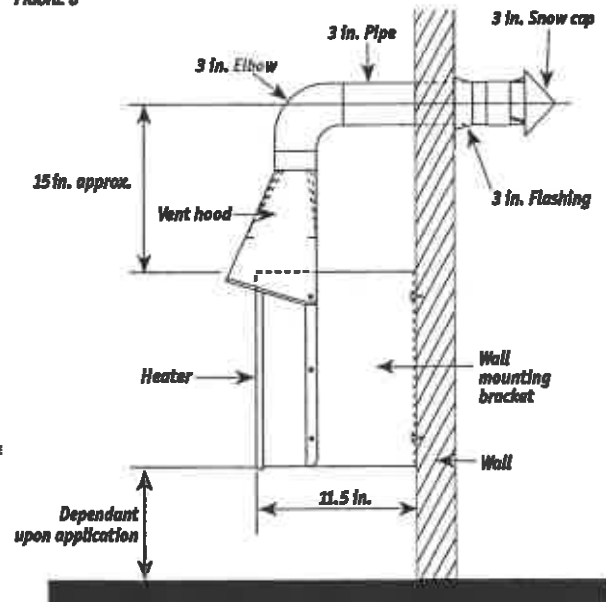


Diagram illustrates typical Natural Gas installation.

Gas appliance regulators and manual shut off valves are required standard components for all CSA approved heaters; they are available as optional accessories for FM approved heaters.

FIGURE 6



OPERATION

All Cata-Dyne™ heaters are supplied with a Safety Shut-Off Valve (SSOV)/Thermocouple assembly to ensure the safe operation of the heater. Under no circumstances should the reset button be held or locked into the depressed position by use of a mechanical restraint. A tamper resistant model SSO V is available if desired.

Start-up

1. Ensure the heater has been installed according to all instructions and relevant codes.
2. Turn on the main gas supply to the system.
3. If the heater is equipped with a thermostatic temperature controller, rotate the dial completely clockwise to the fully open position.
4. Turn on the power to the electrical elements.
5. After 15 minutes, depress the reset button on the top of the 100% safety shut-off valve. The button should return to the original position and internally open the valve and allow gas to flow to the heater. If the valve does not stay open when the reset button is released, it may be necessary to wait an additional few minutes and then depress the reset button again. This will allow the electrical elements additional time to warm up.
6. When the catalytic reaction is well established, turn off the electrical power to the elements.
7. If the heater is equipped with a thermostatic temperature controller, it can be set to the desired setting after the catalytic reaction has been established for at least one hour.

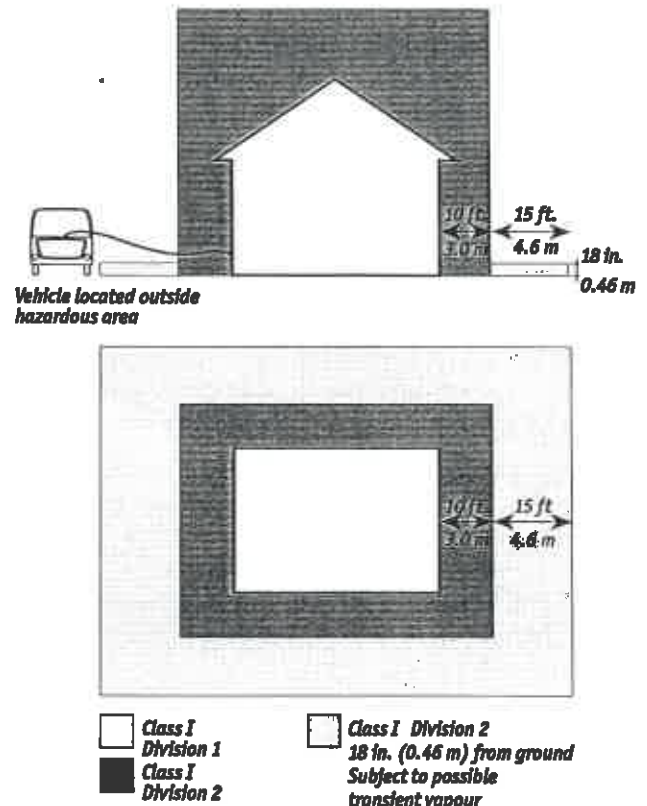
Shut down

Turn off the gas supply to the heater.

Multi-heater start-up

Cata-Dyne™ heaters can also be purchased/installed in multi-heater assemblies. If these assemblies are 12 V, each heater must be started individually. This ensures the correct voltage and current will be reaching the heater from the power supply.

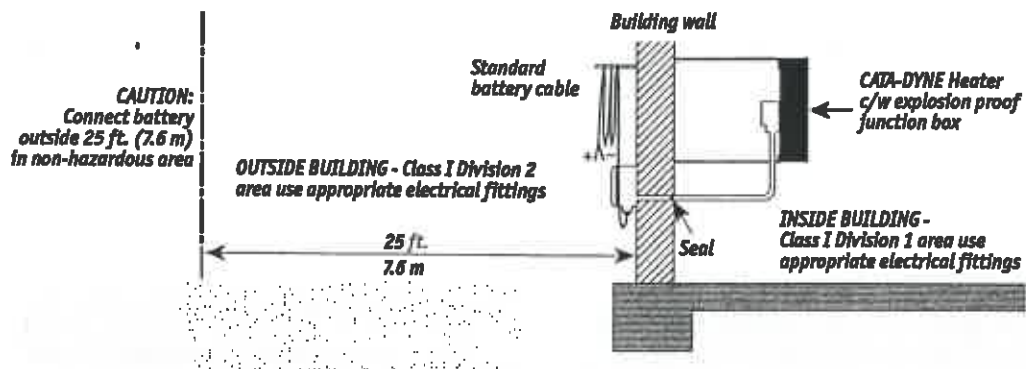
12 V HAZARDOUS ELECTRICAL INSTALLATIONS



Most oil and gas production buildings have an area classification as follows:

1. Class I, Division 1, within the building.
2. Class I, Division 2, outside the building for a distance of 10 ft.(3.0 m) from the building at all elevations.
3. Class I, Division 2, outside the building for a distance of 25 ft.(4.5 m) from the building at an elevation of 18 in. (0.45 m) from the ground.

All electrical apparatus and wiring within this area must conform to the appropriate codes. Connection to the power supply must be outside of the Class I, Division 2 location.



SPOT HEATING

There are several factors to consider when Cata-Dyne™ heaters are utilized for spot heating.

Infrared energy travels in straight lines from the face of the Cata-Dyne™ heater covering approximately 160° of arc and is inversely proportional to the square of the distance. The heater should therefore be mounted as close as practical (min. of 8 in. (20 cm)) to the object requiring heat for maximum temperature rise.

Match the shape of the object requiring heat with the appropriate Cata-Dyne™ heater, e.g. WX/BX 6 x 24 for long narrow objects or WX/BX 12 x 12 for a square object.

Objects requiring heat should be painted dull, dark colors for maximum infrared absorption and objects not requiring heat should be painted light or reflective colors.

Insulate and protect plastic, rubber and similar materials from direct intense Infrared heat.

SPACE HEATING

A separate heat load calculation should be done for each building in which a Cata-Dyne™ heater will be installed for space heating purposes.

The heat load calculation determines the building heat losses through the structure and allows for air infiltration (refer to the sample Heat Load Calculation in the Cata-Dyne™ catalogue).

Cata-Dyne™ heaters produce low intensity infrared heat that is absorbed by objects within the range of the heat source. The closer the object is to the source of heat, the more heat the object will absorb. Cata-Dyne™ heaters should be placed close to the floor level within the building to heat objects close to the floor.

Ideally, Cata-Dyne™ heaters should be mounted 1-3 ft.(0.3-1 m) from the floor and equally spaced around the building perimeter for space heating applications.

If low mounting is not practical, then overhead mounting may be utilized. Overhead mounted heaters should be sloped face down to a maximum 45° angle to direct the Infrared energy towards the floor. Overhead mounting should be restricted to heaters of 30,000 Btu/hr (8.8 kW) capacity and larger.

If the building requires only one heater, place the Cata-Dyne™ heater as close as possible to the center of the longest wall.

For multiple heater installations, space the Cata-Dyne™ heaters as evenly as possible around the perimeter of the building.

Make sure the piping is large enough to handle the gas load (refer to the sample Piping Calculation in the Cata-Dyne™ catalogue for sizing information).

Make sure the electrical starting system has sufficient current carrying capacity and conforms to all applicable electrical codes.

It is advisable to install an indicator light in the electrical circuit to reduce the possibility of the power being left on once the heater is started.

PERSONAL SAFETY

The Cata-Dyne™ flameless infrared catalytic gas heater does not produce harmful carbon monoxide gas when used with natural gas or propane. Adequate ventilation must be incorporated in any building design to ensure oxygen replenishment and removal of any carbon dioxide. Protective grills should be used on any installation where personnel may come in contact with the face of the heater.

ORDERING INFORMATION

You can order any of CCI Thermal's products by telephone, fax, mail or e-mail. To assist us in processing your order as quickly and efficiently as possible, please provide us with the following information:

- ◆ Cata-Dyne™ product name
- ◆ Cata-Dyne™ model number
- ◆ Fuel gas - natural gas or propane
- ◆ Starting voltage - 12, 24, 120, 208, 240, 480, or 600 V
- ◆ Accessories required:
 - Protection Grill
 - Wall Mount Brackets
 - Thermostat
 - Regulator
 - Start Up Leads (12 V system only)
 - Vent Hood
 - Other
- ◆ Company name and contact
- ◆ Billing address, phone number, fax or e-mail
- ◆ Shipping address and phone number
- ◆ Shipping instructions
- ◆ Special tagging instructions
- ◆ Date required
- ◆ Method of payment:
 - on account - P.O. number required
 - credit card - Visa or Mastercard number
 - cash or cheque

GUARANTEE

CCI Thermal warrants all Cata-Dyne™ flameless infrared heaters sold to be free from defects in material or workmanship under normal use and service. The company agrees to repair or replace any Cata-Dyne™ heater which, upon its examination, reveals it to have been defective due to faulty workmanship or material, if returned to our factory, transportation PREPAID, within one (1) year from date of purchase. The company does not assume responsibility for misuse or misapplication of its heaters.

Warranty is void if Cata-Dyne™ heaters are used with sour, dirty or wet gas, or where sulphur content is greater than allowable for utility gas specifications. Warranty is void if, upon our inspection, the heater has been tampered with. Neither CCI Thermal nor the selling dealer shall be held responsible for loss of time, inconvenience, commercial loss or consequential damages relating to the use of Cata-Dyne™ heaters.

RETURN GOODS POLICY

Prior written approval must be obtained from CCI Thermal for the return of any Cata-Dyne™ product(s). A restocking charge of 15% will apply. All returns must be shipped to our factory in Edmonton, freight prepaid. Final acceptance will be contingent on inspection at our factory.

REPAIRS

Cata-Dyne™ heaters may require periodic maintenance or repair. Our factory is staffed with technicians who are qualified to perform any required repairs. The procedure to follow to have a heater repaired is as follows.

Send the heater to our factory in Edmonton. Include the following information with the heater:

- ◆ Company name and address
- ◆ Contact name
- ◆ Telephone number/fax number/e-mail
- ◆ P.O. number
- ◆ Advise if an estimate is required prior to starting the repair
- ◆ Details on the repair or conversion required
- ◆ Return shipping instructions

NOTE: Under the terms of our certification, all repairs must be performed at our factory in Edmonton.

TROUBLE SHOOTING

1. Ensure that the fuel matches that listed on the nameplate.
2. Ensure that the voltage matches that listed on the nameplate.
3. Check for any physical damage. All signs of physical damage to the catalyst pad such as holes, tears or a general deterioration of the catalyst bed signal that it is time to have the heater repaired.
4. Check the gas supply pressure at the heater – 7 in. w.c. (1.73 kPa), 4.5 in. w.c. (1.12 kPa), or 3.5 in. w.c. (0.86 kPa) for natural gas and 11 in. w.c. (2.72 kPa) for propane.
5. Check the gas orifice for obstructions or dirt and ensure the size matches that listed on the nameplate. It may be necessary to install a filter upstream of the heater or regulator if the gas supply is dirty. If the fuel supply is constantly dirty and/or wet it would be advisable to use bottled propane fuel.
6. Check the mounting position of the heater. The face of the heater should be preferably in the vertical position and should not vary more than 45° from the vertical position for maximum efficiency.
7. Check for saturation of the catalyst face caused by condensation or rain running down the face of the heater. If the heater has been exposed to water, it is advisable to place the unit in a warm area for a period of a few hours or longer if required. Once the moisture is removed, the heater can be re-installed and re-started.
8. Check the jumper cable size to ensure that the resistance of the cable is not reducing the current to the heater. This would not allow sufficient power to the electrical element to preheat the catalyst to the activity temperature. It is recommended to run the service vehicle at fast idle while starting the heater.
9. Cata-Dyne™ heaters are designed to use clean fuel and to be used in non-contaminated atmospheres. Sulphur compounds in the fuel or atmosphere will poison the catalyst bed over a period of time and render the heater inoperative. If the heater has been exposed to sulphur compounds, it should be sent to the factory for service.
10. Avoid spraying the face of the heater with high-pressure air, steam or water because this can damage the catalyst bed. If physical damage is visible, return the heater to the factory for servicing.
11. Ensure that the temperature controller is correct for the model size, fuel, and pressure specifications for the heater it is fitted to. If the temperature controller is too low, the heater will not have sufficient fuel rating to operate and will stop.

Separate Installation and Operation Instructions are available for oven and industrial heating applications.



Donaldson Delivers

HAK05 Return-Line Filter

Max Flow: 120 gpm (454 lpm)



Working Pressures to

500 psi
3448 kPa
34.5 bar

Rated Static Burst to

1000 psi
6895 kPa
69 bar

Flow Ranges to

Return-line: 120 gpm/ 454 l/min
Suction: 30 gpm/114 l/min

Beta Rating

- Performance to $\beta_{5(c)}=1000$

Porting Size Options

- 1½" NPT
- SAE-24 O-ring

Replacement Filter Lengths

- 8" / 203 mm
- 16" / 406 mm

Standard Bypass Ratings

- 25 psi / 172.5 kPa / 1.7 bar

Assembly Weight

- 18 lbs / 8.2 kg (long)
- 13 lbs / 5.9 kg (short)

Operating Temperatures

- Synthetic Media:
-20°F to 250°F / -29°C to 121°C

Element Burst Ratings

- 100 psid / 690 kPa / 6.9 bar

Applications

- Return Lines
- Side Loop Systems
- In-Plant and Mobile Machinery
- Lube Oil Systems
- Suction Lines

Features

The hardy HAK05 is perfect for return-line filtering in heavy duty applications where you want a cartridge style filter. Its inside to outside flow pattern means that dirt is collected on the inside of the cartridge, eliminating the need for heavy cleaning of the housing when servicing the filter. HAK05 filters feature a die cast aluminum head, steel body, and a single center-retention bolt that simplifies servicing.

HAK05 is available in two element lengths, 16" and 8", to accommodate various flow ratings. Several elements available at various performance levels. If you're looking for the convenience of a spin-on style filter, use the HMK05 or HMK25.

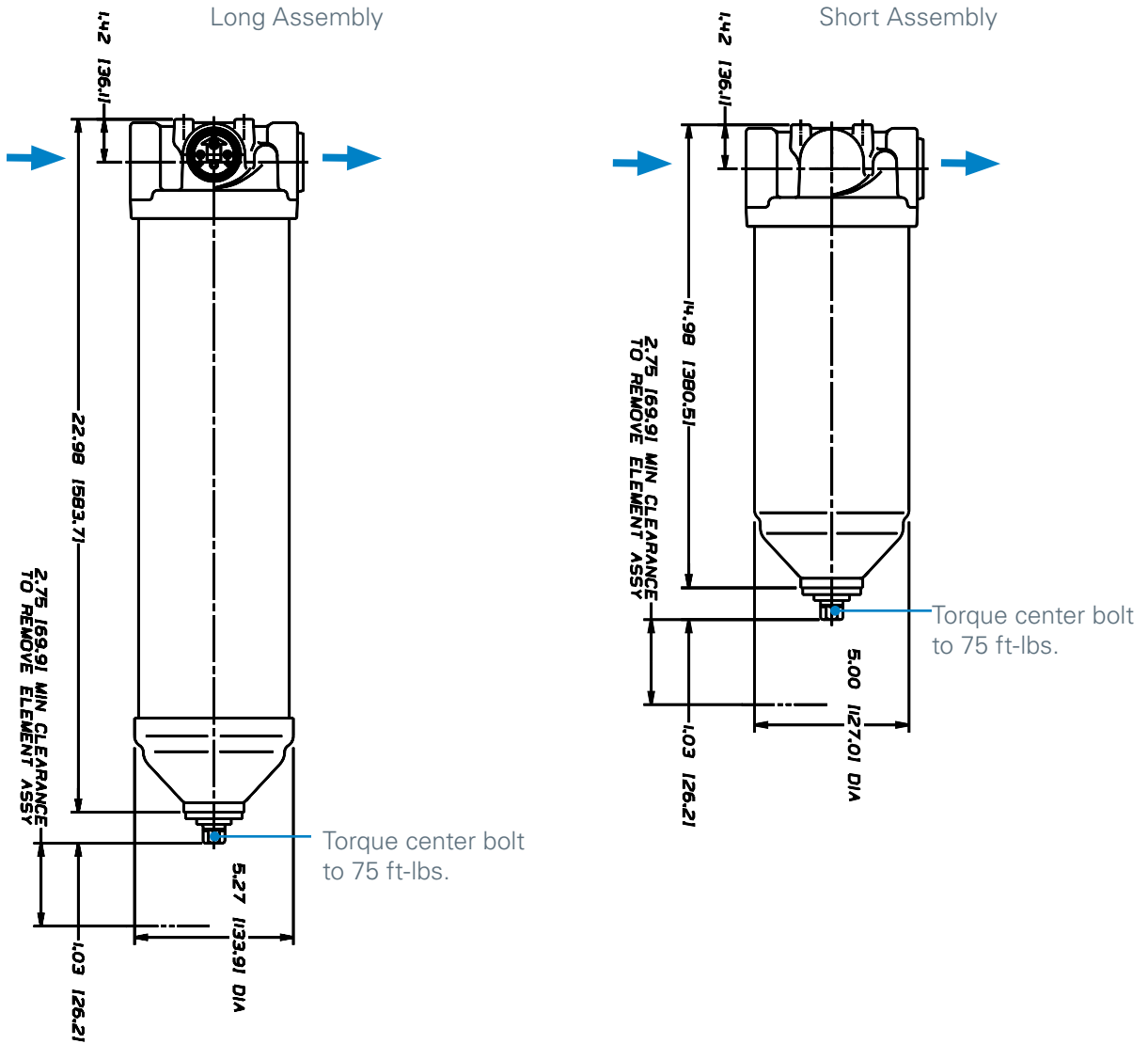
HAK05 Specification Illustrations

All dimensions are shown in inches [millimeters].

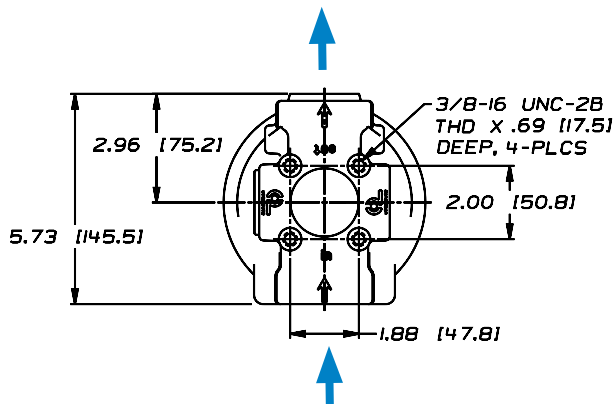
HAK05

Max Flow: 120 gpm (454 lpm)

Assembly - Side View



Head - Top View



Visual Indicator

- P160473 BunaN seal*
- P161847 Viton seal*

Head Assembly

Visual Indicator Right Side,
Recessed Left Side

- P160438 NPT 1 1/2*
- P163257 SAE 24*

Visual Indicator Left Side,
Recessed Right Side

- P160451 NPT 1 1/2*
- P163186 SAE 24*

Repair Kit

- P160710 BunaN seal†

Head O-Ring

- P160016 BunaN seal (Size 351)*
- P161849 Viton seal*

Bypass Indicator O-Ring

- P160125 BunaN seal†
- P161851 Viton seal (Size 227)†

Bypass Valve Assembly

Bypass Valves have BunaN seals and snap into element endcap.

- P160373 Bypass†
- P160351 Bypass†

Housing

- P160412 8"*
- P160083 16"*

Bypass Spring

- P160130 25 psi / 172 kPa†

Commercial # 210

Gasket Washer

- P160020 BunaN seal†
- P161852 Viton seal†

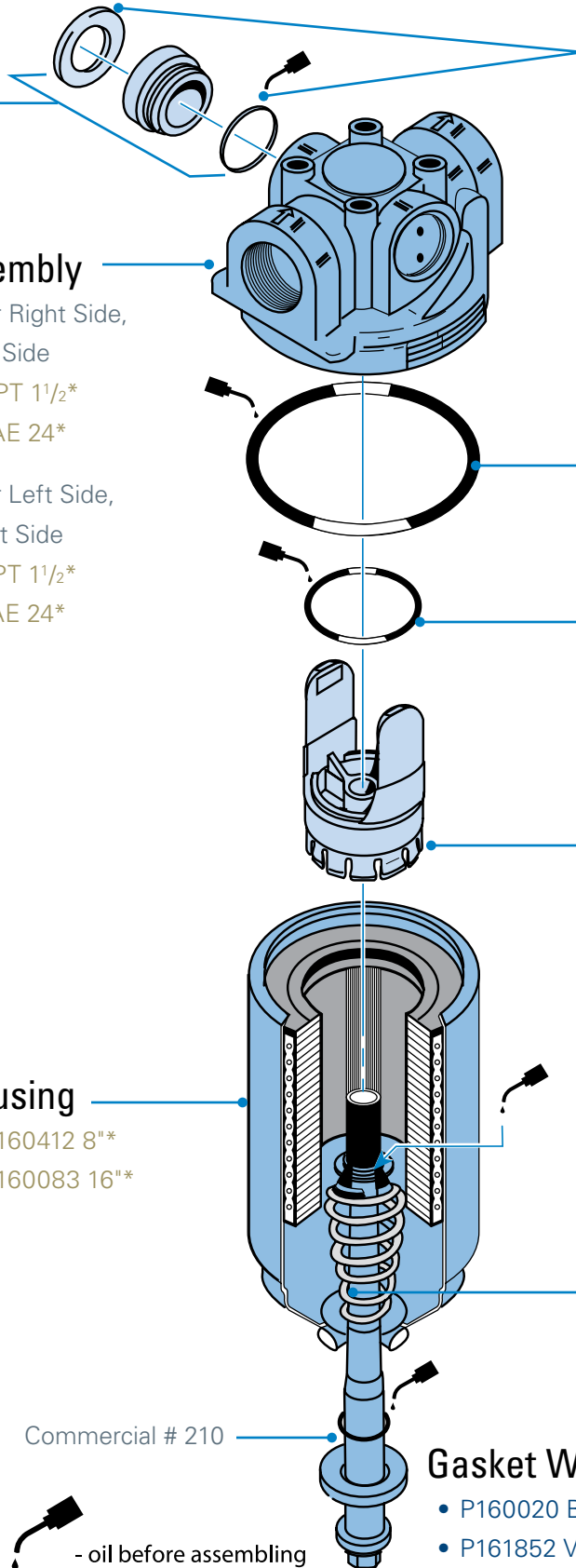
- oil before assembling

Center Bolt

- P160152 8"*
- P160154 16"*

*Lead Times Apply

†Stocked Item



Replacement Cartridge Options

Media Number	Media Technology	$\beta_{x(c)} = 2/20/75$ Rating	Length		Donaldson Part No.
			in	mm	
No. 1	Synteq®	<2 / <2 / 3	16	406	P161016
No. 2	Synteq	2 / 3 / 5	8	203	P165626
	Synteq		16	406	P165628
No. 2 1/2	Synteq	2 / 7 / 10	8	203	P176220
	Synteq		16	406	P176221
No. 6	Synteq	5 / 10 / 13	8	203	P160558
No. 9	Synteq	10 / 17 / 22	8	203	P166461
	Synteq		16	406	P164699
No. 16	Synteq	15 / 30 / 37	8	203	P163172
	Synteq		16	406	P161571
No. 20	Synteq	20 / 33 / 40	8	203	P560527
	Synteq		16	406	P166597
No. 149	Wiremesh	150	8	203	P162368
			16	406	P160700

Filter Notes

Filters with seals made of BunaN are appropriate for most applications involving petroleum oil. Filters with seals made of Viton® (a fluoroelastomer) are required when using diester, phosphate ester fluids, water glycol, water/oil emulsions, and HWCF (high water content fluids) over 150°F. Donaldson offers both types, as shown in the table at the above. (Viton® is a registered trademark of DuPont Dow Elastomers.)

Donaldson Synteq filter media is compatible with petroleum based fluids, most phosphate esters, water oil emulsions, and HWCF (high water content fluids).



Donaldson Company, Inc.
Minneapolis, MN

donaldson.com
shop.donaldson.com

North America 800-374-1374
Mexico, Latin America, &
Caribbean 52-449-300-2400
Brazil 55-11-4894-6339
Europe 32-16-38-3811
South Africa 27-11-997-6000

Southeast Asia 65-6311-7373
Greater China 86-400-650-0610
Japan 81-42-540-4112
Korea 82-2-517-3333
Australasia 61-02-4350-2033
India 91-124-4807-400

Brochure No. F111447 ENG (4/18)

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FAIRCHILD MODEL 10 PNEUMATIC PRECISION REGULATOR

Installation, Operation and Maintenance Instructions

Identification Number 10 2

Pressure Range _____

psig	[BAR]	(kPa)	
0-2	[0-.15]	(0-15)	(1)
0-10	[0-0.7]	(0-70)	(2)
0-20	[0-1.5]	(0-150)	(0)
.5-30	[.03-2]	(3-200)	(3)
1-60	[.10-4]	(10-400)	(4)
2-150	[.15-10]	(15-1000)	(6)
3-200	[.20-14]	(20-1400)	(7)
5-300	[.35-21]	(35-2100)	(8)
5-400	[.35-28]	(35-2800)	(9)

Pipe Size _____

1/4" NPT (2)
3/8" NPT (3)
1/2" NPT (4)

Options _____

Compatibility Options Y = Yes N = No

	T	E	L	R	N	B	C	A	J	U	H	P
(T)	-	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N
(E)	Y	-	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
(L)	Y	Y	-	Y	N	N	Y	Y	Y	Y	Y	Y
(R)	N	N	Y	-	Y	Y	Y	Y	Y	Y	Y	N
(N)	Y	Y	N	Y	-	N	N	Y	Y	Y	Y	Y
(B)	Y	Y	N	Y	N	-	N	Y	Y	Y	Y	Y
(C)	Y	Y	Y	Y	N	N	-	Y	Y	Y	Y	Y
(A)	Y	Y	Y	Y	Y	Y	Y	-	N	Y	Y	Y
(J)	Y	Y	Y	Y	Y	Y	N	-	Y	Y	Y	Y
(U)	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y
(H)	Y	Y ³	Y	Y	Y	Y	Y	Y	Y	N	-	Y
(P)	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	-

1 *Maximum Supply Pressure - 250 psig [17.0 BAR] (1700 kPa)*
2 *Maximum Supply Pressure - 75 psig [5.0 BAR] (500 kPa)*
3 *BSPP Threads in Inlet & Outlet Ports Only. Others BSPT.*

Figure 1. Model 10 Pneumatic Pressure Regulator Identification Number System.

GENERAL INFORMATION

The Model 10 is a high capacity regulator that provides a uniform output pressure independent of supply pressure variation.

ADJUSTMENTS

The Model 10 Regulator does not require field adjustments.

SPECIFICATIONS

Functional Specifications			
Supply Pressure	psig	[BAR]	(kPa)
Maximum (A Option)	500	[35]	(3500)
	75	[5.0]	(500)

Specifications (continued)

Flow Capacity (Nominal)	40 SCFM (68m ³ /HR) @ 100 psig [7 BAR] (700 kPa) Supply & 20 psig [1.5 BAR] (150 kPa) Set.
Exhaust Capacity	5 1/2 SCFM (9.4m ³ /HR) @ downstream pressure 5 psig [.35 BAR] (35 kPa) above 20 psig [1.5 BAR] (150 kPa) Set Pressure.
Sensitivity	Less than 0.125" (.32 cm) Water Column
Ambient Temperature Limits	-40°F to +200°F (-40°C to +93.2°C)
Performance Specifications	
Supply Pressure Effect	Less than .1 psig [.007 BAR] (.7 kPa) for 100 psig [7 BAR] (700 kPa) Change.
Materials of Construction	Body and Housing Aluminum Trim Stainless Steel, Brass, Zinc Plated Steel Diaphragms Buna N on Dacron (Standard Unit Only)

INSTALLATION

Clean all pipelines to remove dirt and scale before installation.

Apply a minimum amount of pipe compound to the male threads of the fitting only. Start with the third thread back and work away from the end of the fitting to avoid the possibility of contaminating the regulator. Install the regulator in the air line.

You can mount the Model 10 regulator in any position without affecting its operation. To panel mount the unit, use the two 1/4"-20 holes in the bonnet. You can wall mount the regulator using using Mounting Bracket 09921 shown in Figure 3.

The inlet and outlet connections are labeled on the underside of the regulator with the arrows pointing in the direction of the flow. Tighten connections securely. Avoid undersized fittings that will limit the flow through the regulator and cause a pressure drop downstream. For more information, see Figure 2. "Outline Dimensions".

NOTE: Oil free air must be applied to the regulator. Use a filter to remove dirt and entrained liquid in the air line ahead of the regulator. If an air line lubricator is used, it MUST be located downstream of the regulator, to avoid interference with regulator performance.

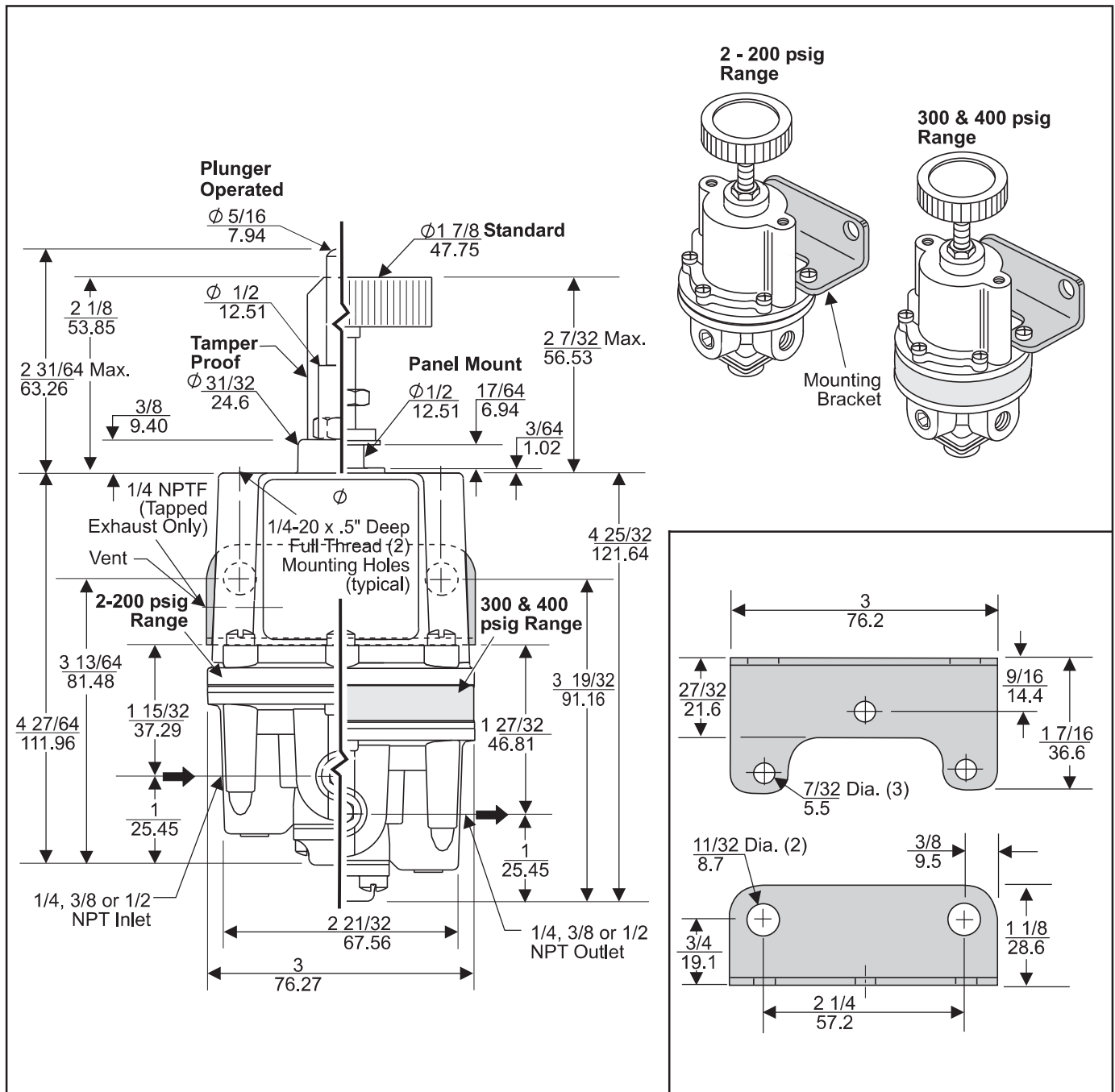
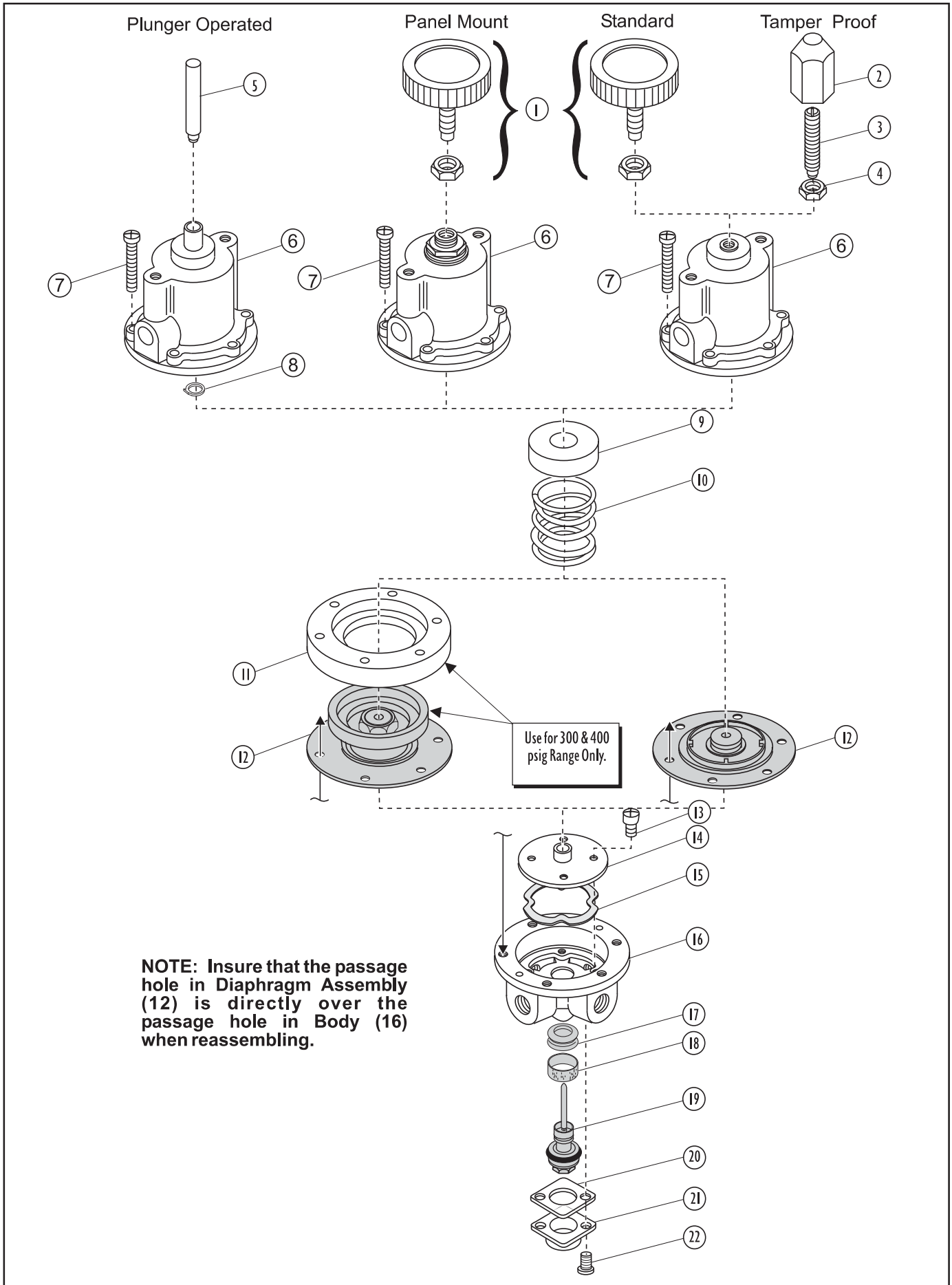


Figure 2. Outline Dimensions

Figure 3. Mounting Bracket 09921 (Sold Separately)



NOTE: Insure that the passage hole in Diaphragm Assembly (12) is directly over the passage hole in Body (16) when reassembling.

Figure 4. Exploded Drawing

MAINTENANCE

To clean the Model 10, use the following procedure:

1. Before disassembly, shut off the valve that is supplying air to the regulator. This is to prevent air from escaping. **It is not necessary to remove the regulator from the air line.**
2. Remove the two Screws (22) from bottom of the unit.
3. Pull out the Inner Valve Assembly (19). Wash the Seat on the Inner Valve Assembly carefully.
4. Wipe off any particles that may be attached to rubber Seat Ring (17) in Body.
5. Replace the assembly carefully.
6. Keep the vent hole in the Bonnet clear for proper regulator operation. Lubricate the adjusting screw with Molycote "G". For more information, see Figure 4. "Exploded Drawing" on page 3.

NOTES: Avoid such solvents as acetone, carbon tetrachloride and trichlorethylene.

If the standard maintenance procedure does not correct the problem install service kit.

TROUBLE-SHOOTING

Problem	Solution (check)
Leakage	Body Screw tightness. Diaphragm.
High Bleed	Relief Pintle and Relief Seat for damage or contamination.
Valve Chatter	Seal Ring lubrication.

HAZARDOUS LOCATION INSTALLATIONS

Information Required	Description Detail
Hazardous Locations	Group II, Category 2, Gas and Dusts: Zones 1, 2 and 21,22, respectively Gas Groups IIA and IIB
Ambient Temperature Range	Use must be evaluated for the relevant flammable gas temperature code
Cleaning	Clean with damp cloth
Grounding	Units must be grounded to earth ground
Codes of Practice	PDCLC/TR 50404:2003 BS 5958

LEGAL NOTICE

The information set forth in the foregoing Installation, Operation and Maintenance Instructions shall not be modified or amended in any respect without prior written consent of Fairchild Industrial Products Company. In addition, the information set forth herein shall be furnished with each product sold incorporating Fairchild's unit as a component thereof.



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IS-1000010
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ASSEMBLY

PUMPS WITH MOTORS

1. No assembly required. Unpack the pump and motor and examine for any signs of shipping damage. If damage is detected, save the packaging and notify the carrier immediately.
2. Proceed to the "Installation" section of these instructions.

PUMPS WITHOUT MOTORS

Note: Do not remove shipping plug located in suction port of the pump until the pump is completely assembled onto the motor.

1. Unpack the pump and examine for any signs of shipping damage. If damage is detected, save packaging and notify the carrier immediately.
2. Place the motor on the fan cover. Align any set screw (item 9) with key slot in motor shaft. Place the aluminum motor adapter (item 8) onto the motor rabbet. Position the slot (shaft sleeve set screw access hole) in motor adapter with the top of the motor. Line up the bolt holes in the motor adapter with the bolt holes in the motor face. Install (4) bolts and lock washers (items 10,11). Securely tighten.
3. Through the top and bottom access holes, tighten securely two of the four set screws on the shaft adapter (item 6). You will need an 1/8" Allen wrench for this.
4. Remove the screw from the shipping plug and then remove the plug from the suction port. Rotate the motor fan until you can tighten the two remaining set screws on the shaft adapter.
5. Rotate the motor fan by hand and check for impeller rubbing. If the impeller rubs loosen the shaft adapter set screws and adjust the impeller accordingly. Retighten the shaft adapter set screws.
6. Proceed to the "Installation" section of these instructions.

INSTALLATION

MOUNTING

Motor or base plate must be securely fastened.

PIPING TO AND FROM THE PUMP

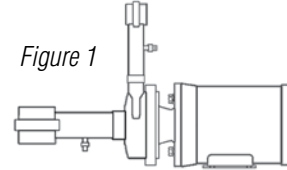
- Always support the piping near the pump to minimize stress and strain on the pump's casing.
- Minimize frictional losses by increasing the suction piping size by one diameter.
- Use a minimal number of bends on suction piping. Keep bends beyond a distance of ten pipe diameters from the pump.
- Install shut off valve on the suction line and flow control valve in the discharge line. Place the valves beyond a distance of ten pipe diameters from the pump.
- Ensure that the piping is leak free.
- Position the pump as close to the liquid source as possible.
- Maintain a flooded suction at all times or prime the pump and maintain prime at all times.

⚠ CAUTION: Suction prime must be maintained at all times.

Running the pump dry will cause damage to pump components. To protect the pump if prime is lost, use a pressure switch on the discharge, a vacuum switch on the suction, or a motor minder to monitor motor current draw.

PUMPING LIQUIDS THAT MAY SOLIDIFY OR CRYSTALLIZE:

Add a flush system to the pump's piping to prevent accumulation of material inside the pump. Install water inlet and outlet valves as shown in Figure 1. Refer to the "Operation" section of these instructions for the flush procedure.



MOTOR/ELECTRICAL

Only qualified personnel trained in the safe installation and operation of this equipment should install the motor. Install the motor according to National Electric Code, NEMA MG-2, IEC standards requirements and/or applicable local electrical codes. The voltage and frequency variations of the power supply should never exceed the limits established in the applicable standard. Prior to connecting to the power line, check nameplate voltage, rotation connection and ensure proper grounding. Sufficient ventilation area should be provided to insure proper operation and cooling of the motor. The motor must be installed with a suitable overload protection circuit. For three phase motors it is recommended to install a phase failure protection device. Download the motor manual from the specific motor manufacturers' website for additional information concerning motor installation, safety and maintenance instructions.

Wire the motor for clockwise rotation when facing the fan end of the motor.

⚠ CAUTION: Do not operate the pump to check rotation until the pump is full of liquid or damage may occur even if the motor is "bumped" to check motor rotation direction.

Check all electrical connections with the wiring diagram on the motor. Make sure the voltage, frequency, phase and amp draw comply with the supply circuit.

If utilized, verify that power monitors or variable frequency drives have been properly installed according to the manufacturer's instructions.

NOTE: A pump running backwards but at a greatly reduced speed.

OPERATION

FLOODED SUCTION SYSTEMS

1. Fully open the suction and discharge valves.
 2. Start the pump and verify liquid is flowing. If there is no liquid flow, refer to the "Troubleshooting" section of these instructions.
 3. Adjust the flow rate and pressure by regulating the discharge valve.
- ⚠ CAUTION:** Never attempt to adjust the liquid flow with the suction valve. Limiting suction will damage pump components.

FLUSHING SYSTEMS EQUIPPED WITH FLUSH VALVES:

1. Fully close the suction and discharge valves.
2. Connect the water supply to the water inlet valve and connect a drain hose to water outlet valve.
3. Turn on the water supply and open the inlet and outlet valves. Flush the system until the pump has been cleared of any material buildup.

(usually approximately 5 minutes).

4. Close the water inlet and outlet valves and turn off water supply.

MAINTENANCE

DISASSEMBLY

1. Disconnect power. Remove electrical wiring.
2. Close the suction and discharge valves and disconnect all piping.
3. Loosen and remove the nut on the V-clamp stud. Remove the V-clamp (item 2) and the impeller housing (item 1). Note V-clamp stud and discharge spout location for reassemble alignment.
4. Remove the motor fan cover and fan. Secure the motor shaft to prevent it from turning, and unthread the impeller.

NOTE: Shaft adapter threads are coated with Loctite Threadlocker #262 to prevent the impeller from spinning off if the motor is inadvertently wired for incorrect rotation. If necessary follow Loctite's recommendations for loosening the threadlocker #262.

5. Remove the seal spring retainer, spring, and the rotating seal component from the shaft adapter. Remove the backhead (item 7) from the pump. Remove the stationary part of the seal from the backhead.
6. If the motor is being replaced, proceed to step 7. If the seal is being replaced, do not loosen or remove the shaft adapter (item 6) from the motor shaft. Proceed to step 3 of the reassembly instructions
7. Remove the four bolts holding the motor adapter/mounting plate assembly (items 8 & 15) to the motor and remove the motor adapter. Loosen all four setscrews and remove the shaft adapter.
8. Inspect all parts for wear and replace as required. Note the finish on the shaft adapter where the rotating seal boot is located. If damaged or not smooth, replace the shaft adapter.

REASSEMBLY

1. Install the shaft adapter (item 6) onto the motor shaft. Be sure one of the setscrews is protruding into the motor shaft keyway slot, but do not tighten any setscrews yet.
2. Install the motor adapter/mounting plate assembly (8 & 15) with setscrews access slots at 12 and 6 location, and tighten all four bolts.
3. Lubricate the outer boot on the stationary part of the seal with a chemically compatible lubricant, and press into the backhead (item 7) until it is fully seated. The polished seal surface should be facing away from the motor.

NOTE: To keep the polished surface of the seal face clean, use a piece of cardboard to protect the seal face during installation.

4. Insert the backhead (item 7) into the motor adapter (item 8) bore and press into place.

If the shaft adapter was not loosened or removed, go to step 5. If replacing the shaft adapter, firmly hold the backhead toward the motor, and adjust the shaft adapter until the shoulder is $.843 (27/32)$ inches from the stationary seal face (see figure 2). Tighten all four setscrews with a T wrench through the access slots in the motor adapter.

5. Lubricate the inside of the rotating seal component with a chemically

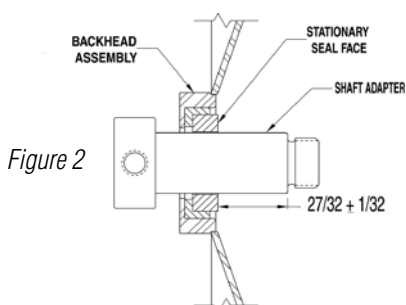


Figure 2

compatible lubricant and carefully slide it over the shaft adapter with a rotating face pointing at the motor (as shown in figure 3).

NOTE: Rotating seal must be completely seated against the stationary seal face.

6. Place the seal spring and spring retainer over the shaft adapter.

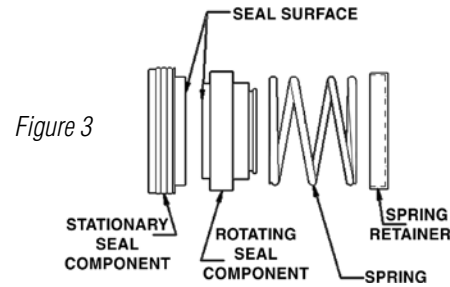


Figure 3

NOTE: To prevent spinning the impeller off in case the motor is wired for incorrect rotation, it is recommended to coat the shaft adapter threads with Loctite Threadlocker #262.

7. Holding the motor shaft firmly, thread the impeller onto the shaft adapter until it stops at the adapter shoulder.
 8. Lubricate the housing o-ring (item 3) with chemically compatible lubricant, and install onto the backhead. Install the impeller housing (item 1), the V-clamp (item 2), and the nut onto the V-clamp stud. Verify the V-clamp stud and housing discharge orientation and tighten the V-clamp. Firmly tap the V-clamp to seat it in several places and retighten the V-clamp nut.
- NOTE: Stainless Steel hardware can gall, be damaged and become very difficult to remove. To prevent galling use a lubricant like Loctite Anti-Seize or some other compatible lubricant or coating material, use a slow RPM speed to tighten and immediately stop tightening if galling is noticed. If galled remove & replace the hardware.
9. Rotate the motor shaft by hand to verify there is no rubbing. Replace the motor fan and fan cover. Reinstall the pump into the system.

TROUBLESHOOTING

NO OR INSUFFICIENT FLOW

1. Pump not primed.
2. Closed valve.
3. Viscosity too high.
4. Air leaks in suction piping.
5. Discharge head higher than anticipated.
6. Suction lift too high or insufficient NPSH.
7. Check for clogged suction line.
8. Motor wired for wrong rotation.

INSUFFICIENT PRESSURE

1. Air or gas in liquid.
2. Impeller diameter too small.
3. Discharge head higher than anticipated.
4. Motor speed insufficient (too low) or motor rotation incorrect.

LOSS OF PRIME

1. Leaking suction line.
2. Foot valve or suction opening not submerged enough.
3. Foot valve too small or leaking.
4. Air or gas in liquid.
5. Foreign matter in impeller.

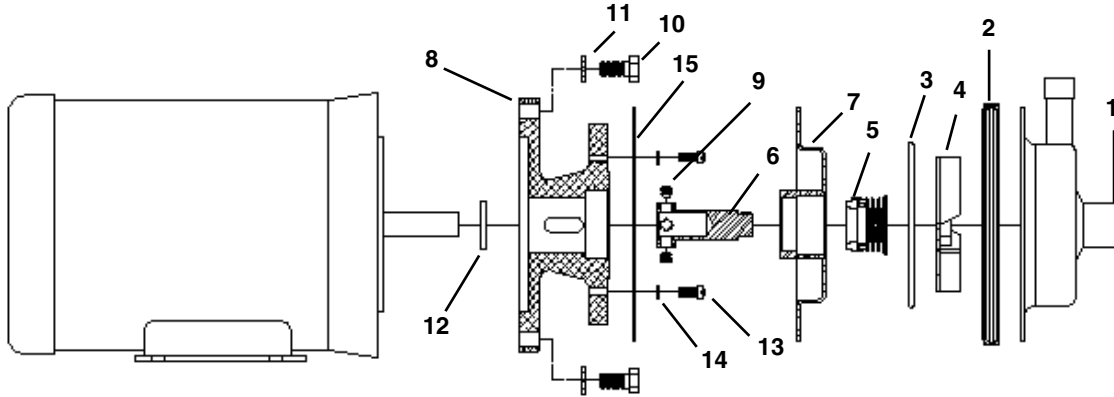
EXCESSIVE POWER CONSUMPTION

1. Head lower than rating. Excessive flow.
2. Specific gravity or viscosity of liquid is too high.

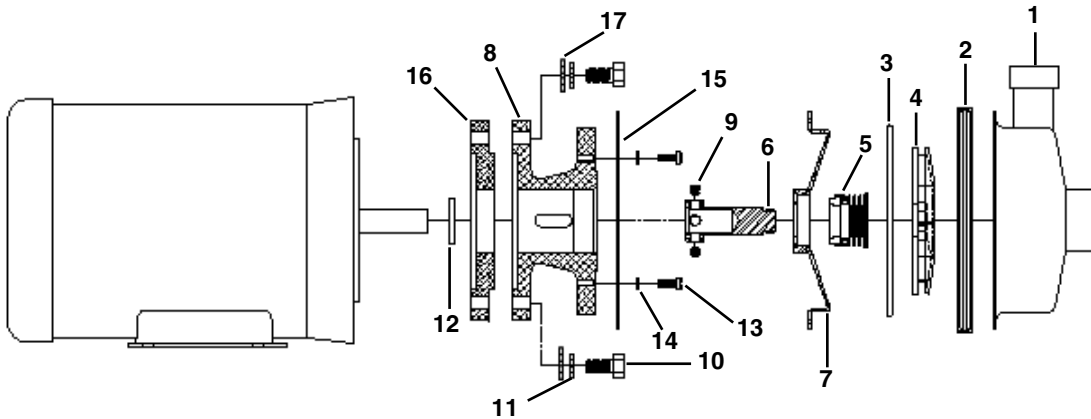
EXCESSIVE VIBRATION

1. Loose piping or bolts.
2. Pump cavitating from improper suction or feed.

AC4 EXPLODED VIEW



AC5 EXPLODED VIEW



Item	Qty	Description	Part Number
		Impeller Housing	
		AC4STS1 - 316 SS - 3/4" x 1/2" FNPT/BSP	A102106-1
		AC4STS2 - 316 SS - 3/4" x 1/2" FNPT/BSP w/ drain & plug	A102106-2
		AC4STS3 - 316 SS - 3/4" x 1/2" ANSI 150# dimensional flanges	106923
		AC4STS4 - 316 SS - 1" x 1" ANSI 150# dimensional flanges	108454
		AC4STS5 - 316 SS - 1-1/2" x 3/4" electropolished tri-clamp fittings	108453
		AC4STS6 - 316 SS - 1-1/2" x 1" electropolished tri-clamp fittings	108453-1
		AC5STS1 - 1-1/2" x 1-1/4" standard FNPT	A102112-1
		AC5STS2 - 1-1/4" x 3/4" standard FNPT	A102113-1
		AC5STS4 - 1-1/2" x 1-1/4" standard BSP	A102112-3
		AC5STS5 - 1-1/4" x 3/4" standard BSP	A102113-2
		AC5STS7 - 1-1/2" x 1-1/2" electropolished tri-clamp fittings	108530
		AC5STS5 - 1-1/4" x 3/4" ANSI 150# dimensional flanges	107248
		AC5STS9 - 1-1/2" x 1" ANSI 150# dimensional flanges	108471
		AC5STS10 - 1-1/2" x 1-1/2" ANSI 150# dimensional flanges	108472-1
		AC5STS11 - 1-1/2" x 1" electropolished tri-clamp fittings	108469
1	1	AC5STS3 - 2" x 1-1/2" standard FNPT (high flow)	A102133-1
		AC5STS6 - 2" x 1-1/2" standard BSP (high flow)	A102133-2
		AC5STS12 - 2" x 1-1/2" ANSI 150# dimensional flanges (high flow)	108473-1
		AC5STS13 - 2" x 1-1/2" electropolished tri-clamp fittings (high flow)	108378-1
		AC5HTS1 - 1/2" x 1/4" high head FNPT	A102120-1
		AC5HTS2 - 1/2" x 1/4" high head BSP	A102120-2
		AC5HTS3 - 1/2" x 1/4" high head FNPT electropolished	A102120-3
		AC5HTS4 - 1/2" x 1/4" high head ANSI 150# dimensional flanges	108502
		AC5HTS5 - 1/2" x 1/4" high head electropolished tri-clamp fittings	108503
		AC5RTS1 - 1-1/2" x 1-1/4" recessed FNPT	A102112-2
		AC5RTS2 - 2" x 1-1/2" recessed FNPT	A102133-3
		AC5RTS3 - 1-1/2" x 1-1/4" recessed BSP	A102112-4
		AC5RTS4 - 2" x 1-1/2" recessed BSP	A102133-4
		AC5RTS5 - 1-1/2" x 1-1/2" recessed ANSI #150 dimensional flanges	108472-2
		AC5RTS6 - 2" x 1-1/2" recessed ANSI #150 dimensional flanges	108473-2
		AC5RTS7 - 1-1/2" x 1" recessed electropolished tri-clamp fittings	108469-1
		AC5RTS8 - 2" x 1-1/2" recessed electropolished tri-clamp fittings	108378-2

Item	Qty	Description	Part Number
2	1	V-Clamp	
			J102947
3	1	O-Ring	
		FKM (AC4)	J102946
		EPDM (AC4)	J103004
		Buna (AC4 FDA compliant)	108213
		PTFE (AC4)	J103042
		FKM (AC5)	J102960
		EPDM (AC5)	J103003
		Buna (AC5 FDA compliant)	108214
		PTFE (AC5)	J103043
4	1	Impeller	
		400 - 4.00" x 1/4" standard (AC5STS)	A102114-1
		420 - 4.25" x 1/4" standard (AC5STS)	A102114-2
		450 - 4.50" x 1/4" standard (AC5STS)	A102114-3
		470 - 4.75" x 1/4" standard (AC5STS)	A102114-4
		400 - 4.00" x 1/4" standard electropolished (AC5STS)	108445-1
		420 - 4.25" x 1/4" standard electropolished (AC5STS)	108445-2
		450 - 4.50" x 1/4" standard electropolished (AC5STS)	108445-3
		470 - 4.75" x 1/4" standard electropolished (AC5STS)	108445-4
		408 - 4.00" x 3/8" standard (AC5STS high flow)	A102114-9
		428 - 4.25" x 3/8" standard (AC5STS high flow)	A102114-10
		458 - 4.50" x 3/8" standard (AC5STS high flow)	A102114-11
		478 - 4.75" x 3/8" standard (AC5STS high flow)	A102114-12
		408 - 4.00" x 3/8" standard electropolished (AC5STS high flow)	108445-5
		428 - 4.25" x 3/8" standard electropolished (AC5STS high flow)	108445-6
		458 - 4.50" x 3/8" standard electropolished (AC5STS high flow)	108445-7
		478 - 4.75" x 3/8" standard electropolished (AC5STS high flow)	108445-8
		300 - 3.00" x 1/2" recessed (AC4STS/AC5RTS)	A102105-1
		320 - 3.25" x 1/2" recessed (AC4STS/AC5RTS)	A102105-2
		350 - 3.50" x 1/2" recessed (AC4STS/AC5RTS)	A102105-3
		370 - 3.75" x 1/2" recessed (AC5RTS)	A102105-4
		450 - 4.50" x 1/2" recessed (AC5RTS)	A102105-5
		300 - 3.00" x 1/2" recessed electropolished (AC4STS/AC5RTS)	108444-1
		320 - 3.25" x 1/2" recessed electropolished (AC4STS/AC5RTS)	108444-2
		350 - 3.50" x 1/2" recessed electropolished (AC4STS/AC5RTS)	108444-3
		370 - 3.75" x 1/2" recessed electropolished (AC5RTS)	108444-4
		450 - 4.50" x 1/2" recessed electropolished (AC5RTS)	108444-5
		450 - 4.50" x 1/8" high head (AC5HTS)	A102183-1
		475 - 4.75" x 1/8" high head (AC5HTS)	A102183-1
		450 - 4.50" x 1/8" high head electropolished (AC5HTS)	A102183-2
		475 - 4.75" x 1/8" high head electropolished (AC5HTS)	108446
5	1	Seal	
		3/4" Carbon/Ceramic/FKM seal	J102957-1
		3/4" Carbon/Ceramic/EPDM seal	J102957-2
		3/4" Carbon/Ceramic/Buna seal (FDA compliant)	108073
		3/4" Carbon/Ceramic/Kalrez seal	J103081
		3/4" Silicon Carbide/Silicon Carbide/FKM seal	J103066
		3/4" Silicon Carbide/Silicon Carbide/EPDM seal	J103067
6	1	Shaft Adapter w/ Set Screws	
		56C frame	A102895
		71-B14 frame	A102896
		80 frame (AC5 only)	A102897
		90 frame (AC5 only)	A102898
7	1	Backhead	
		AC4	A102110-1
		AC5	A102121-1
8	1	Motor Adapter	
		56C frame	M102049-1
		71-B14 frame	M102049-2
		80 frame (AC5 only)	M102049-3
		90 frame (AC5 only)	M102049-4
9	4	1/4-20 x 1/4" Cup Point Set Screw	
			J100220
10	4	Hex Head Cap Screw	
		3/8-16 x 1" (56C frame)	J100114
		M6 x 25 mm (71-B14 & 80 frame)	J103456
		M8 x 40 mm (90 frame)	J102760

Item	Qty	Description	Part Number
11	4	Lock Washer	
		3/8" (56C)	J100115
		5/16" (90 frame only)	J101282
		1/4" (71-B14 & 80 frame)	J100672
12	1	Slinger Ring	
		56C Frame	M102064-1
		71-B14 Frame	M102064-2
		80 Frame (AC5 only)	M102064-3
		90 Frame (AC5 only)	M102064-4
13	4	Cap Screw Fillister Head (all)	
			J100932
14	4	#10 Lock Washer (all)	
			J100824
15	1	Mounting Plate	
			J103389-1
16	1	Metric Motor Adapter	
		90 Frame only	M102129
17	4	Flat Washer - 5/16"	
		90 Frame only	J101293

WARRANTY

Finish Thompson, Inc (manufacturer) warrants this pump product to be free of defects in materials and workmanship for a period of one year from date of purchase by original purchaser. If a warranted defect, which is determined by manufacturer's inspection, occurs within this period, it will be repaired or replaced at the manufacturer's option, provided (1) the product is submitted with proof of purchase date and (2) transportation charges are prepaid to the manufacturer. Liability under this warranty is expressly limited to repairing or replacing the product or parts thereof and is in lieu of any other warranties, either expressed or implied. This warranty does not apply to normal wear of the product or components. This warranty does not apply to products or parts broken due to, in whole or in part, accident, overload, abuse, chemical attack, tampering, or alteration. The warranty does not apply to any other equipment used or purchased in combination with this product.

The manufacturer accepts no responsibility for product damage or personal injuries sustained when the product is modified in any way. If this warranty does not apply, the purchaser shall bear all cost for labor, material and transportation.

Manufacturer shall not be liable for incidental or consequential damages including, but not limited to process down time, transportation costs, costs associated with replacement or substitution products, labor costs, product installation or removal costs, or loss of profit. In any and all events, manufacturer's liability shall not exceed the purchase price of the product and/or accessories.

Warranty Registration

Thank you for your purchase of this quality Finish Thompson product. Be sure to take a minute to register your pump at Finishthompson.com/warranty. Simply provide the model number, serial number and a few other pieces of information.





CHEMICAL REACTION DISCLAIMER

The user must exercise primary responsibility in selecting the product's materials of construction, which are compatible with the fluid(s) that come(s) in contact with the product. The user may consult Finish Thompson, Inc. (manufacturer) and a manufacturer's representative/distributor agent to seek a recommendation of the product's material of construction that offers the optimum available chemical compatibility.

However neither manufacturer nor agent shall be liable for product damage or failure, injuries, or any other damage or loss arising out of a reaction, interaction or any chemical effect that occurs between the materials of the product's construction and fluids that come into contact with the product's internals.

Call our toll free Technical Service Hot Line, 1-800-888-3743, if you have any questions regarding product operation or repair.

SAFETY PRECAUTIONS FOR ATEX PUMPS

-  **WARNING:** Proper materials of construction must be chosen for the fluid being pumped. Improper material selection could lead to pump failure and leakage. This is the responsibility of the end user.
-  **WARNING:** ATEX pumps must have a power monitor, flow switch, pressure switch or similar device installed to protect against running dry, closed discharge valve, major leaks, and possible sources of ignition due to motor bearing failure. Any of these conditions could lead to a rise in surface temperature of the pump. The device must be set to stop the pump within three seconds of a fault.
-  **WARNING:** The pump must be checked for leaks on a regular basis. If leaks are detected, the pump must be repaired or replaced immediately.
-  **WARNING:** The pump must be cleaned on a regular basis to avoid dust buildup greater than 5mm.

Temperature Classification

Pump temperature is completely dependent on operating conditions. Pump will transfer heat from the piping system, motor, and fluid. These items must be considered as a system when assessing an ATEX application.

EU Declaration of Conformity

Manufactured by:

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Phone: 1-(814)-455-4478
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FINISH THOMPSON INC.



1026

II 2GD
Ex h IIC TX Gb
Ex h IIIC TX Db
FTZU 05 A127-05

This declaration applies to Finish Thompson **AC Series pumps**.

Finish Thompson declares under our sole responsibility that the product listed above conforms to the relevant provisions of EU directive **2014/34/EU of 26 February 2014** for equipment and protective systems intended for use in potentially explosive atmospheres, and is certified for safe use in **Atmosphere Group IIC/IIIC category 2 areas**.

This product has used the following harmonized standards to verify conformance:

Non-electrical equipment for potentially explosive atmospheres: **EN ISO 80079-36:2016**
Basic Methods and Requirements.

Non-electrical equipment intended for use in potentially explosive atmospheres: **EN ISO 80079-37:2016**
Protection by construction safety "ch." and control of ignition source "bh"

This product must not be used in areas other than specified above. If in doubt consult an authorized distributor, or refer to the manufacturer Finish Thompson.

Approved by:

Date: 5/5/2017



FINISH THOMPSON INC.
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EU Declaration of Conformity



Finish Thompson Inc. hereby declares that the following machine(s) fully comply with the applicable health and safety requirements as specified by the EU Directives listed. The product may not be taken into service until it has been established that the drive motor for the centrifugal pump complies with the provisions of all relevant EU Directives. The complete product complies with the provisions of the EC Directive on machinery safety provided motors carry CE marking.

This declaration is valid provided that the devices are fully assembled and no modifications are made to these devices.

Type of Device:

Centrifugal Pumps

Models:

AC/AK/AV - 400/500/600/800	GP-11/22/32	VKC-5.5/6/6H/7/8/10
DB-3/4/5/5.5/6/6H/7/8/9/10/11/15/22	MSKC	SP-10/11/15/22
KC-3/4/5/5.5/6/6H/8/10/11/22/32	MSVKC	
UC-1516/1516L/1518/1518L/2110/3158/326/326H/328/436/438/4310H/326H/4310H/6410		

EU Directives:

Machinery Safety (2006/42/EC)

Applied Harmonized Standards:

EN ISO 12100

EN 809

Manufacturer: Finish
Thompson Inc.
921 Greengarden Road
Erie, Pennsylvania 16501-1591 U.S.A

Signed,

President

1 August 2016

Person(s) Authorized to Compile Technical File: Finish Thompson GmbH
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P/N J103334, Rev. 20, 4/5/2019



May 2013

627 Series Pressure Reducing Regulators

WARNING

Failure to follow these instructions or to properly install and maintain this equipment could result in an explosion and/or fire causing property damage and personal injury or death.

Fisher® regulators must be installed, operated, and maintained in accordance with federal, state, and local codes, rules and regulations, and Emerson Process Management Regulator Technologies, Inc. (Regulator Technologies) instructions.

If the regulator vents gas or a leak develops in the system, service to the unit may be required. Failure to correct trouble could result in a hazardous condition.

Call a gas service person to service the unit. Only a qualified person must install or service the regulator.



W4793

Figure 1. Typical 627 Direct-Operated Pressure Reducing Regulator

Introduction

Scope of the Manual

This manual provides instructions for the installation, adjustment, maintenance, and parts ordering information for the 627 Series regulators. These regulators are usually shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the Instruction Manual of the other equipment for installation and operating instructions.

Description

The 627 Series direct-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.

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 section, 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



627 Series

Specifications

The Specifications section gives some general specifications for the 627 Series regulators. The nameplates give detailed information for a particular regulator as it comes from the factory.

Available Constructions

Type 627: Direct-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 627LR: Type 627R with light rate relief spring (Figure 9).

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 NPT downstream control line connection (Figure 10).

Type 627MR: Type 627M with internal relief (Figure 11).

Type 627H: Type 627 with a diaphragm limiter to deliver a higher outlet pressure (Figure 12).

Type 627HM: Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4 NPT downstream control line connection (Figure 13).

Body Sizes and End Connection Styles

BODY SIZE		END CONNECTION STYLE	CONSTRUCTION AVAILABLE
NPS	DN		
3/4	----	NPT	All
1	25	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	
2	50	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	

Maximum Inlet Pressure⁽¹⁾ (Body Rating)

NPT Stainless Steel: 2000 psig / 138 bar

Flanged Stainless Steel: 1440 psig / 99.3 bar

NPT Steel: 2000 psig / 138 bar

Flanged Steel: 1500 psig / 103 bar

Ductile Iron: 1000 psig / 69.0 bar

Maximum Valve Disk Inlet Pressure Rating⁽¹⁾

Nylon (PA) Disk: 2000 psig / 138 bar

Nitrile (NBR) Disk: 1000 psig / 69.0 bar

Fluorocarbon (FKM) Disk: 300 psig / 20.7 bar

Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges⁽¹⁾

See Table 1 for pressures by orifice size and spring range

Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

See Table 2

Maximum Body Outlet Pressure⁽¹⁾⁽²⁾

(Types 627M, 627MR, and 627HM Only)

NPT Steel: 2000 psig / 138 bar

Flanged Steel: 1500 psig / 103 bar

Ductile Iron: 1000 psig / 69.0 bar

Orifice Sizes

See Table 1

Internal Relief Performance

Type 627R: See Table 3

Type 627LR: See Table 4

Type 627MR: Limited by field-installed control line piping

Elastomer Temperature Capabilities⁽¹⁾⁽³⁾

MATERIAL	DISK/ DIAPHRAGM	TEMPERATURE	
		°F	°C
Nitrile (NBR)	Disk	-40 to 180	-40 to 82
	Diaphragm		
Fluorocarbon (FKM)	Disk	0 to 180	-18 to 82
	Diaphragm		
Nylon (PA)	Disk	-40 to 180	-40 to 82
Neoprene (CR) for Types 627H and 627HM only	Diaphragm	-40 to 180	-40 to 82

Flow Coefficients

See Table 5

IEC Sizing Coefficients

See Table 6

Pressure Registration

Type 627, 627H, 627R, or 627LR: Internal

Type 627M, 627HM, or 627MR: External through 1/4 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 Types 627R, 627LR, and 627MR (see Figures 8, 9, and 11)

Spring Case Vent Connection

3/4 NPT with removable screened vent assembly

Approximate Weights

Ductile Iron, Steel, or Stainless Steel Casings: 10 pounds / 4 kg

Aluminum Casings: 6.3 pounds / 3 kg

1. The pressure/temperature limits in this Instruction Manual or any applicable standard limitation should not be exceeded.

2. Types 627, 627H, 627R, and 627LR are limited by maximum diaphragm casing pressure.

3. Stainless steel body is rated to -40°F / -40°C. Steel and Ductile Iron bodies are rated to -20°F / -29°C.

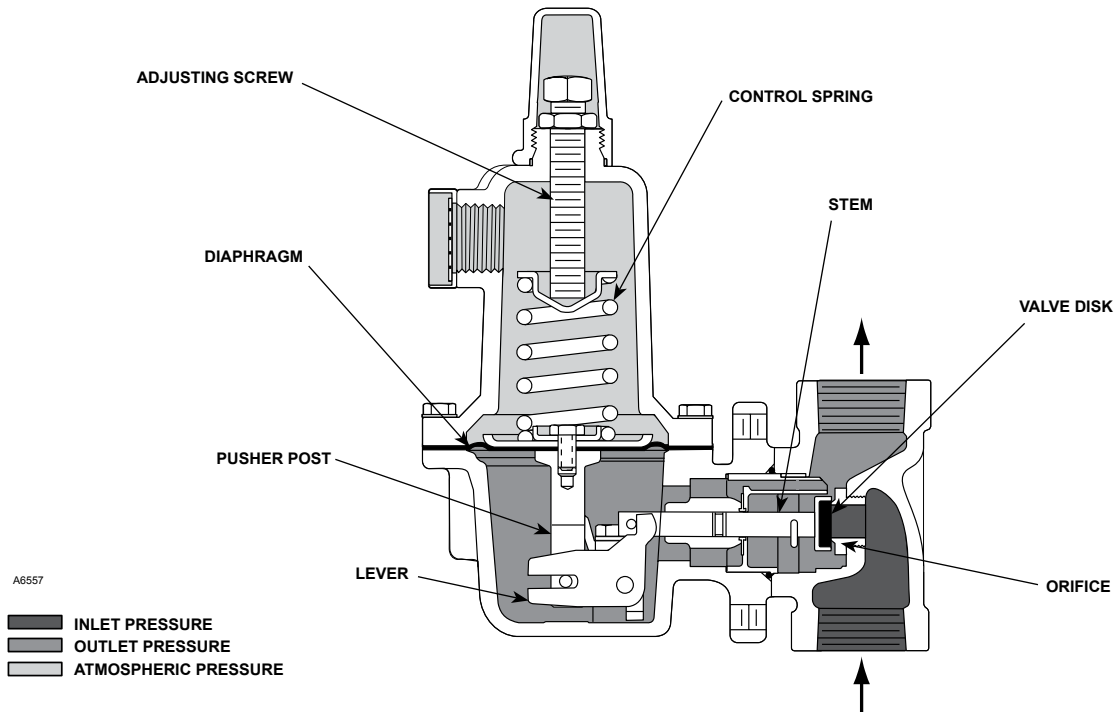


Figure 2. Type 627 Operational Schematic

those limits. The Type 627R, 627LR, or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in the Specifications section, 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.

Principle of Operation

Refer to Figure 2. When downstream demand decreases, the pressure under the diaphragm increases. This pressure overcomes the regulator setting (which is set by a spring). Through the action of the pusher post assembly, lever, and valve stem the valve disk moves closer to the orifice and reduces gas flow. If demand downstream increases, pressure under the diaphragm decreases. Spring force pushes the pusher post assembly downward and the valve disk moves away from the orifice.

Product Description

Types 627 and 627H Direct-Operated Pressure Reducing Regulators—The Types 627 and 627H regulators provide economical pressure reducing control for a variety of residential, commercial, and industrial applications. The regulator pitot tube located in a high velocity stream provides dynamic boost that compensates for outlet pressure drop.

Type 627 Long Body—The Type 627 Long Body regulator can be used as a drop-in replacement for existing Type 630 installations without the need to modify piping.

Internal Relief for Type 627R, 627LR, or 627MR Regulator—The Type 627R internal relief performance values were obtained **by removing the disk assembly** from the regulator. For the Type 627R, 627LR, or 627MR regulator, the internal relief across the diaphragm provides overpressure protection in many applications. As outlet pressures build up above the start-to-discharge point, the diaphragm moves off the relief valve seat allowing the excess pressure to bleed out through the screened vent.

For extra protection, should failure conditions exist which would prevent normal operation of the regulator

627 Series

Table 1. Maximum Inlet Pressures and Outlet Pressure Ranges

TYPE	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	ORIFICE SIZE		MAXIMUM INLET PRESSURE ⁽¹⁾					
				Nylon (PA) Disk		Nitrile (NBR) Disk		Fluorocarbon (FKM) Disk	
		Inches	mm	psig	bar	psig	bar	psig	bar
627 and 627M ⁽³⁾	5 ⁽²⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	250	17.2	250	17.2	250	17.2
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	500	34.5	500	34.5	300	20.7
		1/2	13	300	20.7	300	20.7	300	20.7
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
		3/16	4.8	1750	121	1000	69.0	300	20.7
		1/4	6.4	1500	103	1000	69.0	300	20.7
		3/8	9.5	1000	69.0	1000	69.0	300	20.7
		1/2	13	750	51.7	750	51.7	300	20.7
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
3/16		4.8	2000	138	1000	69.0	300	20.7	
1/4		6.4	1750	121	1000	69.0	300	20.7	
3/8		9.5	1250	86.2	1000	69.0	300	20.7	
1/2		13	750	51.7	750	51.7	300	20.7	
627R and 627MR	5 ⁽²⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1750	121	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
3/16		4.8	500	34.5	500	34.5	300	20.7	
1/4		6.4	300	20.7	300	20.7	300	20.7	
3/8		9.5	200	13.8	200	13.8	200	13.8	
1/2		13	200	13.8	200	13.8	200	13.8	
627LR	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4			1000	69.0	300	20.7
		1/8	3.2			1000	69.0	300	20.7
		3/16	4.8			750	51.7	300	20.7
		1/4	6.4			500	34.5	300	20.7
627H and 627HM ⁽³⁾	140 to 250 psig / 9.7 to 17.2 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		
		3/8	9.5	1000	69.0	750	51.7		
		1/2	13	750	51.7	500	34.5		
	240 to 500 psig / 16.5 to 34.5 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		

1. For inlet pressure in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 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 627HM should have a 3/8 inch / 9.5 mm or larger orifice.
 [Shaded area] - Shaded areas indicate that Fluorocarbon (FKM) and Nylon (PA) disk material are not available.

Table 2. Maximum Spring and Diaphragm Casing Pressure⁽¹⁾

MAXIMUM PRESSURE DESCRIPTION	DIAPHRAGM CASING MATERIAL	TYPE 627		TYPES 627R AND 627LR		TYPE 627M		TYPE 627MR		TYPES 627H AND 627HM	
		psig	bar	psig	bar	psig	bar	psig	bar	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	
	Ductile iron					250	17.2	Not Available		Not Available	
	Steel or Stainless steel							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	32.1	465	32.1	465	32.1	465	32.1	Not Available	
	Steel or Stainless steel	1500	103	1500	103	1500	103	1500	103	1500	103
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All materials	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 local Sales Office for details.

(for example, disk broken off or disk erosion), the pusher post contacts the lever retainer causing the relief valve assembly to open. Since the diaphragm continues to rise as downstream pressure builds, it opens the relief valve; thereby, opening the valve. This internal relief may be adequate for the application.

Downstream Control Line for Type 627M, 627HM, or 627MR Regulator—A Type 627M, 627HM, or 627MR regulator has a blocking throat stem seal with O-rings and a 1/4 NPT control line connection in the diaphragm case. A regulator with a downstream control line is used for monitoring applications or other applications where other equipment is installed between the regulator and the pressure control point. The stem seal separates the body outlet pressure from the diaphragm case.

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 13. Ensure that the operating temperature capabilities listed in Specifications section are not exceeded.

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate Instruction Manual.

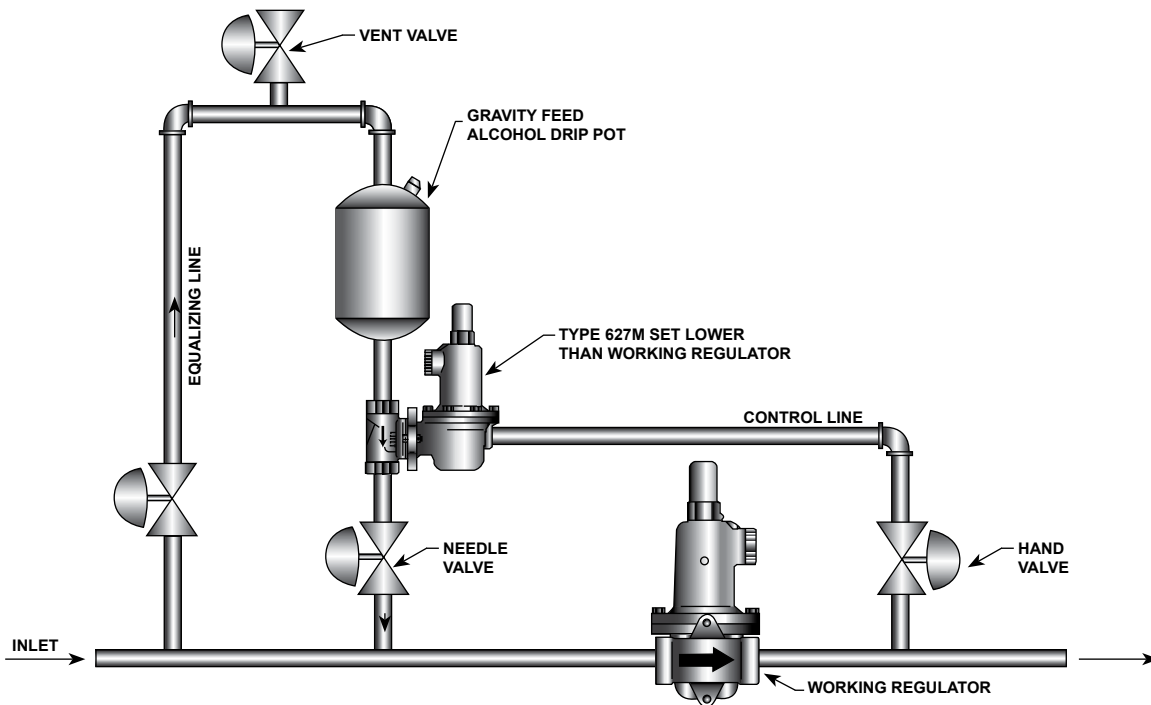
Perform steps 1 through 6 for all types of regulators:

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.



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 and Spring Case Area Maintenance Procedures in the Maintenance section to reposition the screened vent for the application.



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Figure 3. De-Icer System Operational Schematic

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 / 9.5 mm 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 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. It should be as short as possible with 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 form within this regulator. The formation of ice decreases the size of the orifice, 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 orifice, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flowstream prevents additional ice from forming on the orifice. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

Overpressure Protection

627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure-

Table 3. Type 627R Internal Relief Performance⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾											
					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 / 13	
					psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
5 ⁽³⁾ to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	10	0.69	60	4.1	1250	86.2	740	51.0	320	22.1	190	13.1	95	6.6	75	5.2
			100	6.9	2000	138	1500	103	620	42.7	390	26.9	180	12.4	130	9.0
			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	9.0
			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		
	20	1.4	60	4.1	850	58.6	490	33.8	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	600	41.4	360	24.8	170	11.7	120	8.3
			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 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	15	1.0	60	4.1	1000	69.0	380	26.2	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	590	40.7	350	24.1	170	11.7	120	8.3
			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	110	960	66.2	450	31.0	320	22.1		
	20	1.4	60	4.1	630	43.4	200	13.8	150	10.3	100	6.9	70	4.8	65	4.5
			100	6.9	2000	138	1200	82.7	550	37.9	330	22.8	160	11.0	120	8.3
			125	8.6	2000	138	1700	117	760	52.4	450	31.1	210	14.5	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	630	43.4	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	460	31.7	320	22.1		
	30	2.1	100	6.9	2000	138	950	65.5	450	31.1	260	17.9	140	9.7	110	7.6
			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	8.3	108	7.4
			125	8.6	2000	138	1300	89.6	560	38.6	340	23.4	180	12.4	140	9.7
			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	

1. The internal relief performance values are obtained by removing the disk assembly.
 2. For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 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 1 gives the maximum inlet pressure for normal regulator operation.

- continued -

relieving or pressure-limiting device must be provided by the user for the Types 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

Types 627R and 627LR regulators provide internal relief which limits the total outlet pressure buildup over setpoint. Use Tables 3 and 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.

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

627 Series

Table 3. Type 627R Internal Relief Performance⁽¹⁾ (continued)

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾⁽³⁾											
					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 / 13	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
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	9.7
			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	9.7
			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	31.0	270	18.6	190	13.1	140	9.7	130	9.0
			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	1900	131	600	41.4	400	27.6	260	17.9	200	13.8	175	12.1	
		200	13.8	2000	138	1200	82.7	630	43.4	380	26.2	250	17.2	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
			200	13.8	2000	138	960	66.2	520	35.9	330	22.8	240	16.5	210	14.5
			250	17.2	2000	138	2000	138	1000	69.0	620	42.7	350	24.1	280	19.3
	100	6.9	200	13.8	1500	103	250	17.2	240	16.5	230	15.9	210	14.5	210	14.5
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	

- The internal relief performance values are obtained by removing the disk assembly.
 - For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
 - 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 1 gives the maximum inlet pressure for normal regulator operation.

Table 4. Type 627LR Internal Relief Performance⁽¹⁾

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED ⁽²⁾							
					Orifice Size, Inches / mm							
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
15 to 40 psig / 1.03 to 2.8 bar 10B3077X012 Green	30	2.1	55	3.8	500	34.5	270	18.6	110	7.6	80	5.5
			60	4.1	850	58.6	480	33.1	200	13.8	120	8.3
			66	4.5	1000	69.0	660	45.5	290	20.0	175	12.1
	40	2.8	66	4.5	380	26.2	190	13.1	85	5.9	80	5.5
			70	4.8	700	48.3	370	25.5	150	10.3	115	7.9
			75	5.2	1000	69.0	560	38.6	240	16.5	160	11.0

- The internal relief performance values are obtained by removing the disk assembly.
- For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.

Table 5. Flow Coefficients

ORIFICE		3/4 NPT			NPS 1 / DN 25 BODY			NPS 2 / DN 50 BODY		
Inch	mm	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁	Wide-Open C _g for External Relief Sizing	Wide-Open C _g for External Relief Sizing	C ₁
3/32	2.4	6.9	0.24	29.2	6.9	0.24	28.5	6.9	0.23	29.7
1/8	3.2	12.5	0.43	29.1	12.5	0.43	29.4	12.5	0.42	29.5
3/16	4.8	29	1.01	28.6	29	0.93	31.2	29	1.02	28.5
1/4	6.4	50	1.63	30.6	50	1.71	29.3	52	1.66	31.3
3/8	9.5	108	2.99	36.1	108	3.42	31.6	115	3.39	33.9
1/2	13	190	4.87	39.0	190	5.29	35.9	200	5.01	39.9

Table 6. IEC Sizing Coefficients

ORIFICE SIZE		X _T			F _D	F _L
Inch	mm	3/4 NPT Body	NPS 1 / DN 25 Body	NPS 2 / DN 50 Body		
3/32	2.4	0.539	0.514	0.558	0.50	0.85
1/8	3.2	0.536	0.547	0.539		0.79
3/16	4.8	0.517	0.616	0.514		0.85
1/4	6.4	0.592	0.543	0.620		0.87
3/8	9.5	0.824	0.632	0.727		0.89
1/2	13	0.962	0.815	1.01		0.86

Table 7. Maximum Torque Values

KEY NUMBER ⁽¹⁾	DESCRIPTION	MAXIMUM TORQUE	
		FOOT-POUNDS	N•m
2	Orifice	25	34
3	Cap screw (with aluminum diaphragm casing)	16	22
	Cap screw (with ductile iron or steel/stainless steel diaphragm casing)	25	34
18	Lever cap screw	7	9.5
22	Diaphragm connector nut	17	23
26	Guide retainer (for Types 627R, 627LR, and 627MR only)	3	4.1
37	Spring case cap screw (with aluminum or ductile iron diaphragm casing)	7	9.5
	Spring case cap screw (with steel/stainless steel diaphragm casing)	35	47
46	Diaphragm cap screw (with Type 627 or 627M)	7	9.5
	Diaphragm cap screw (with Type 627H or 627HM)	14	19

1. Refer to Figures 7 through 13 for key number locations.

pressure to prevent an overpressure condition on the diaphragm of the regulator.

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 shut-off valve.
2. Slowly open the downstream shut-off 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. 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 Table 1, 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.

Note

Always use a pressure gauge to monitor pressure when making adjustments.

627 Series

Refer to Figures 7 through 13 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 counterclockwise.
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 shut-off valve.
2. Close the nearest downstream shut-off valve.
3. Open the vent valve between the regulator and the downstream shut-off valve nearest to it.
4. For a Type 627, 627H, 627R, or 627LR regulator, the regulator will open to release pressure between the upstream shut-off 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 shut-off 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 7.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, orifice, and diaphragm must

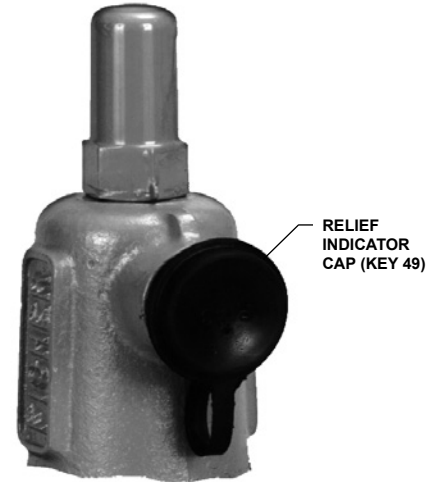


Figure 4. Relief Indicator

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 orifice and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flowstream. Instructions are given below for replacing the disk assembly, orifice, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.

Problem Indication for Types 627R, 627LR, 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 orifice.

If the disk assembly and orifice are not damaged, refer to the Diaphragm and Spring Case Area Maintenance Procedures in this section.

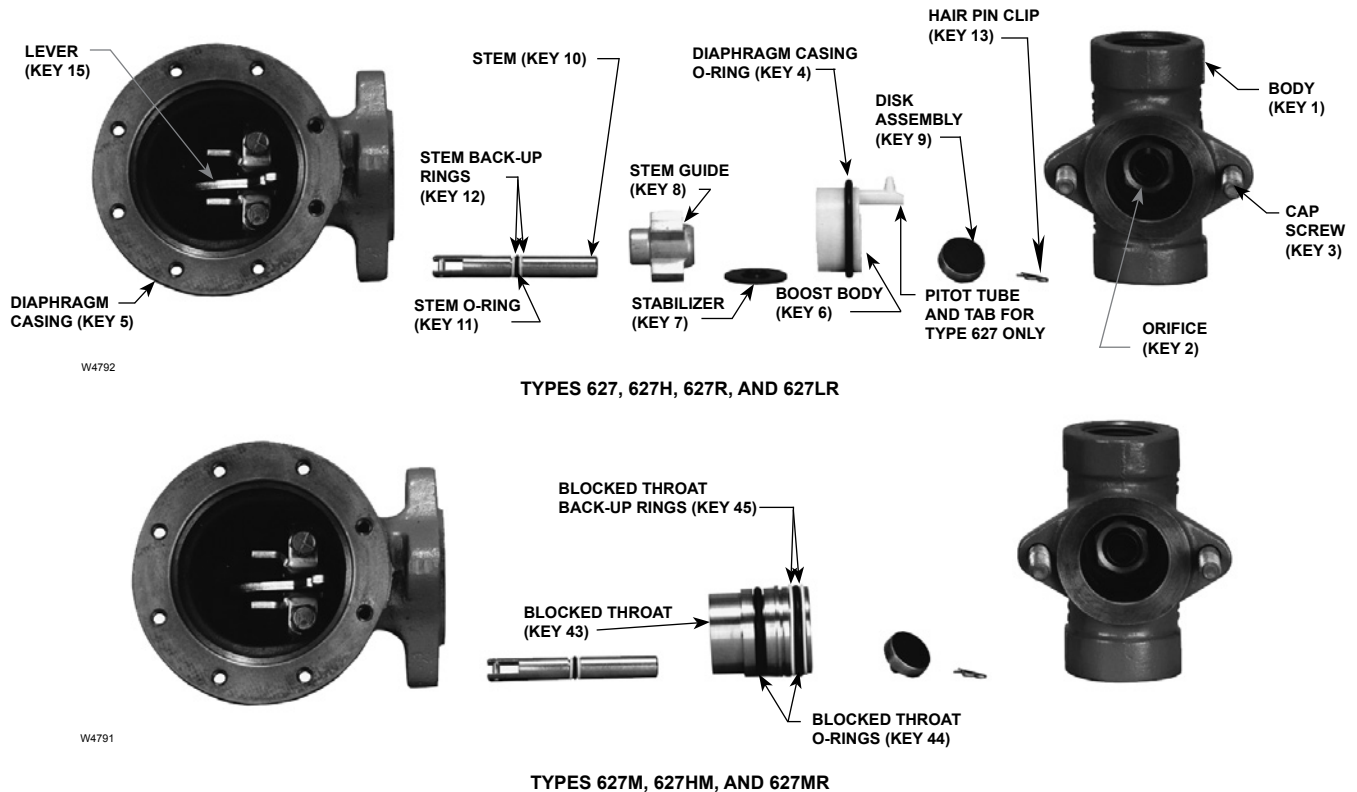


Figure 5. Stem Assemblies

The disk assembly and orifice 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, orifice, diaphragm casing O-ring, and stem assembly. All pressure must be released from the diaphragm casing before performing these steps.

While using the following procedures, refer to Figures 7 through 13 for key number locations.

Replacing the Disk Assembly or Orifice

1. To inspect and replace the disk assembly (key 9) or orifice (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 orifice (key 2). If removed, coat the threads of the replacement orifice with lubricant and torque to 25 foot-pounds / 34 N•m.

3. Inspect the disk assembly (key 9) 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.

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 Types 627, 627H, 627R, and 627LR regulators, or steps 9 through 19 for Types 627M, 627HM, and 627MR regulators.

Perform steps 4 through 8 for Types 627, 627H, 627R, and 627LR Regulators only:

4. 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, 9, or 12) and replace it if necessary.

627 Series

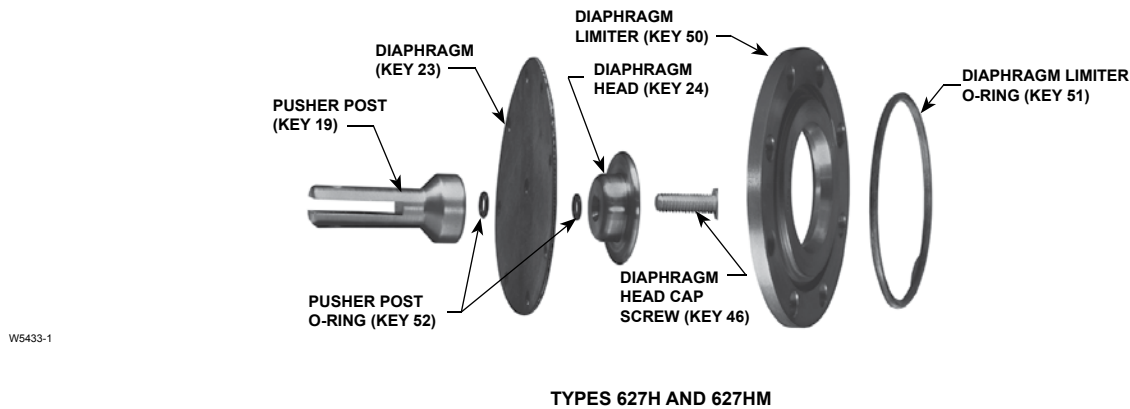
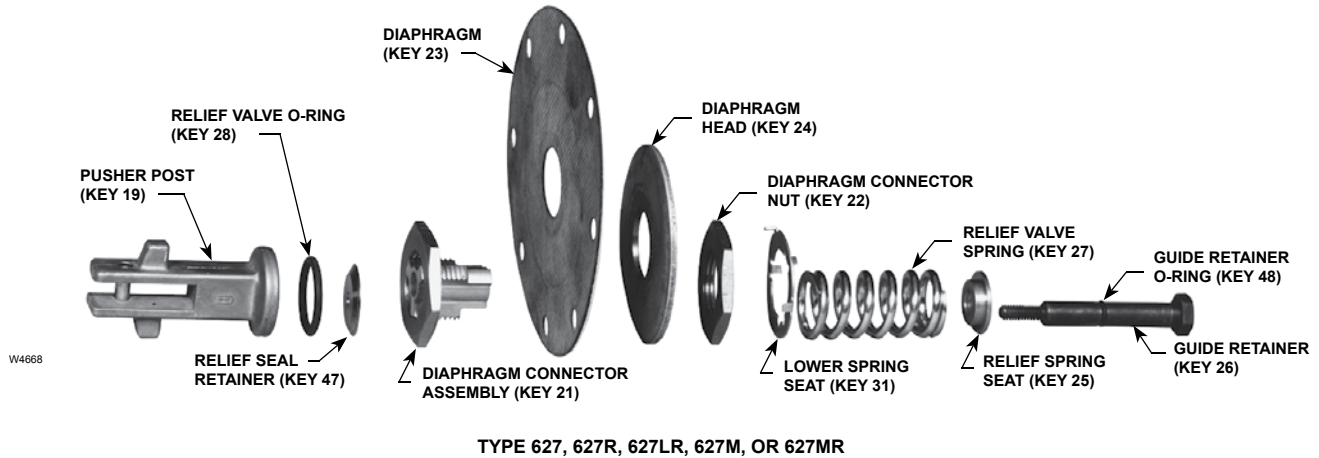


Figure 6. Diaphragm Assemblies

7. Apply lubricant to a replacement diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) 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 12). Skip to step 14.
- Perform steps 9 through 19 for Types 627M, 627HM, and 627MR Regulators only:**
9. 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.
11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, Figure 5) and back-up rings (key 45, Figure 5).
12. Apply lubricant to replacement blocked throat O-rings (key 44) and back-up rings (key 45).
13. Apply lubricant to the replacement stem O-ring (key 11) and stem back-up rings (key 12) and install them on the stem (key 10).
14. For assembly, lubricate the stem (key 10) and insert the diaphragm casing (key 5) and hook it on the lever (key 15).
15. Lubricate the contact points of the lever (key 15).
16. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see Figure 5).
17. Install 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).
18. Position the diaphragm casing (key 5) plus attached parts in relation to the body (key 1) so that they are correct for the application.

19. Secure the diaphragm casing (key 5) to the body with the cap screws (key 3, Figure 5). For an aluminum diaphragm casing, 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.
20. 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 13 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut (key 34), 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.
3. Remove the diaphragm limiter O-ring and diaphragm limiter (keys 51 and 50, 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 / 9.5 N•m.

If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Types 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Types 627R, 627LR, and 627MR regulators.

Perform steps 6 through 11 for Types 627, 627H, 627M, and 627HM Regulators only:

6. For Types 627, 627H, 627M, and 627HM regulators (Figures 5 and 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 pusher post 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 (key 15) and torque the diaphragm head cap screw (key 46) to 7 foot-pounds / 9.5 N•m for the Type 627 or 627M. On the Type 627H or 627HM, torque the diaphragm head cap screw to 14 foot-pounds / 19 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.

Perform steps 12 through 19 for Types 627R, 627LR, and 627MR Regulators only:

12. For Types 627R, 627LR, 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).

627 Series

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 / 23 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 apply lubricant. 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 / 4.1 N•m.
18. Hook the pusher post (key 19) (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 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 over the screw holes, insert the spring case cap screws (key 37), and finger tighten.
23. Screw in the adjusting screw (key 35) 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 / 9.5 N•m of torque.
25. If necessary, refer to the installation and/or the Startup and Adjustment procedures.
26. Install the adjusting locknut (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your local Sales Office about this equipment, always reference the equipment serial number or FS number that can be found on the nameplate.

When ordering replacement parts, reference the key number of each needed part as found in the following parts list. Separate kits containing all recommended spare parts are available.

Parts List

Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the NACE International Standard MR0175.

Key	Description	Part Number
	Type 627 Parts Kit with Aluminum/Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627H Parts Kit with SST/Nylon (PA) trim	R627HX00S12
	Type 627R Parts Kit with Aluminum/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body ⁽¹⁾	
	Ductile iron	
	1000 psig / 69.0 bar maximum inlet pressure	
	3/4 NPT	30B3046X012
	1 NPT	30B3048X012
	2 NPT	30B3096X012
	Ductile iron (Long Body)	
	1000 psig / 69.0 bar maximum inlet pressure	
	1 NPT	39B2451X012
	2 NPT	39B0414X012
	Steel	
	2000 psig / 138 bar maximum inlet pressure	
	3/4 NPT	30B3050X012
	1 NPT	30B3051X012
	2 NPT	30B7452X012
	Steel (Long Body)	
	2000 psig / 138 bar maximum inlet pressure	
	1 NPT	39B0412X012
	2 NPT	39B0415X012
	Steel, CL600 RF flanged	
	1500 psig / 103 bar maximum inlet pressure	
	NPS 1 / DN 25	40B6754X012
	NPS 2 / DN 50	40B6756X012
	Steel, CL300 RF flanged	
	750 psig / 51.7 bar maximum inlet pressure	
	NPS 1 / DN 25	41B8978X012
	NPS 2 / DN 50	41B8080X012

1. Bodies can be used for both standard and NACE constructions.

627 Series

Key	Description	Part Number	Key	Description	Part Number
1	Body ⁽¹⁾ (continued)		4*	Diaphragm Case O-ring	
	Steel, CL150 RF flanged			Nitrile (NBR)	
	290 psig / 20.0 bar maximum inlet pressure			For Type 627, 627H, or 627R only	17A2325X022
	NPS 1 / DN 25	43B8656X022		Fluorocarbon (FKM)	
	NPS 2 / DN 50	44B0666X012		For Types 627, 627R, and 627LR only	10A0037X012
	Steel, BWE		5	Diaphragm Case	
	1000 psig / 69.0 bar maximum inlet pressure			For Type 627, 627R, or 627LR	
	NPS 1 / DN 25	33B6723X012		Aluminum without 1/8-inch / 3.2 mm gauge tap	40B3084X012
	NPS 2 / DN 50	38B1688X012		Aluminum with 1/8-inch / 3.2 mm gauge tap	
	Steel, PN 16/25/40 RF			for 627 Series (except Types 627H and 627HM)	11B5380X012
	580 psig / 40.0 bar maximum inlet pressure			Ductile iron without 1/8-inch / 3.2 mm gauge tap	30B3053X012
	NPS 1 / DN 25	44B0386X012		Ductile iron with 1/8-inch / 3.2 mm gauge tap	
	NPS 2 / DN 50	44B3342X012		for 627 Series (except Types 627H and 627HM)	31B0641X012
	Stainless Steel ⁽²⁾ , NPT			For Type 627, 627R, or 627LR	
	2000 psig / 138 bar maximum inlet pressure			Steel	30B3104X012
	3/4 NPT	30B3050X062		Ductile iron with 1/4 NPT gauge tap for	
	1 NPT	30B3051X092		627 Series (except Types 627H and 627HM)	39A5987X012
	2 NPT	30B7452X052		Steel with 1/4 NPT gauge tap for 627 Series	
	Stainless Steel ⁽²⁾ , CL150 RF flanged			(except Type 627H)	30B8734X012
	275 psig / 18.9 bar maximum inlet pressure			For Type 627M or 627MR	
	NPS 1 / DN 25	43B8656X052		Ductile iron	39A5987X012
	NPS 2 / DN 50	44B0666X022		Steel	30B8734X012
	Stainless Steel ⁽²⁾ , CL300 RF flanged			For Type 627H, Steel	30B3104X012
	720 psig / 49.6 bar maximum inlet pressure			For Type 627, Stainless steel	30B3104X082
	NPS 1 / DN 25	41B8978X072		For Type 627HM, Steel	30B8734X012
	NPS 2 / DN 50	41B8080X072	6	Boost Body (not for Type 627M, 627HM,	
	Stainless Steel ⁽²⁾ , CL600 RF flanged			or 627MR), Delrin [®]	
	1440 psig / 99.2 bar maximum inlet pressure			For Type 627 or 627H	30B3056X012
	NPS 1 / DN 25	40B6754X102		For Type 627R or 627LR	30B3057X012
	NPS 2 / DN 50	40B6756X062	7	Stabilizer	
	Stainless Steel ⁽²⁾ , PN 16/25/40 RF			Nitrile (NBR)	
	580 psig / 40.0 bar maximum inlet pressure			For Types 627, 627H, 627R, and 627LR only	10B3060X012
	NPS 1 / DN 25	44B0386X032		Fluorocarbon (FKM)	
	NPS 2 / DN 50	44B3342X032		For Types 627, 627R, and 627LR only	10B3060X022
2*	Orifice		8	Stem Guide (for Types 627, 627H, 627R, and	
	Aluminum			627LR only), Powdered metal	20B3061X012
	3/32 inch / 2.4 mm	0R044109022	9*	Disk Assembly (for all Orifice Size)	
	1/8 inch / 3.2 mm	1A936709012		Aluminum holder and Nitrile (NBR) disk	1C4248X0212
	3/16 inch / 4.8 mm	00991209012		303 Stainless steel holder and Nitrile (NBR) disk	1C4248X0202
	1/4 inch / 6.4 mm	0B042009012		Aluminum holder and Nylon (PA) disk	1C4248X00A2
	3/8 inch / 9.5 mm	0B042209012		303 Stainless steel holder and Nylon (PA) disk	1C4248X0062
	1/2 inch / 13 mm	1A928809012		316 Stainless steel holder and Nylon (PA) disk	1C4248X0262
	303 Stainless steel			316 Stainless steel holder and Nitrile (NBR) disk	1C4248X0252
	3/32 inch / 2.4 mm	0R044135032		303 Stainless steel holder and	
	1/8 inch / 3.2 mm	1A936735032		Fluorocarbon (FKM) disk	1C4248X0052
	3/16 inch / 4.8 mm	00991235032		Aluminum holder and Fluorocarbon (FKM) disk	1C4248X0182
	1/4 inch / 6.4 mm	0B042035032		316 Stainless steel holder and	
	3/8 inch / 9.5 mm	0B042235032		Fluorocarbon (FKM) disk	1C4248X0192
	1/2 inch / 13 mm	1A928835032	10	Stem	
	316 Stainless steel, NACE construction only			303 Stainless steel	10B3059X012
	3/32 inch / 2.4 mm	0R0441X0012		316 Stainless steel (NACE)	10B3059X022
	1/8 inch / 3.2 mm	1A9367X0022	11*	Stem O-ring	
	3/16 inch / 4.8 mm	009912X0012		Nitrile (NBR)	
	1/4 inch / 6.4 mm	0B0420X0012		Fluorocarbon (FKM) For Types 627, 627R,	
	3/8 inch / 9.5 mm	0B0422X0012		627LR, 627M, and 627MR only	1N430406382
	1/2 inch / 13 mm	1A9288X0012	12*	Stem Back-up Ring,	
3	Cap Screw (not shown), (2 required)			Polytetrafluoroethylene (PTFE) (2 required)	1K786806992
	627 Series		13	Hair Pin Clip, Stainless steel	10B3058X012
	For Ductile iron/Steel diaphragm case	1A560724052	14	Drive Pin, Plated steel	1H3671X0012
	For Aluminum diaphragm case		15	Lever, Plated steel	20B3063X012
	(not applicable for Types 627H and 627HM)	1A352524052	16	Lever Retainer, Plated steel	30B3097X012
	Type 627 Only		17	Lever Pin	
	For Ductile iron/Steel diaphragm case	1A5607X0052		Stainless steel	10B3083X012
	For Aluminum case with Steel diaphragm case	10A3869X012		316 Stainless steel (NACE)	10B3083X022
	For SST Case and body	1A5607X0052			
	For Aluminum Case and SST body	10A3869X022			

*Recommended spare part.

1. Bodies can be used for both standard and NACE constructions.

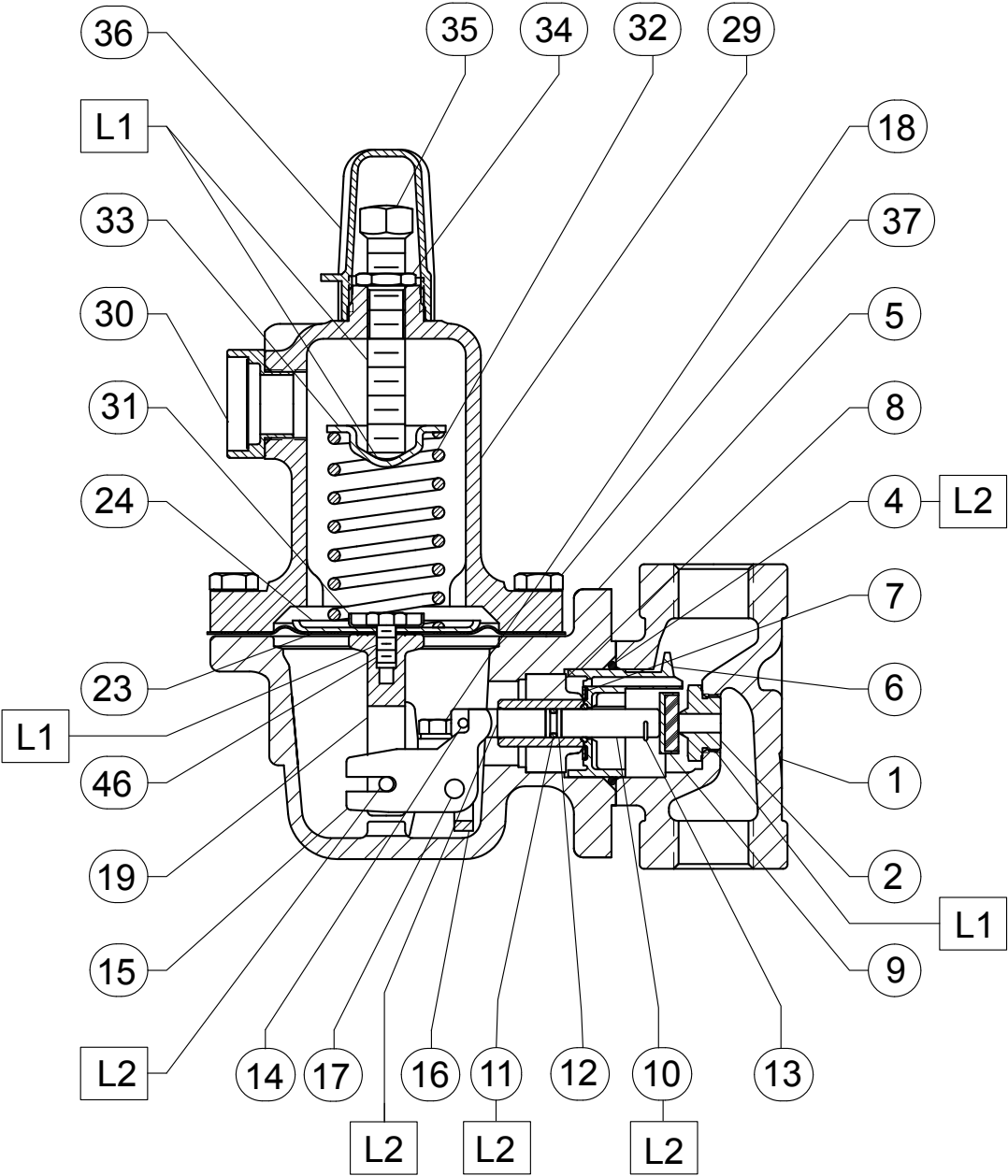
2. Stainless steel body material can be used for applications in temperature ranges down to -40°F / -40°C and are only available for Types 627, 627R, and 627H.

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627 Series

Key	Description	Part Number	Key	Description	Part Number
18	Lever Cap Screw (2 required) Plated steel	10B7454X012	30	Screened Vent Assembly, Plastic	10B3093X012
	316 Stainless steel (NACE)	1B2905X0012	31	Lower Spring Seat, Plated steel For Type 627 or 627M	1D666625072
19	Pusher Post, Aluminum For Type 627 or 627M	10B3098X012		For Type 627R, 627LR, or 627MR	20B3073X012
	For Type 627R, 627LR, or 627MR	10B3098X022	32	Control Spring, Plated steel	
	For Type 627H or 627HM, 416 Stainless steel	10B3098X032		5 to 20 psig / 0.34 to 1.4 bar, Yellow	10B3076X012
	Stainless steel (NACE)	10B3098X102		15 to 40 psig / 1.0 to 2.8 bar, Green	10B3077X012
21	Diaphragm Connector (for Type 627R, 627LR, or 627MR only), Stainless steel	28B8832X012		35 to 80 psig / 2.4 to 5.5 bar, Blue	10B3078X012
22	Diaphragm Connector Nut (for Type 627R, 627LR, or 627MR only), Stainless steel	10B7449X012		70 to 150 psig / 4.8 to 10.3 bar, Red	10B3079X012
23*	Diaphragm Nitrile (NBR) For Type 627 or 627M with Aluminum or Ductile iron diaphragm case	10B3069X012	33	Upper Spring Seat, Plated steel	1D667125072
	For Type 627 or 627M with Steel diaphragm case	10B8735X012	34	Locknut, Plated steel	1D667728982
	For Type 627R, 627LR, or 627MR with Aluminum or Ductile iron diaphragm case	10B3068X012	35	Adjusting Screw, Plated steel For Type 627, 627M, 627H, or 627HM	10B3081X012
	For Type 627R, 627LR, or 627MR with Steel diaphragm case	10B8736X012		For Type 627R, 627LR, or 627MR	10B3080X012
	For Type 627H or 627HM with Steel diaphragm case (diaphragm is Neoprene (CR) with Nylon (PA) fabric)	12B0178X012	36	Adjusting Screw Cap, Plastic	20B3082X012
	Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR with Steel case	10B8736X022	37	Spring Case Cap Screw, Plated steel (8 required) For Aluminum or ductile iron diaphragm case	1A391724052
	For Types 627 and 627M with Steel case	10B8735X042		For Steel diaphragm case	1A368324052
	For Types 627R, 627LR, and 627MR with Ductile Iron and Aluminum Casing	10B3068X022		For Stainless steel case and body	1A3683X0062
	For Types 627 and 627M with Ductile Iron and Aluminum Casing	10B3069X032		For Aluminum case and SST body	1A3917X0062
24	Diaphragm Head, Plated steel For Type 627 or 627M, Plated steel	1D666428982		For Type 627H/HM, steel diaphragm case	1A346424052
	For Type 627R, 627LR, or 627MR, Plated steel	10B3071X012		For Type 627H, Stainless steel case and body	1A3464X0022
	For Type 627H or 627HM, 416 Stainless steel	12B0175X012	43	Blocked Throat (For Type 627M, 627HM, or 627MR only), Stainless steel	10B3085X012
25	Relief Spring Seat (For Type 627R or 627MR only), Steel	10B7446X012	44*	Blocked Throat O-ring Nitrile (NBR) For Type 627M, 627HM, or 627MR only (2 required)	1E264306992
26	Guide Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7450X012		Fluorocarbon (FKM) For Types 627M and 627MR only	1E2643X0022
27	Relief Spring (For Type 627R or 627MR only), Plated steel	10B6757X012	45*	Blocked Throat Back-up Ring (For Type 627M, 627HM, or 627MR only), PTFE (2 required)	10B3106X012
	For Type 627LR	1B541327022	46	Diaphragm Head Cap Screw, Steel For Type 627 or 627M	1B290524052
28*	Relief Seal O-ring Nitrile (NBR) For Type 627R, 627LR, or 627MR only	1J108506992		For Type 627H or 627HM	1C379124052
	Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR only	1J1085X0042	47	Relief Seal Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7445X012
29	Spring Case For Type 627, 627R, or 627LR		48*	Guide Retainer O-ring Nitrile (NBR) For Type 627R, 627LR, or 627MR only	1D682506992
	Aluminum	40B3086X012		Fluorocarbon (FKM) For Types 627R, 627LR, and 627MR only	1N423906382
	Ductile iron	30B3055X012	49	Relief Indicator (For Type 627R, 627LR, or 627MR only), Rubber (not shown)	30B3100X012
	Steel	30B3102X012	50	Diaphragm Limiter (For Types 627H and 627HM only)	22B0176X012
	Stainless steel (Types 627 and 627R only)	30B3102X092	51*	Diaphragm Limiter O-ring For Types 627H and 627HM only	1K877606992
29	Spring Case (continued) For Type 627M or 627MR		52*	Pusher Post O-ring (2 required) For Types 627H and 627HM only	1C853806992
	Ductile iron	30B3055X012	58	Pipe Plug, Zinc	1D8293T0022
	Steel	30B3102X012	67	Drive Screw, 18-8 Stainless steel	1A368228982
	For Type 627H or 627HM		72	Pipe Plug, Zinc-plated steel	1A767524662
	Steel	30B3102X012			
	Stainless steel (Type 627H only)	30B3102X092			

*Recommended spare part.

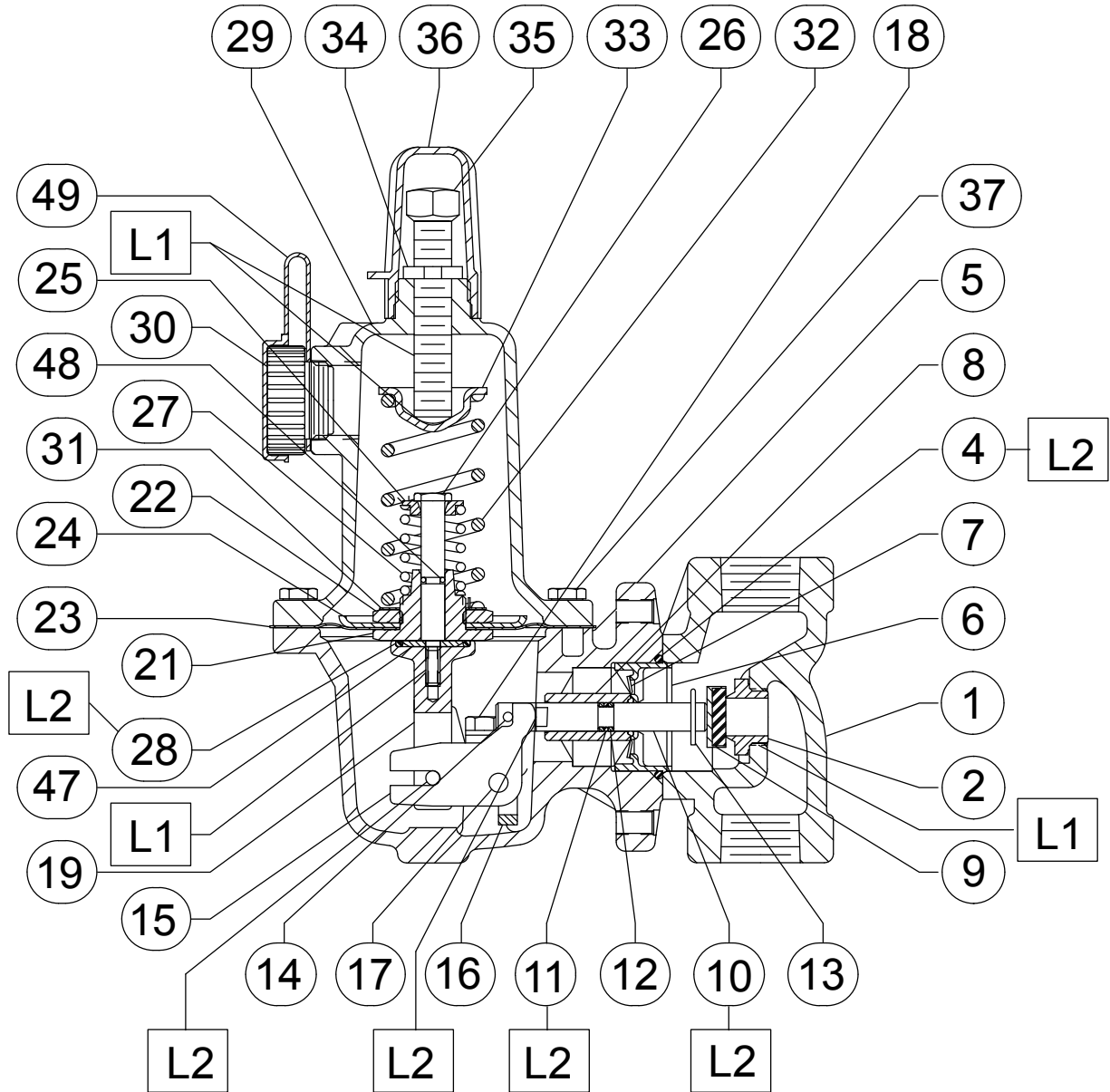


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□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 7. Type 627 Regulator Assembly

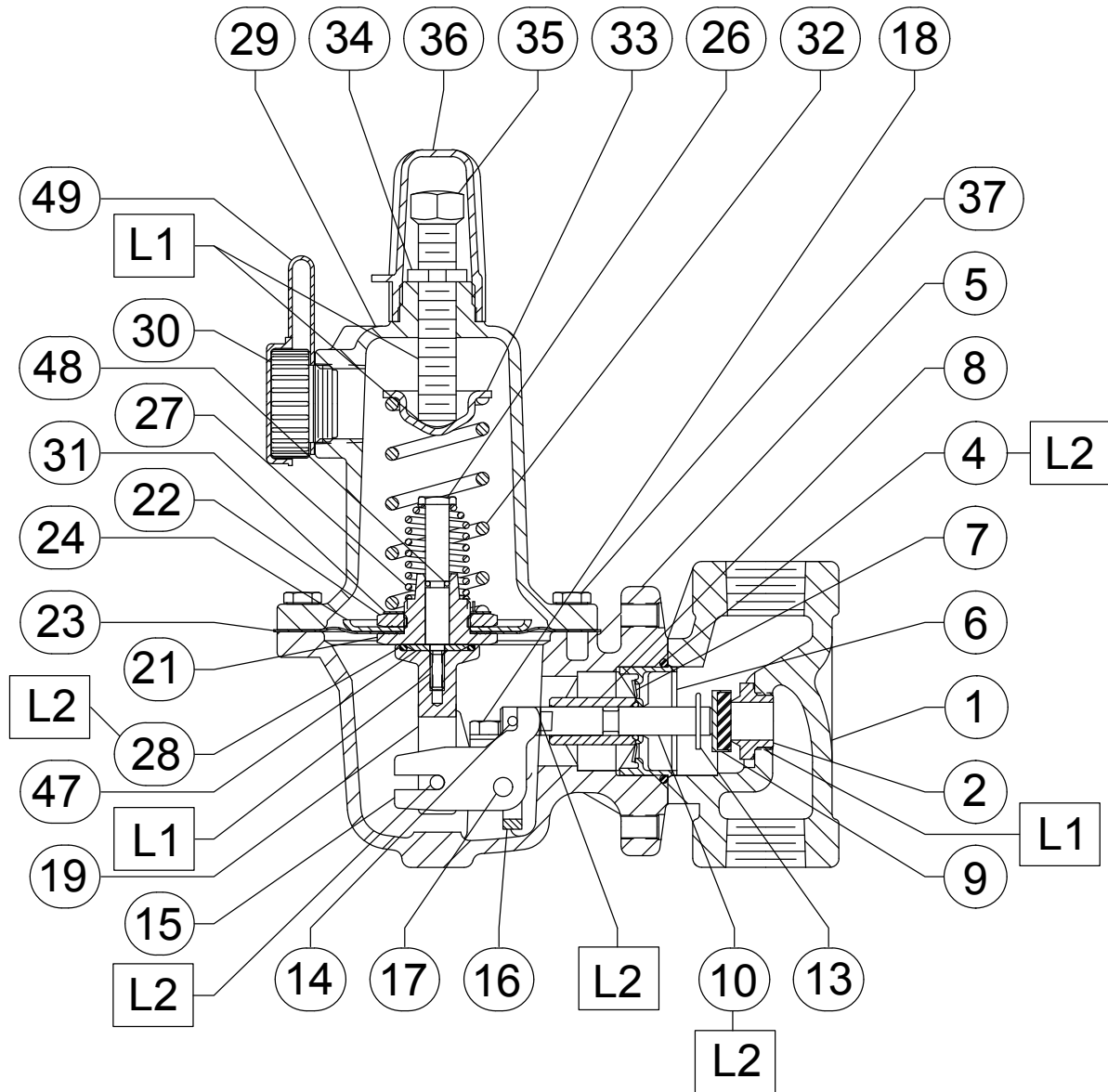


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- APPLY LUBRICANT⁽¹⁾
- L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
- L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
- PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 8. Type 627R Regulator Assembly



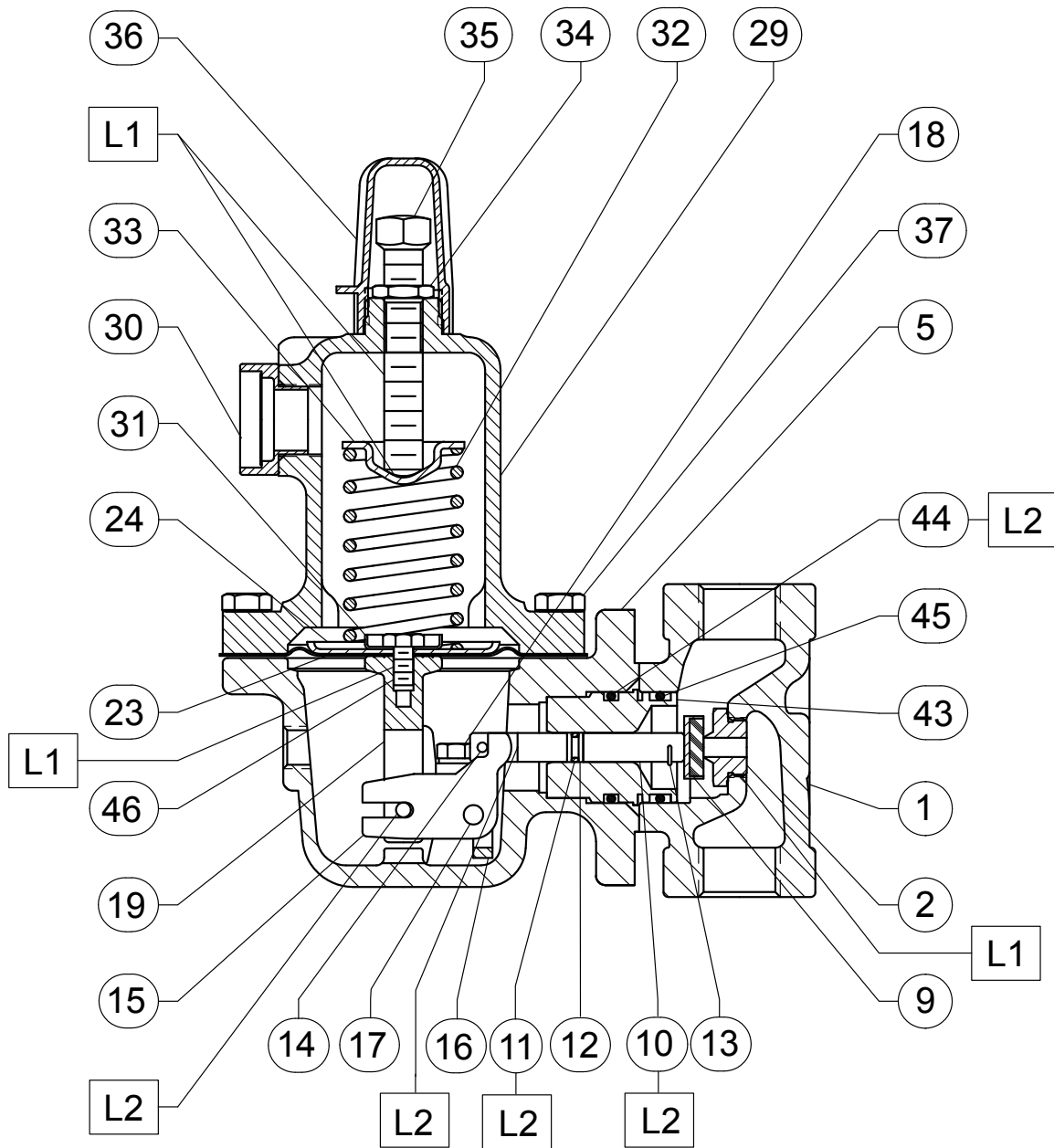
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□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 9. Type 627LR Regulator Assembly

627 Series

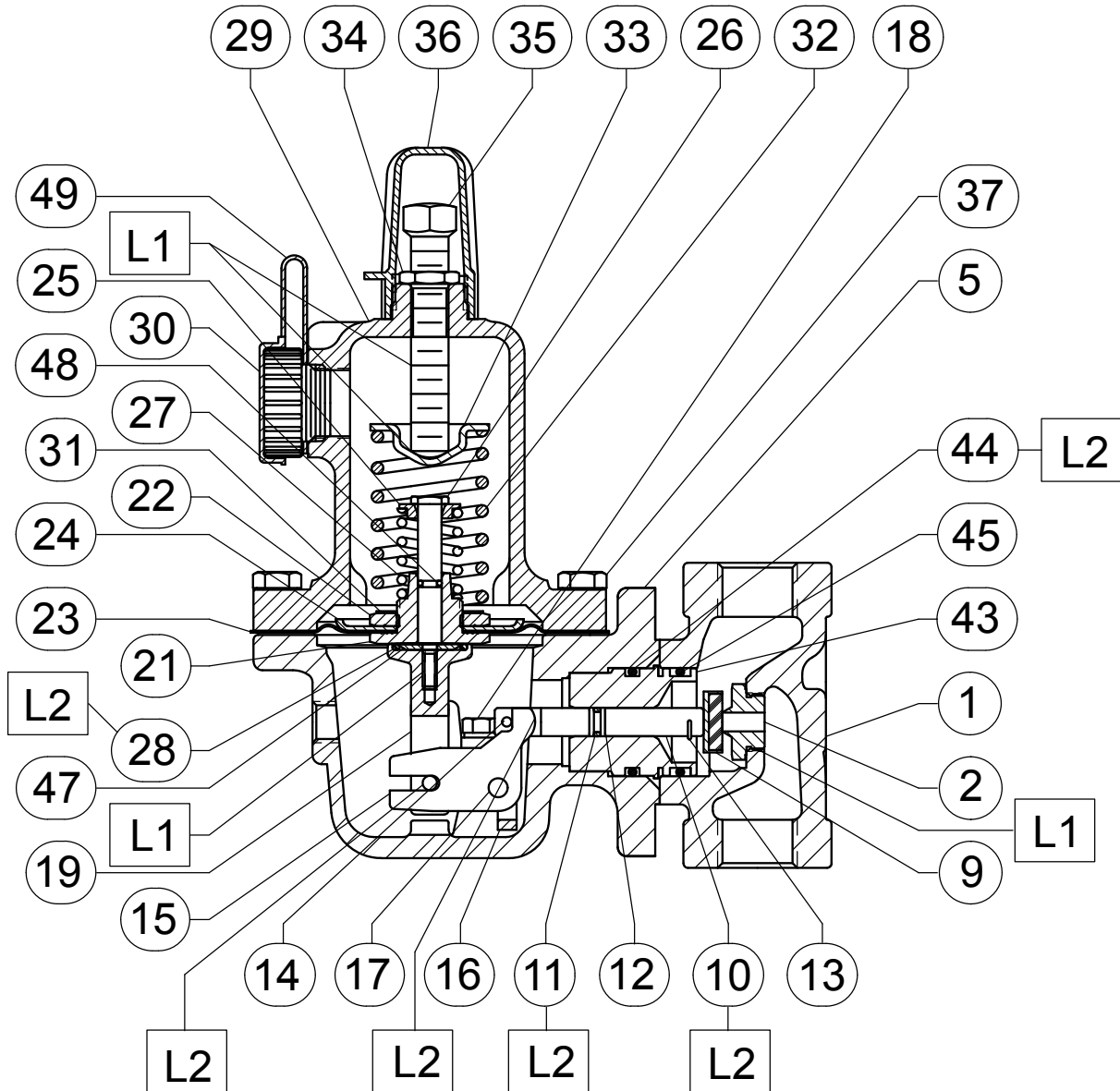


30B6433_E

- APPLY LUBRICANT⁽¹⁾
- L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
- L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
- PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 10. Type 627M Regulator Assembly

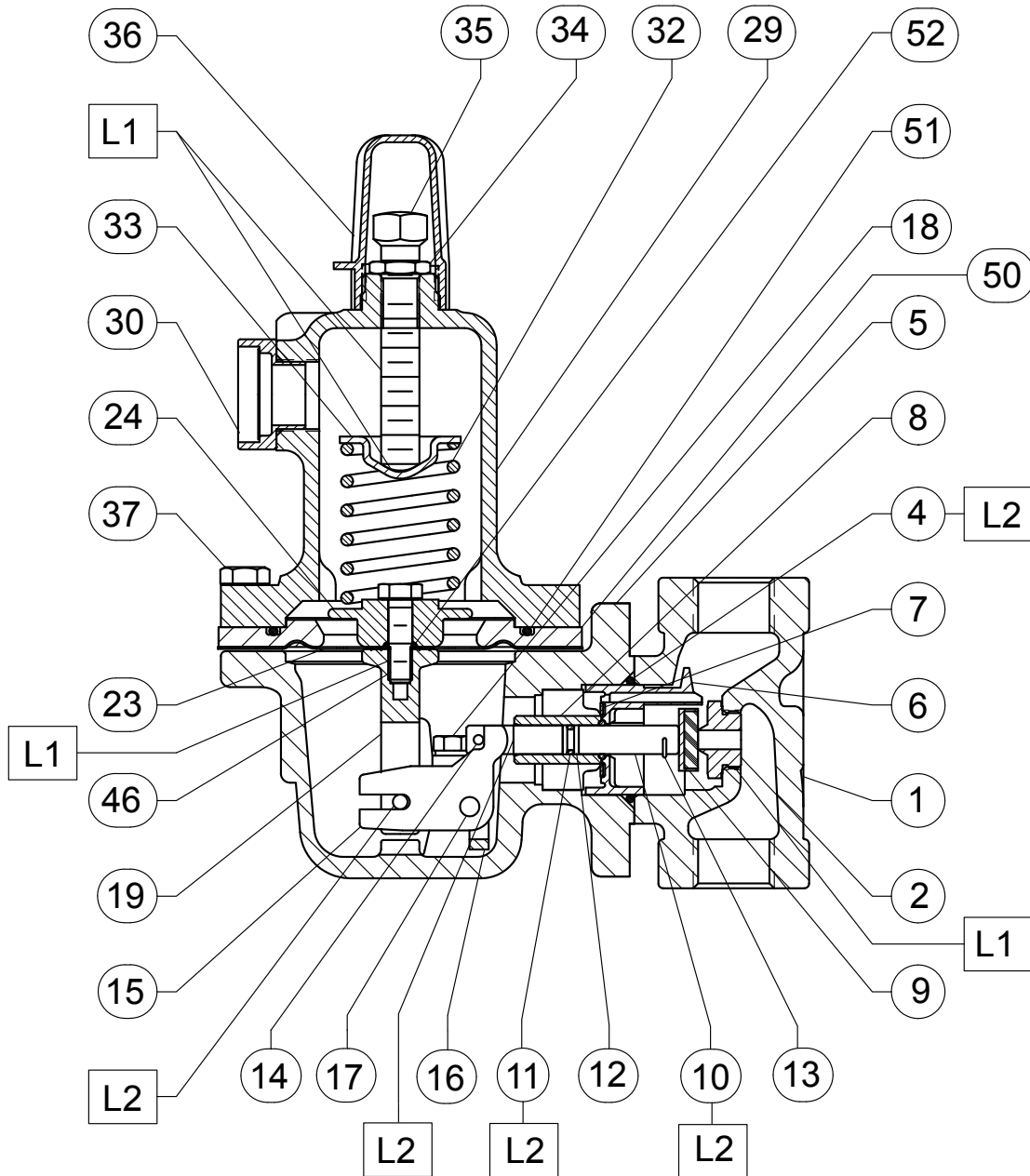


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□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 11. Type 627MR Regulator Assembly

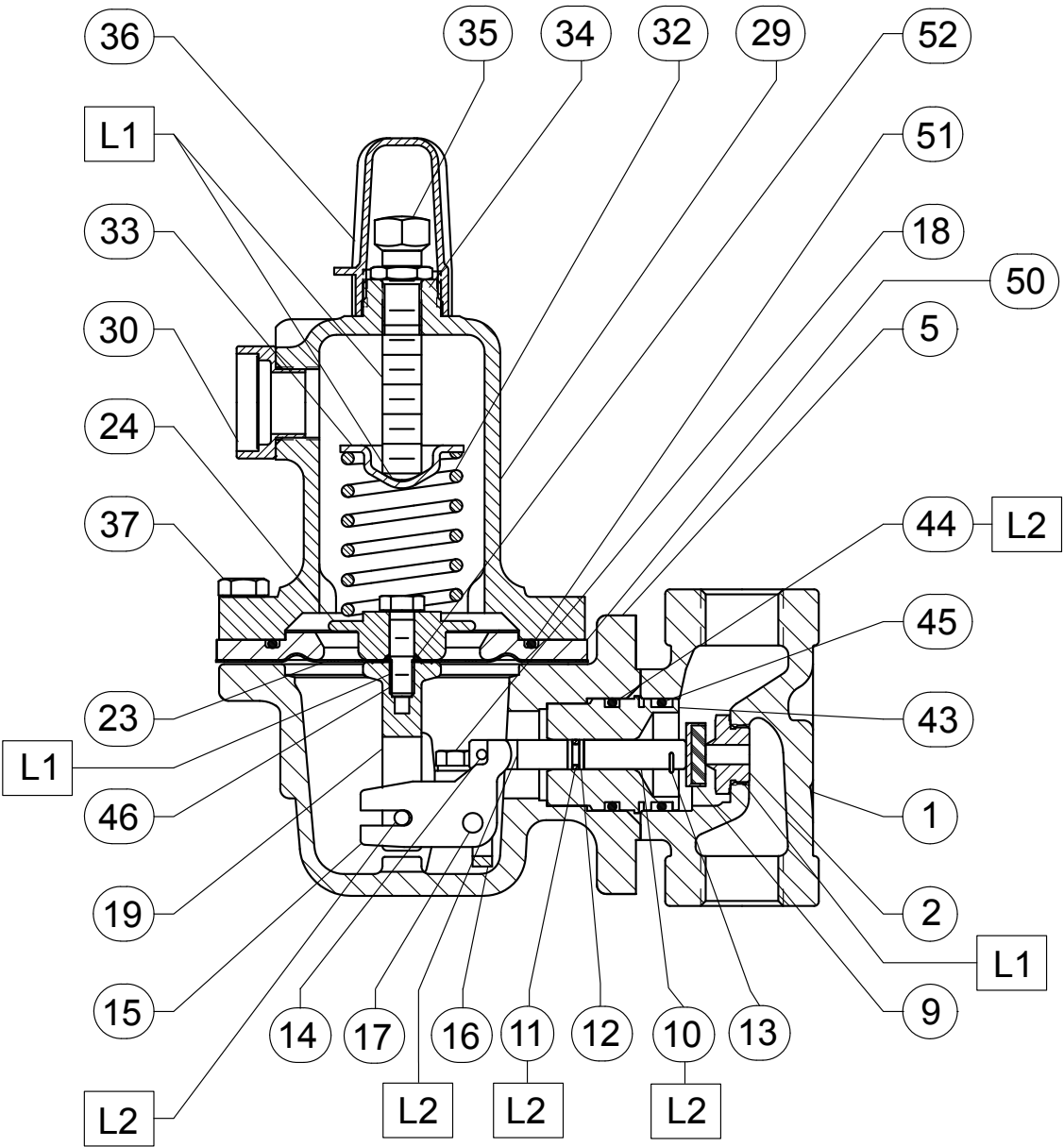


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□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 12. Type 627H Regulator Assembly



31B9872_D

□ APPLY LUBRICANT⁽¹⁾
 L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
 L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
 PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 13. Type 627HM Regulator Assembly

Industrial Regulators

Emerson Process Management Regulator Technologies, Inc.

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Tel: +1 800 558 5853
Outside U.S. +1 972 548 3574

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Fisher® D4 Control Valve Assembly

Contents

Introduction	1
Scope of Manual	1
Description	1
Specifications	2
Educational Services	2
Installation	4
Spring Adjustment	5
Maintenance	6
Valve Plug and Seat Ring	6
Valve Packing	8
Actuator	10
Parts Ordering	14
Repair Kits	17
Parts List	17
Appendix A	19

Figure 1. Fisher D4 Control Valve



W8531

Introduction

Scope of Manual

This instruction manual provides installation, maintenance, and parts information for the Fisher D4 control valve.

Do not install, operate, or maintain a D4 control valve without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

The D4 control valve is a compact, rugged valve designed primarily for high-pressure throttling applications. This valve is ideal for use on pressure and flow control applications within the oil and gas production industry. The D4 valve also makes an excellent dump valve for high-pressure separators and scrubbers.

The D4 control valve meets the metallurgical requirements of NACE MR0175/ISO 15156 without environmental limits for temperatures below 135°C (275°F). If the temperature is above 135°C (275°F), the N07718 Belleville washers will impose some limits, as shown in table 3.



Table 1. Specifications

<p>Available Configurations Spring-to-Close Spring-to-Open</p> <p>Valve Body Sizes and End Connection Styles⁽¹⁾ See table 2</p> <p>Maximum Inlet Pressures and Temperatures⁽¹⁾ If the valve nameplate shows an ASME pressure-temperature class, maximum inlet pressure and temperature is consistent with the applicable class per ASME B16.34. If the nameplate does not show an ASME class, it will show a maximum cold working pressure at 38°C (100°F) (for example, 293 bar [4250 psi])</p> <p>Maximum Pressure Drops⁽¹⁾ See tables 4, 5, 6, and 7</p> <p>Input Signal to Actuator See tables 4, 5, 6, and 7</p> <p>Actuator Maximum Casing Pressure⁽¹⁾ 3.4 bar (50 psig)</p> <p>Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4 Class IV</p>	<p>Material Temperature Capabilities⁽¹⁾ Actuator Assembly: -40 to 93°C (-40 to 200°F) Valve Body Assembly: <i>Standard Bonnet O-Ring:</i> -40 to 135°C (-40 to 275°F) <i>Optional Fluorocarbon Bonnet O-Ring:</i> -23 to 204°C (-10 to 400°F)</p> <p>Flow Characteristic Equal percentage</p> <p>Flow Direction Flow up only</p> <p>Port Diameters See table 2</p> <p>Valve Plug Travel 19 mm (0.75 inch)</p> <p>Valve Plug Style Micro-Form valve plug</p> <p>Actuator Diaphragm Effective Area 452 cm² (69 inches²)</p> <p>Actuator Pressure Connection Size 1/4 NPT internal</p>
--	--

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.

Specifications

Table 1 lists specifications for the D4 control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate located on the actuator spring barrel.

Educational Services

For information on available courses for Fisher D4 valves, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
P.O. Box 190; 301 S. 1st Ave.
Marshalltown, IA 50158-2823
Phone: 800-338-8158 or
Phone: 641-754-3771
FAX: 641-754-3431
e-mail: education@emerson.com

Table 2. Valve Sizes and Connection Styles

VALVE SIZE, NPS	PORT DIAMETER, (INCHES)	SCREWED	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		4250 psi	CL150	CL300	CL600	CL900 and CL1500	CL600	CL900 and CL1500
1	0.25, 0.375, 0.5, 0.75	X	X	X	X	X	X	X
2	0.25, 0.375, 0.5, 0.75, 1, 1.25	X	X	X	X	X	X	X

X = Available construction.

Table 3. D4 Environmental Limits for NACE MR0175/ISO 15156 with Sour Trim

MAXIMUM TEMPERATURE		MAXIMUM H ₂ S PARTIAL PRESSURE		COMPATIBLE WITH ELEMENTAL SULFUR?
°C	°F	MPa	psia	
232	450	0.2	30	No
204	400	1.4	200	No
199	390	2.3	330	No
191	375	2.5	360	No
149	300	2.8	400	No
135	275	No Limit		Yes

Table 4. Maximum Shutoff Pressure Drops⁽¹⁾ for Fisher D4 Control Valves (Spring-to-Close) When Used with Typical Control Instrumentation⁽²⁾

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate				Heavy Rate							
INITIAL SPRING SETTING		0.77 Bar (11.2 Psig)		0.77 Bar (11.2 Psig)		0.85 Bar (12.4 Psig)		1.05 Bar (15.3 Psig)		1.18 Bar (17.1 Psig)		1.18 Bar (17.1 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	293 ⁽³⁾	4250 ⁽³⁾	293 ⁽³⁾	4250 ⁽³⁾	293	4250	293	4250	293	4250	293	4250
9.5	0.375	293 ⁽³⁾	4250 ⁽³⁾	293 ⁽³⁾	4250 ⁽³⁾	293	4250	293	4250	293	4250	293	4250
12.7	0.5	191	2765	191	2765	219	3180	288	4180	293	4250	293	4250
19.1	0.75	80	1160	80	1160	92	1340	123	1785	143	2080	143	2080
25.4	1	42	610	42	610	49	715	67	965	78	1130	78	1130
31.8	1.25	25	365	25	365	30	430	41	590	48	700	48	700

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
 3. For applications with downstream pressure in excess of 196 bar (2845 psig), use 196 bar (2845 psig) for Maximum Shutoff Pressure.

Table 5. Maximum Shutoff Pressure Drops⁽¹⁾ for Fisher D4 Control Valves (Spring-to-Close) When Used with Instrumentation with Restricted Output Range⁽²⁾

INPUT SIGNAL TO ACTUATOR		0.4 to 2.0 Bar (6 to 30 Psig)				0.14 to 2.3 Bar (2 to 33 Psig)			
SPRING		Heavy Rate				Heavy Rate			
INITIAL SPRING SETTING		0.97 Bar (14.0 Psig)				1.17 Bar (17.0 Psig)			
PORT DIAMETER		Maximum Pressure Drop							
mm	Inches	Bar		Psi		Bar		Psi	
6.4	0.25	293 ⁽³⁾		4250 ⁽³⁾		293		4250	
9.5	0.375	210 ⁽³⁾		3045 ⁽³⁾		293		4250	
12.7	0.5	113		1635		282		4095	
19.1	0.75	45		655		120		1750	
25.4	1	23		330		65		945	
31.8	1.25	13		185		39		580	

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, an Electro-Pneumatic Transducer calibrated for 0.4-2.0 bar (6-30 psig) output pressure.
 3. For applications with downstream pressure in excess of 118 bar (1715 psig), use 118 bar (1715 psig) for Maximum Shutoff Pressure.

Table 6. Maximum Shutoff Pressure Drops⁽¹⁾ for Fisher D4 Control Valves (Spring-to-Open) When Used with Typical Control Instrumentation⁽²⁾

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate						Heavy Rate					
INITIAL SPRING SETTING		0.23 Bar (3.4 Psig)		0.23 Bar (3.4 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	293 ⁽³⁾	4250 ⁽³⁾	293 ⁽³⁾	4250 ⁽³⁾	293	4250	293	4250	293	4250	293	4250
9.5	0.375	293 ⁽³⁾	4250 ⁽³⁾	293 ⁽³⁾	4250 ⁽³⁾	293	4250	293	4250	293	4250	293	4250
12.7	0.5	187	2715	233	3380	293	4250	293	4250	293	4250	293	4250
19.1	0.75	78	1135	99	1430	147	2130	178	2575	198	2875	293	4250
25.4	1	41	600	53	765	80	1160	97	1410	109	1575	195	2830
31.8	1.25	24	355	32	465	49	715	60	875	68	985	123	1785

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
 3. For applications with downstream pressure in excess of 190 bar (2760 psig), use 190 bar (2760 psig) for Maximum Shutoff Pressure.

Table 7. Maximum Shutoff Pressure Drops⁽¹⁾ for Fisher D4 Control Valves (Spring-to-Open) When Used with Instrumentation with Restricted Output Range⁽²⁾

INPUT SIGNAL TO ACTUATOR		0.4 to 2.0 Bar (6 to 30 Psig)				0.14 to 2.3 Bar (2 to 33 Psig)			
SPRING		Heavy Rate							
INITIAL SPRING SETTING		0.69 Bar (10.0 Psig)				0.42 Bar (6.1 Psig)			
PORT DIAMETER		Maximum Pressure Drop							
mm	Inches	Bar		Psi		Bar		Psi	
6.4	0.25	293 ⁽³⁾		4250 ⁽³⁾		293		4250	
9.5	0.375	293 ⁽³⁾		4250 ⁽³⁾		293		4250	
12.7	0.5	196		2845		293		4250	
19.1	0.75	82		1195		156		2265	
25.4	1	43		630		85		1235	
31.8	1.25	26		380		52		765	

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
 2. For example, an Electro-Pneumatic Transducer calibrated for 0.4-2.0 bar (6-30 psig) output pressure.
 3. For applications with downstream pressure in excess of 202 bar (2925 psig), use 202 bar (2925 psig) for Maximum Shutoff Pressure.

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

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, 5, 6, and 7. Use pressure-relieving devices 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.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

⚠ WARNING

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 Emerson Process Management sales office.

⚠ WARNING

Avoid personal injury or property damage caused by possible actuator failure. The use of a rigidly-mounted support on the actuator casing may cause additional stress on the actuator leading to premature wear and/or failure of the actuator components.

CAUTION

To avoid product damage, inspect the valve before installation for any damage or any foreign material that may have collected in the valve body. Also remove any pipe scale, welding slag, or other foreign material from the pipeline.

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 external 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 Spring-to-Open configuration to the 1/4-18 NPT connection in the upper casing assembly (key 23) as shown in figure 5. The Spring-to-Close configuration loading pressure connection is in the lower casing assembly (key 39) as shown in figure 4.

Spring Adjustment

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.

In order to maximize shutoff pressure drop values, the actuator spring must be accurately adjusted for each Input Signal Pressure Range. If the actuator has been disassembled or pressure conditions have changed, the spring may require adjustment. Refer to tables 2 and 4 to determine the Initial Spring Set values based on the Input Signal range that is available to the actuator. These values include packing friction.

Spring-to-Close

Refer to figure 4.

1. Loosen the adjusting screw nut (key 44).
2. Turn the adjusting screw (key 31) clockwise to compress the spring or counterclockwise to decrease spring compression.
3. After adjustment, tighten the adjusting screw nut (key 44).

Spring-to-Open

Refer to figure 5.

1. Unscrew the spring case assembly (key 27).
2. Turn the adjusting stem nut (key 44) clockwise to compress the spring or counterclockwise to decrease spring compression.
3. After adjustment, replace the spring case assembly (key 27).

Maintenance

Refer to figure 4.

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.

⚠ WARNING

Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- Do not remove the actuator from the valve while the valve is still pressurized.
- 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.
- Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valve Plug and Seat Ring

The D4 control valve is designed to allow easy access to the valve plug and seat ring without disturbing the packing. Refer to other sections of this instruction manual if additional maintenance is required.

Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Break the hammer nut (key 6) loose with a hammer. Continue turning the hammer nut by using a hammer or a large adjustable wrench, tightened around one ear of the hammer nut. If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 7) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

3. Use a socket wrench to loosen the seat ring (key 3).
4. Remove the seat ring (key 3) and seat ring gasket (key 9) from the valve body.
5. Inspect parts for wear or damage that would prevent proper operation of the valve body. Carefully clean the seat ring gasket surfaces and seat ring threads.

⚠ WARNING

Be careful to avoid damaging the seating surface on the valve plug or seat ring 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.

Table 8. Torque for Seat Ring (Key 3)

VALVE SIZE	RECOMMENDED TORQUE	
	NPS	
1	N•m	Lbf•ft
1	407	300
2	698	515

6. **For spring-to-close only:** To remove the valve plug (key 2), drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47). If the groove pin (key 4) is not exposed, verify that downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47).

If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

7. **For spring-to-open only:** To remove the valve plug (key 2), first remove the spring case assembly (key 27). Remove the adjustment screw nut (key 44), the upper spring seat (key 29), and the spring (key 30). Push the adjustment stem (key 31) fully downward until the diaphragm plate (key 40) contacts the cap screws (key 38), exposing the groove pin (key 4) in the plug. If the groove pin (key 4) is not exposed, verify that downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47). Drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47).

If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

Assembly

1. Make sure the bonnet O-ring (key 8) is on the bonnet and lubricated with lithium grease (key 49).

2. Install the plug (key 2) on the stem (key 47) and insert a new groove pin (key 4).
3. Thoroughly clean the seat ring and bonnet threads in the valve body (key 1). Also clean the valve body seat ring gasket surfaces.
4. Apply anti-seize lubricant (key 54) to the threads of the seat ring (key 3), and its mating threads in the valve body.
5. Apply anti-seize lubricant (key 54) to the seat ring gasket (key 9) and install into the valve body.
6. Screw the seat ring into the valve body. Use a socket wrench to tighten the seat ring to the torque values shown in table 8. Remove all excess lubricant after tightening.
7. Lubricate (key 54) the threads on the valve body and hammer nut and the contact surfaces of the bonnet and hammer nut flange. Install the bonnet and actuator assembly with pinned valve plug onto the valve body. Tighten the hammer nut using an adjustable wrench until the nut stops turning. A few hammer blows will be required to ensure that the assembly is tight.
8. See the actuator assembly and spring adjustment sections of this manual.

Valve Packing

Note

These instructions apply to valves manufactured with serial numbers equal to and greater than 18679262. See Appendix A for information on packing constructions with serial numbers less than 18679262.

If your D4 valve assembly has a packing retainer lock ring (see figure 6), proceed to Appendix A.

WARNING

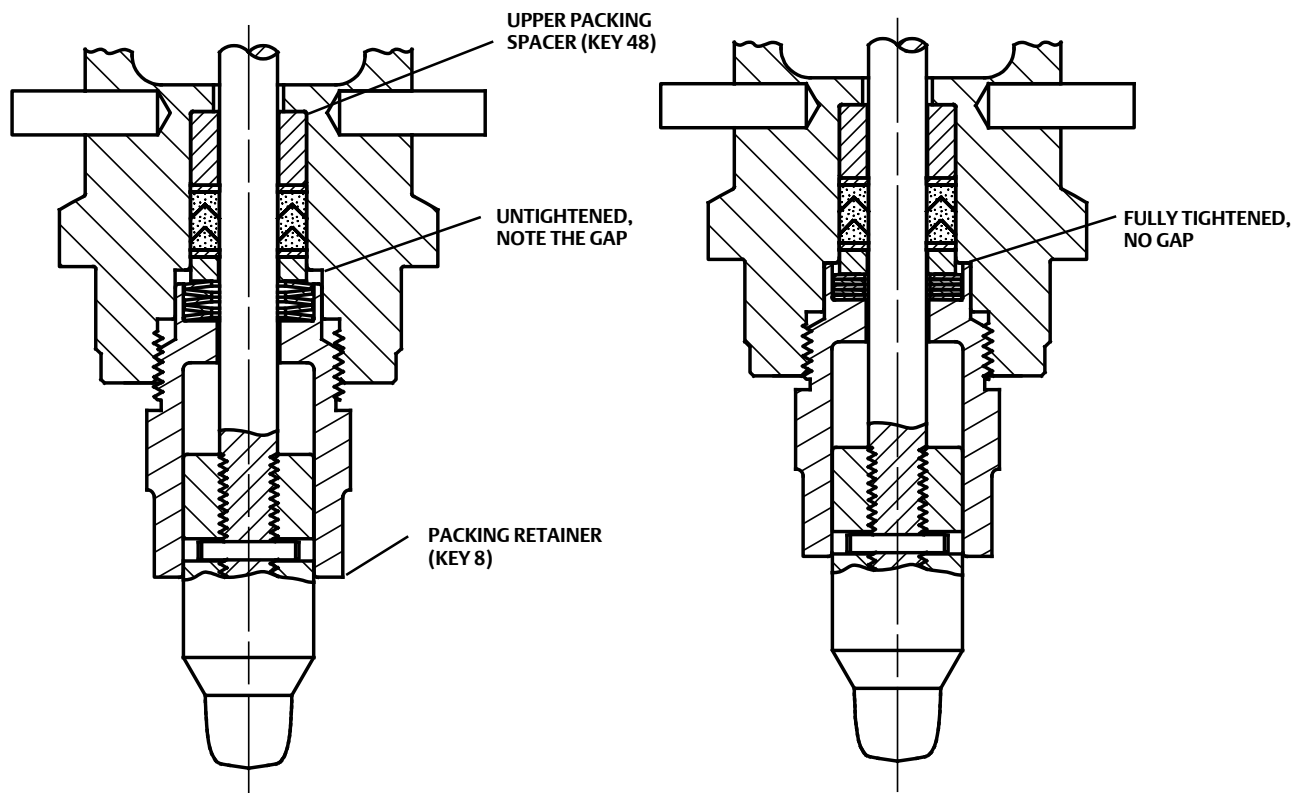
Observe the warning at the start of the Maintenance section.

The valve stem packing can only be accessed from within the valve body. If packing maintenance is required, first disassemble per steps 1, 2, and 6 or 7 in the Valve Plug and Seat Ring Disassembly section of this document.

Disassembly

1. Unscrew the packing retainer (key 10) from the bonnet (key 5).
2. Remove the five Belleville springs (key 11), packing spacer (key 14), packing (key 13), and two anti-extrusion rings (key 12) from the bonnet, using a formed wire hook.
3. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Emerson Process Management sales office.
4. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.

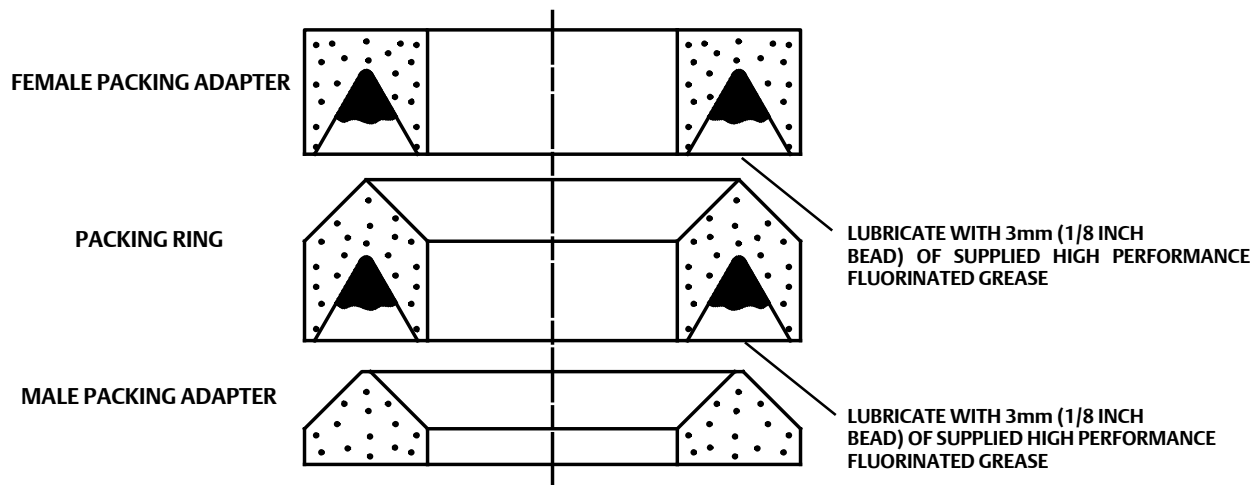
Figure 2. Fisher D4 Packing Installation



BELLEVILLE SPRINGS FULLY ENCLOSED BY THE PACKING RETAINER

VALVE PLUG, BELLEVILLE SPRINGS, AND PACKING RETAINER CORRECTLY INSTALLED AND TIGHTENED

Figure 3. Lubrication Locations on Packing



Assembly

Refer to figures 2, 3, 4, and 5.

Note

If your D4 valve assembly has a packing retainer lock ring (see figure 6), proceed to Appendix A.

1. Ensure the upper packing spacer (key 48) is installed, as shown in figure 2.
2. Using a non-marring installation tool, such as a 12-inch length of 1/2 inch PVC pipe, push the first anti-extrusion washer (key 12) fully into the packing box by hand. Then, use the packing spacer (key 14) to fully seat the anti-extrusion washer by firmly tapping the packing spacer against the anti-extrusion washer with a hammer and the PVC pipe.
3. Remove the packing spacer from the packing bore.

CAUTION

All D4 packing kits include a single use packet of high performance fluorinated grease. This is the only acceptable D4 packing lubricant.

Note

In the following procedure, carefully install each packing ring individually over the valve stem and push completely into the packing box with a non-marring tube. A 12-inch length of 1/2 inch PVC pipe works well for this. It is recommended that the lubricated packing rings be installed individually rather than pushed in as a set.

4. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the female packing adaptor as shown in figure 3 and install over the valve stem (key 16).
5. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the packing ring as shown in figure 3 and install over the valve stem.
6. Install the male packing adaptor, lower anti-extrusion washer (key 10), and lower packing spacer over the valve stem as shown in figure 2.
7. Firmly press all packing parts into the packing bore with a tube.
8. Install the five Belleville springs (key 11) over the valve stem. The Belleville springs should be single-stacked with the inside diameter of the inner spring contacting the packing spacer (key 14), and the outside diameter of the outer spring contacting the packing retainer (key 10).
9. Lubricate the threads of the packing retainer with anti-seize and install into the bonnet using a 1-5/8 inch wrench. Make sure the Belleville springs are completely enclosed by the packing retainer as shown in figure 2.
10. Torque the packing retainer to 136 N•m (100 lbf•ft). The packing retainer has been installed correctly when a metal-to-metal contact has been made between the packing retainer end and the bonnet (key 5). The packing retainer threads should be completely enclosed by the bonnet.

Actuator (Spring-to-Close)

⚠ WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 4.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Loosen the adjusting screw nut (key 44) and turn the adjusting screw (key 31) counterclockwise to remove all spring compression.
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39).
3. Remove the spring seat (key 29) and actuator spring (key 30).
4. Lift out the diaphragm, diaphragm plate, and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
5. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
6. Separate the parts--diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).
7. 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.
8. 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 38) and lift off the lower casing (key 39). Replace the O-ring if necessary.
9. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

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 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 (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

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.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. 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). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter is against the O-ring (key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and lower spring seat (key 28) are on the spring side.
4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

5. Replace the spring (key 30) on the diaphragm plate (key 40). Replace the upper spring seat (key 29). Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
6. Adjust the initial spring set per the Spring Adjustment section in this manual.

Actuator (Spring-to-Open)

▲ WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 5.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Unscrew the spring case assembly (key 27). Turn the adjusting screw nut (key 44) counterclockwise to remove all spring compression. Remove the adjusting screw nut, upper spring seat, and spring (keys 44, 29, and 30)
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39). Remove the cotter pin (key 36) and unscrew the adjusting stem (key 31).
3. Lift out the diaphragm (key 15), diaphragm plate (key 40), and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
4. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
5. Separate the parts--diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).
6. 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.
7. 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 38) and lift off the lower casing (key 39). Replace the O-ring if necessary. Inspect the adjusting stem bushing (key 26) and actuator stem O-ring (key 53). Replace if necessary.

8. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

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 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 (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

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.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. 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). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).
3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter is against the O-ring (key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and diaphragm washer (key 41) are on the upper side.

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.
5. Screw the adjusting stem (key 31) onto the stem (key 47) and secure the cotter pin (key 36). Make sure the bushing and O-ring are in place in the upper casing.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

6. Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.

7. Replace the spring (key 30), spring seat (key 29), and adjusting stem nut (key 44) over the adjusting stem. Replace the spring case assembly (key 27).
8. Adjust the initial spring set per the Spring Adjustment section in this manual.

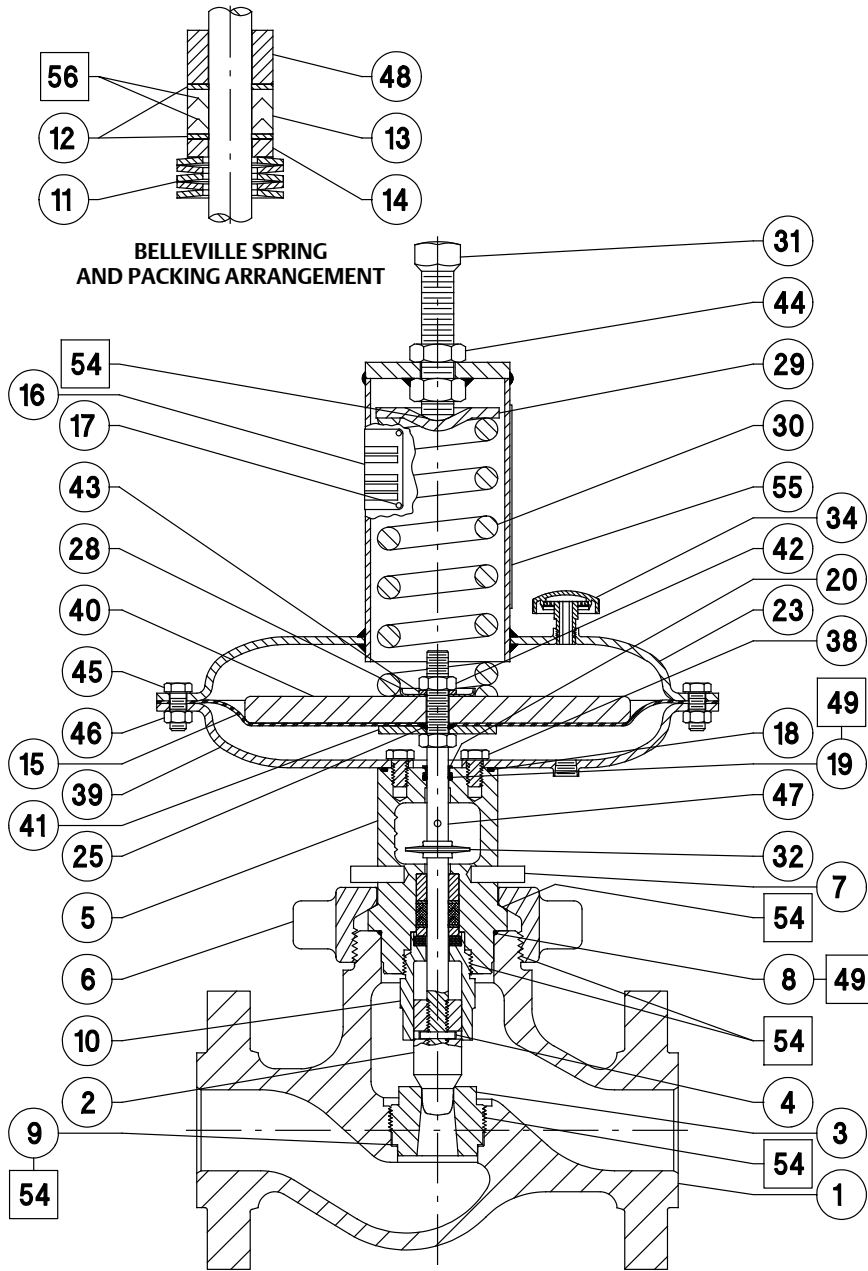
Parts Ordering

Each D4 control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting your Emerson Process Management sales office for assistance or when ordering replacement parts.

▲ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

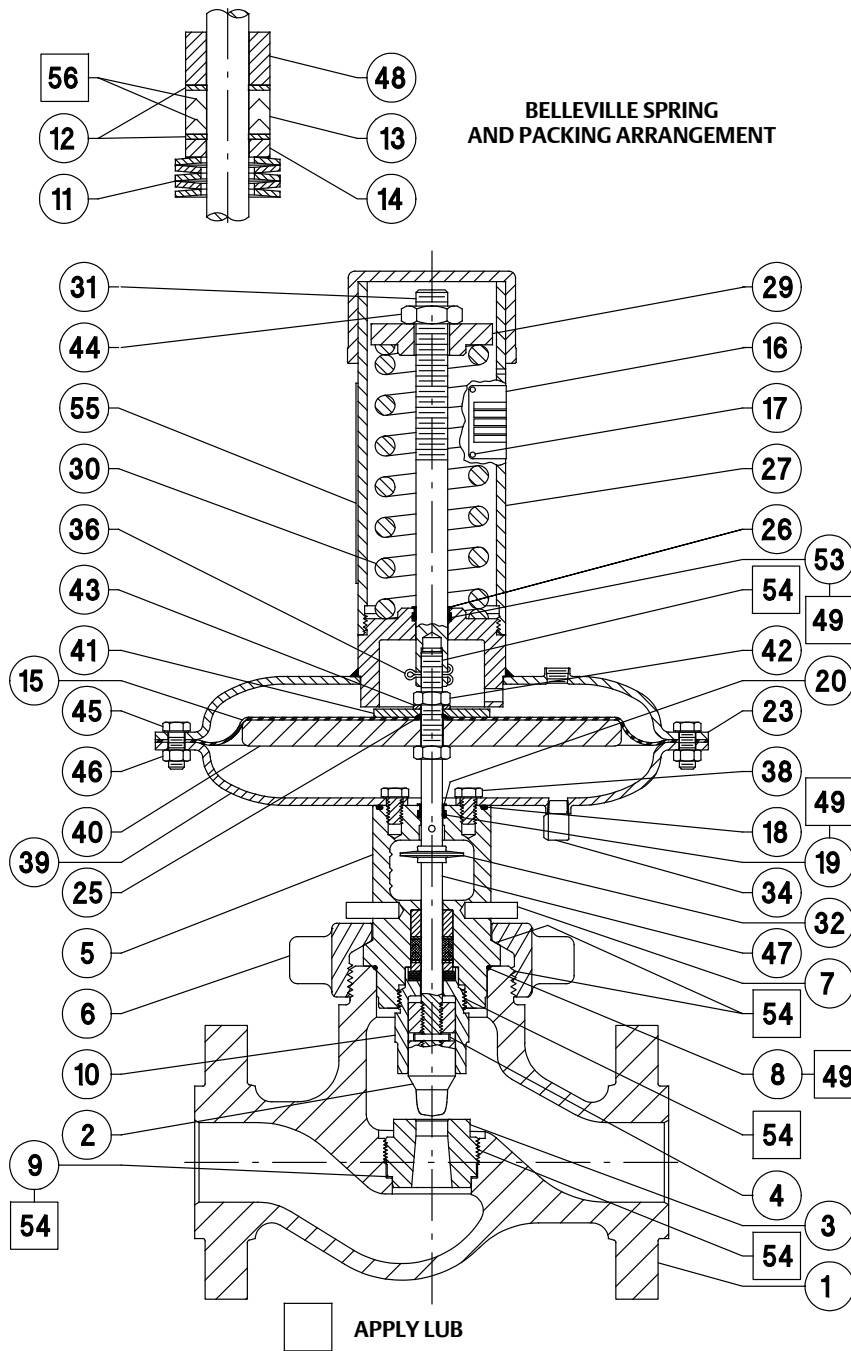
Figure 4. Fisher D4 Valve Assembly (Spring-to-Close)



GE02332-C

APPLY LUB

Figure 5. Fisher D4 Valve Assembly (Spring-to-Open)



GE02334-E

Repair Kits

Note

All repair kits are supplied with hydrogenated nitrile bonnet O-ring. FKM (fluorocarbon) bonnet O-ring must be ordered separately when required.

Description	Part Number
* Packing Repair Kit Includes key numbers 4, 8, 12 (2 req'd), 13, and high performance fluorinated grease	RD4X0000012
* Actuator Repair Kit Includes key numbers 4, 8, 12 (2 req'd), 13, 15, 18, 19, 20, 25, 26, 36, 53, and high performance fluorinated grease	RD4X0000022

Parts List

Note

For part numbers not shown, contact your Emerson Process Management sales office.

Key	Description	Part Number
1	Valve Body	
2*	Valve Plug	
	S41000 / S41600 HT	
	NPS 1 valve	
	0.25 inch port diameter	20C3692X012
	0.375 inch port diameter	20C3693X012
	0.5 inch port diameter	20C3694X012
	0.75 inch port diameter	GE01557X012
	NPS 2 valve	
	0.25 inch port diameter	GE00992X012
	0.375 inch port diameter	GE00993X012
	0.5 inch port diameter	GE00994X012
	0.75 inch port diameter	GE01558X012
	1-inch port diameter	GE01561X012
	1.25 inch port diameter	GE01555X012
	S17400 H1150 DbI	
	NPS 1 valve	
	0.25 inch port diameter	20C3692X032
	0.375 inch port diameter	20C3693X032
	0.5 inch port diameter	20C3694X032
	0.75 inch port diameter	GE01557X032
	NPS 2 valve	
	0.25 inch port diameter	GE00992X032
	0.375 inch port diameter	GE00993X032
	0.5 inch port diameter	GE00994X032
	0.75 inch port diameter	GE01558X032
	1-inch port diameter	GE01561X032

Key	Description	Part Number
	1.25 inch port diameter	GE01555X032
	Tungsten Carbide	
	NPS 1 valve	
	0.25 inch port diameter	20C3696X012
	0.375 inch port diameter	20C3697X012
	0.5 inch port diameter	20C3698X012
	0.75 inch port diameter	20C3699X012
	NPS 2 valve	
	0.25 inch port diameter	20C3682X012
	0.375 inch port diameter	20C3683X012
	0.5 inch port diameter	20C3685X012
	0.75 inch port diameter	20C3686X012
	1-inch port diameter	20C3687X012
	1.25 inch port diameter	20C3688X012
3*	Seat Ring	
	S17400 H1150 DbI	
	NPS 1 valve	
	0.25 inch port diameter	GE00982X032
	0.375 inch port diameter	GE00983X032
	0.5 inch port diameter	GE00984X032
	0.75 inch port diameter	GE00985X032
	NPS 2 valve	
	0.25 inch port diameter	GE00986X032
	0.375 inch port diameter	GE00987X032
	0.5 inch port diameter	GE00988X032
	0.75 inch port diameter	GE00989X032
	1-inch port diameter	GE00990X032
	1.25 inch port diameter	GE00991X032
	Tungsten Carbide	
	NPS 1 valve	
	0.25 inch port diameter	GE07347X012
	0.375 inch port diameter	GE07363X012
	0.5 inch port diameter	GE07364X012
	0.75 inch port diameter	GE07365X012
	NPS 2 valve	
	0.25 inch port diameter	GE07389X012
	0.375 inch port diameter	GE07394X012
	0.5 inch port diameter	GE07397X012
	0.75 inch port diameter	GE07398X012
	1-inch port diameter	GE07399X012
	1.25 inch port diameter	GE07406X012
	4*	Groove Pin
	5	Bonnet
	6	Hammer Nut
	7	Spring Pin
	8*	Bonnet O-ring
	Hydrogenated Nitrile	
	-46 to 149°C (-50 to 300°F)	10C3680X012
	FKM, -23 to 204°C (-10 to 400°F)	10C3680X022
9*	Seat Ring Gasket	
	For NPS 1 valve	1B198636042
	For NPS 2 valve	1B198836042
10	Packing Retainer	
11	Belleville Springs, 5 req'd	
12*	Anti-Extrusion Washer, 2 req'd	12B6335X022
13*	Packing Set	12B6667X012
14	Packing Spacer	
15*	Diaphragm	22B3521X012
16	Nameplate	
17	Drive Screw	
18*	Casing O-ring	1F9141X0142
19*	Stem O-ring	1K7561X0072
20*	Bonnet Bushing	17A7112X012
23	Upper Casing Assembly	

*Recommended spare parts

Key	Description	Part Number	Key	Description	Part Number
25*	Actuator O-ring	1K7561X0072	40	Diaphragm Plate	
26*	Adjusting Stem Bushing (spring-to-open only)	17A4059X012	41	Diaphragm Washer	
27	Spring Case Assembly		42	Hex Nut	
28	Lower Spring Seat		43	Lockwasher	
29	Upper Spring Seat		44	Adjustment Screw Nut	
30	Spring		45	Cap Screw	
	Spring-to-Close, Light Rate	1F176827092	46	Hex Nut	
	Spring-to-Close, Heavy Rate	1E792427082	47*	Valve Stem	
	Spring-to-Open, Light Rate	1F176727032		S20910, Reverse Acting	20C3681X022
	Spring-to-Open, Heavy Rate	1F714327092		S20910, Direct Acting	20C3716X022
31	Adjustment Screw or Stem		48	Upper packing spacer	
32	Travel Indicator		49	Lubricant (lithium grease)	
34	Vent Assembly		51	Drive Screw	
36*	Cotter Pin (spring-to-open only)	1C608035022	53*	Actuator Stem O-ring (spring-to-open only)	1C7821X0182
37	Pipe Plug		54	Lubricant (anti-seize)	
38	Cap Screw		55	Spring Setting Label (not shown)	
39	Lower Casing		56	High Performance Fluorinated Grease Packing Lubricant	

Appendix A

Note

These instructions apply to valves manufactured with serial numbers less than 18679262.

Valve Packing

⚠ WARNING

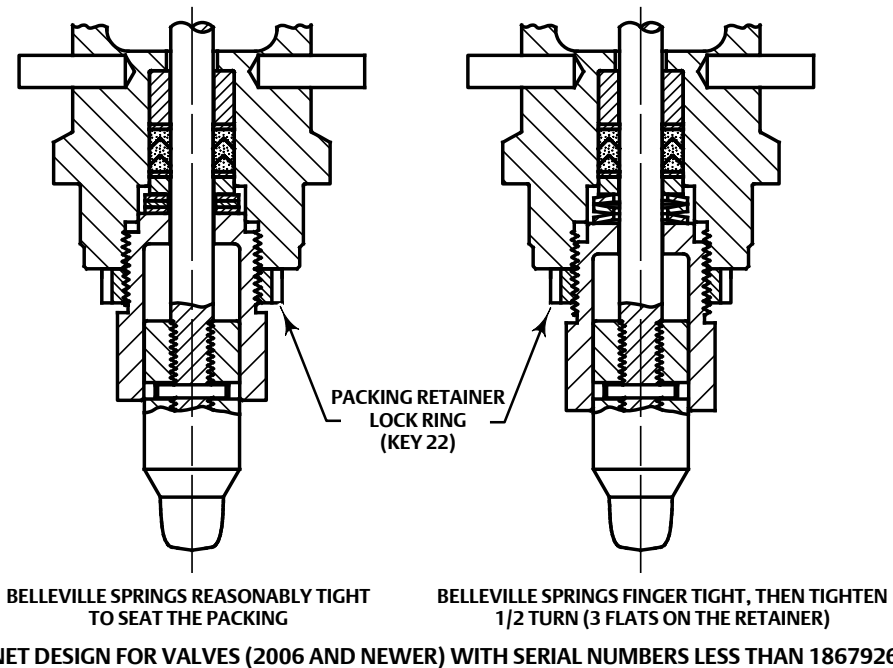
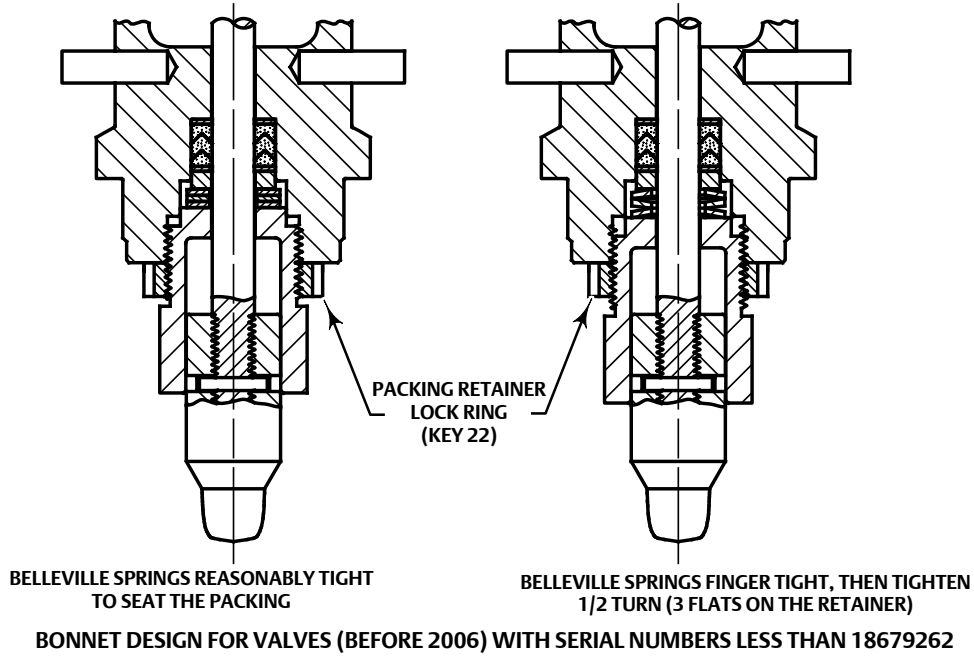
Observe the warning at the start of the Maintenance section.

The valve stem packing can only be accessed from within the valve body. If packing maintenance is required, first disassemble per steps 1, 2, and 6 or 7 in the Valve Plug and Seat Ring Disassembly section of this document.

Disassembly

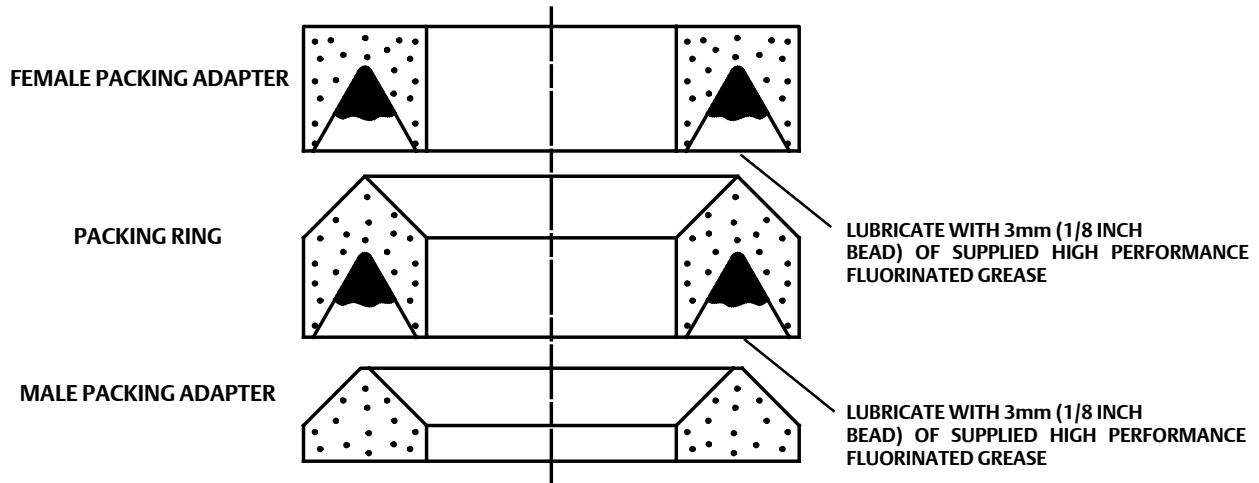
1. Loosen the packing retainer locknut (key 22) with a spanner wrench or with a punch and hammer.
2. Unscrew the packing retainer (key 10) from the bonnet (key 5).
3. Remove the three Belleville springs (key 11), packing spacer (key 14), packing (key 13), and two anti-extrusion rings (key 12) from the bonnet, using a formed wire hook.
4. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Emerson Process Management sales office.
5. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.

Figure 6. Fisher D4 Belleville Spring Procedure



NOTE: RECOMMENDED SPARE PARTS, INCLUDING PACKING KITS, ARE THE SAME FOR BOTH BONNET DESIGNS.
NOTE: FOR SERIAL NUMBERS GREATER THAN 18679262, SEE THE STANDARD SECTION OF THIS INSTRUCTION MANUAL.

Figure 7. Lubrication Locations on Packing



Assembly

Refer to figures 6 and 7.

1. Install new packing and Belleville springs according to the packing arrangement shown in figure 6.
2. Using a non-marring installation tool, such as a 12-inch length of 1/2 inch PVC pipe, push the first anti-extrusion washer (key 12) fully into the packing box by hand. Then, use the packing spacer (key 14) to fully seat the anti-extrusion washer by firmly tapping the packing spacer against the anti-extrusion washer with a hammer and the PVC pipe.
3. Remove the packing spacer from the packing bore.

CAUTION

All D4 packing kits include a single use packet of high performance fluorinated grease. This is the only acceptable D4 packing lubricant.

Note

In the following procedure, carefully install each packing ring individually over the valve stem and push completely into the packing box with a non-marring tube. A 12-inch length of 1/2 inch PVC pipe works well for this. It is recommended that the lubricated packing rings be installed individually rather than pushed in as a set.

4. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the female packing adaptor as shown in figure 7 and install over the valve stem (key 16).
5. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the packing ring as shown in figure 7 and install over the valve stem.
6. Install the male packing adaptor, lower anti-extrusion washer (key 10), and lower packing spacer over the valve stem as shown in figure 6.
7. Firmly press all packing parts into the packing bore with a tube.

8. Install the Belleville springs (key 11). The Belleville springs (key 11) should be single stacked with the I.D. of the inner spring contacting the packing spacer (key 14) and the O.D. of the outer spring contacting the packing retainer (key 10). The final Belleville spring should be within the 1.26 inch diameter bore of the bonnet.
9. Adjust the packing retainer by hand until it makes contact with the Belleville springs. Do not tighten by hand, simply install the packing retainer until it makes contact with the Belleville springs. Tighten the packing retainer clockwise precisely 1.16 turns (7 flats on the retainer) to seat the packing. This should fully compress the Belleville springs as detected by an increase in torque between 6 and 7 flats.
10. Loosen the packing retainer completely. Adjust the packing retainer by hand until it makes contact with the Belleville springs. Do not tighten by hand, simply install the packing retainer until it makes contact with the Belleville springs. Tighten the packing retainer clockwise precisely 1/2 turn (3 flats on the retainer).
11. Lock the packing retainer (key 10) solidly in place by tightening the packing retainer locknut (key 22) using a spanner wrench or a hammer and punch or chisel.

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Model 1530

1" to 1½"

DN25 to DN40



Three-Way Thermostatic Valves

Compact and Reliable Temperature Control

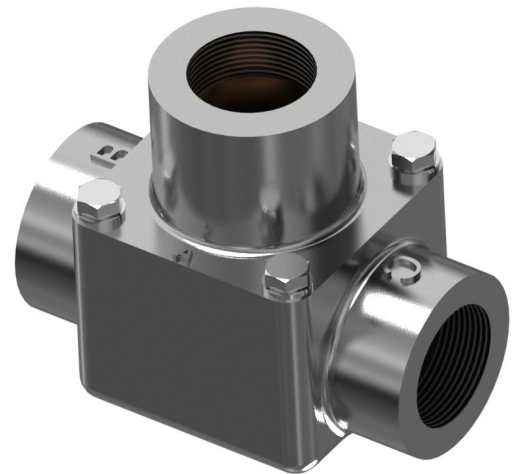
Fluid Power Energy (FPE) thermostatic valves utilize the principle of expanding wax, which in the semi-liquid state undergoes large expansion rates within a relatively narrow temperature range. The self-contained element activates a stainless steel sleeve, which directs flow. All FPE thermostatic valves are factory set at predetermined temperatures: no further adjustments are necessary.

When used in a diverting application, on start-up the total fluid flow is routed back to the main system. As fluid temperature rises to the control range, some fluid is diverted to the cooling system. As fluid temperature continues to increase, more flow is diverted. When the thermostat is in a fully stroked condition, all fluid flow is directed to the cooling system.

FPE thermostatic valves may also be used in a mixing application. Hot fluid enters the "B" port and colder fluid enters the "C" port. The flows mix and the thermostat adjusts flow through ports "B" and "C" to reach the desired temperature, exiting the "A" port.

Standard FPE thermostatic valve housings are made from aluminum and grey iron castings, however, ductile iron, bronze, steel and stainless steel housings are available.

Additional BSP, SAE and JIS threads available.



Including:

1530	1½" NPT
1530M	1½" NPT, lever manual override
1530MZ	1½" NPT, nut manual override
1530J16	1" SAE O-Ring
1530J20	1¼" SAE O-Ring
1530J24	1½" SAE O-Ring
SF1530X	1½" 300lbs RF Flange

Flange options available

Features and Benefits

- Wide range of temperatures
- Heavy duty
- Self-contained
- Replaceable element
- Non-adjustable
- Rugged construction
- Tamper-proof
- Operate in any orientation
- Compact

www.FPEvalves.com

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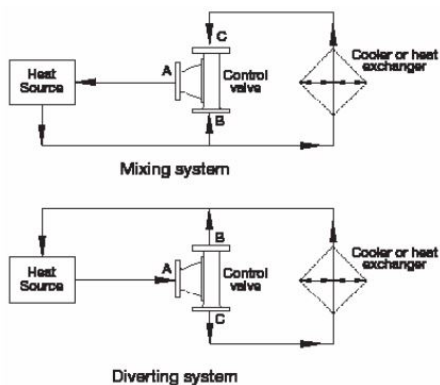
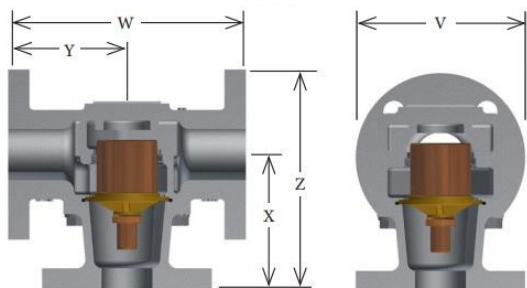
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Model 1530 Three-Way Thermostatic Valve Specifications

All units in inches (mm) or lbs (Kg); English (metric)

Model Number	Body Material*	Nominal Pipe Size	Principal Dimensions Units					Flange Drilling			No. of elements
			X	Y	W	Z	V	No. of holes	Dia. of holes	Bolt circle	
*1530 *1530M	A, AL B, D, S, SS	1 1/2" NPT	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530J16 *1530MJ16	A, AL B, D, S, SS	SAE 16 1/2 5/16"-12	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530J20 *1530MJ30	A, AL B, D, S, SS	SAE 20 1/2 5/8"-12	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530J24 *1530MJ24	A, AL B, D, S, SS	SAE 24 1/2 7/8"-12	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530JU33 *1530MJU33	A, AL B, D, S, SS	JIS-SAE 33 M 33x2.0	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530JU42 *1530MJU42	A, AL B, D, S, SS	JIS-SAE 42 M 42x2.0	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*1530JU48 *1530MJU48	A, AL B, D, S, SS	JIS-SAE 48 M 48x2.0	3 3/4 (95)	3 1/16 (77)	6 1/8 (155)	5 1/4 (133)	3 3/4 (95)	N/A	N/A	N/A	1
*F1530 *F1530M *F1530MZ	A	1 1/2" 125lbs FF FLANGE	3 7/8 (99)	3 7/16 (87)	6 7/8 (174)	6 3/8 (162)	5 (127)	4	5/8 (15)	3 7/8 (98)	1
	B	1 1/2" 150lb FF FLANGE	3 13/16 (96)	3 5/16 (84)	6 5/8 (168)	6 1/4 (159)	5 (127)	4	5/8 (15)	3 7/8 (98)	1
	D	1 1/2" 150lbs RF FLANGE	4 (102)	3 9/16 (90)	7 1/8 (181)	6 1/2 (165)	5 (127)	4	5/8 (15)	3 7/8 (98)	1
	S	1 1/2" 150lbs RF FLANGE	3 7/8 (99)	3 3/8 (87)	6 7/8 (174)	6 7/16 (163)	5 (127)	4	5/8 (15)	3 7/8 (98)	1
	SS	1 1/2" 150lbs RF FLANGE	3 7/8 (99)	3 3/8 (87)	6 7/8 (174)	6 7/16 (163)	5 (127)	4	5/8 (15)	3 7/8 (98)	1
*F1530X *F1530XM *F1530XMZ	S, SS	1 1/2" 300lbs RF FLANGE	4 1/8 (103)	3 5/8 (92)	7 1/4 (184)	7 7/8 (198)	6 1/8 (155)	4	7/8 (22)	4 1/2 (114)	1
*F1530-X15 *F1530-X15M *F1530-X15MZ	S, SS	1 1/2" 600# RF FLANGE	4 3/8 (112)	4 (100)	8 (200)	8 1/8 (206)	6 1/8 (155)	4	7/8 (22)	4 1/2 (114)	1

Replace * with body material type: A = Cast iron, AL = Aluminum B = Bronze, D = Ductile iron, S = Steel, SS = Stainless Steel.



Pressure ratings @ 250°F

Material	A, AL	B	D	S	SS
psi	150	180	225	670	590
Bar	10.3	12.4	15.5	46.1	40.6

Weights

	A	AL	B	D	S & SS
psi	8 (4)	4 (2)	8 (4)	7 (3)	9 (4)

Service Kits (xxx represents temperature °F)

Model	O-Ring	Gasket	LipSeal	Thermostat
1500-xxx	1 of Buna-N	1	1	1
1500V-xxx	1 of Viton	1	1	1
1500E-xxx	1 of Neoprene	1	1	1

Lip Seal Insertion Tools

Part Number	Component
1571-IT	Lip Seal Insertion Plug

Lip Seal Extraction Tools

Part Number	Component
1571-RT	Lip Seal Extraction Plug

NOTE: Service Kits are supplied with Housing O-Rings & Housing Gaskets. Make sure to replace your original housing seal using the same style seal, and discard the extra component. If your valve was originally supplied with a gasket, DO NOT attempt to use an O-Ring, as the seal will leak without a groove to accept the O-Ring

Note: FPE reserves the right to substitute ordered material for better quality.

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Customer Name Joe Herauf
 Company NEXT Compression
 Location Rocky View County
 Quote # 9004506
 Reference
 Valve PSV/Tag Number PSV-100
 Please reference Quote Number on all corresponding Purchase Orders.
 Quote is only valid for 30 days from the sized on date.
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Quote Revision
 Rev.: 1
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 Page 1 of 3

MERCER VALVE CO., INC.®
 "AUTO SEAT TECHNOLOGY"®

Fluid Data	GAS/VAPOR	REQUIRED CAPACITY	Water Vapor	
	MOLECULAR WEIGHT	SPECIFIC GRAVITY	28.97	1
	GAS COEFFICIENT	k-RATIO OF SPECIFIC HEATS	341.6	1.244
	COMPRESSIBILITY FACTOR		0.997	
	REQUIRED AREA	FLOW COEFFICIENT	0.122 in ²	0.818
	LIQUID 1	REQUIRED CAPACITY		
	SPECIFIC GRAVITY	DENSITY		
	VISCOSITY	VISCOSITY CORRECTION FACTOR		
	REQUIRED AREA	FLOW COEFFICIENT		
	LIQUID 2	REQUIRED CAPACITY		
SPECIFIC GRAVITY	DENSITY			
VISCOSITY	VISCOSITY CORRECTION FACTOR			
REQUIRED AREA	FLOW COEFFICIENT			
Process Conditions	SUPERIMPOSED CONST BP	SUPERIMPOSED VARIABLE BP	2 psig	0 psig
	BUILT-UP BP	TOTAL BACK PRESSURE	5 psig	7 psig
	OPERATING TEMP	RELIEVING TEMPERATURE	60 °F	353 °F
	OPERATING PRESSURE	ATMOSPHERIC PRESSURE	2 psig	13.4 psia
	SET PRESSURE	CDTP	125 psig	123 psig
	OVER PRESSURE	INLET PRESSURE LOSSES	26.25 psig / 21 %	0 psig / 0 %
		FLOWING PRESSURE		164.65 psia
	DISCHARGE COEFFICIENT AND AREAS	VALVE CERTIFICATION / DESIGN CODE	ASME Certified	ASME BPVC, SECTION VIII, DIVISION 1
SYSTEM TYPE		Set on Air	Capacity Generation Due to Fire	
Sizing Results	TOTAL REQUIRED AREA	Rupture Disk Correction	0.122 in ²	1.0
	SELECTED ORIFICE AREA	SELECTED ORIFICE	0.122 in ²	D ORIFICE
	MAXIMUM CAPACITY OF GAS AT OVER PRESS.		1061.4 lb/hr	
	MAXIMUM CAPACITY OF LIQUID 1 AT OVER PRESS.			
	MAXIMUM CAPACITY OF LIQUID 2 AT OVER PRESS.			
	TAG CAPACITY		278 SCFM AIR	
DECIBEL LEVEL	SINGLE OUTLET REACTION FORCE	95.49 dB @ 100 ft	11.44 lbf	
Materials	INLET BASE / BODY MATERIAL		(5) - Carbon Steel / WCB Carbon Steel	
	SEAT	O-RINGS	(V) - Fluorocarbon 90 DUROMETER	(2) - Fluorocarbon, V0884-75
	SOUR SERVICE	TRIM MATERIALS	YES	(EN) - 316 SS DISK & NOZZLE
	ADJ SCREW	ADJ BUSHING	STNLS STL	STNLS STL
	SPRING	DISK	MP35N	316 STNLS STL
	NOZZLE MATERIAL	NOZZLE TYPE	316 STNLS STL	Semi Nozzle
	CAP TYPE	INLET PIPE TAP	(1) - CLOSED CAP	NOT AVAILABLE
Valve Information	VALVE SERIES		9100 SERIES SPRING OPERATED VALVE	
	FLANGED OR THREADED		Threaded	
	VALVE P/N:	REPAIR KIT P/N:	91-16D51V07EN2	1D1V2EN1
	TEST GAG		NO	
	INLET AND OUTLET		(16) - 1" FNPT x 1" FNPT	
	CENTER TO FACE DIMENSIONS		A = 3.202 ± 0.062 in. (81.3 ± 1.6 mm.)	B = 2.312 ± 0.062 in. (58.7 ± 1.6 mm.)
VALVE DESIGN TEMP	VALVE DESIGN PRESS	-20°F to 400°F (-29°C to 204°C)		
Pricing Information	Quantity	Lead Time (ARO)	1	
	Price Per Valve (US\$)	Total Valve Price (US\$)		
Comments				
WARNING	RELIEVING TEMPERATURE ONLY USED IN SIZING CALCULATIONS AND NOT IN MATERIAL SELECTION			

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Customer Name Joe Herauf
Company NEXT Compression
Location Rocky View County
Quote # 9004506
Reference
Valve PSV/Tag Number PSV-100

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 Page 2 of 3



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Fluid Properties	Variable Name	Symbol	Input Value	Equation Value
Gas	Molecular Weight	M	28.97	28.97
	Ratio of Specific Heats	k	1.244	1.244
	Compressibility	Z	0.997	0.997
Process Conditions	Gas Required Area	AGAS	0.122 in ²	0.122 in ²
	Set Pressure	Pset	125 psig	125 psig
	Over Pressure	Pover	21 %	26.25 psig
	Inlet Line Loss	Ploss	0 %	0 psig
	Variable Superimposed Back Pressure	Pvs	0 psig	0 psig
	Constant Superimposed Back Pressure	Pcs	2 psig	2 psig
	Built-up Back Pressure	Pbu	5 psig	5 psig
	Atmospheric Pressure	Patm	13.4 psia	13.4 psia
	Relieving Temperature	T1	353 °F	812.67 °R
	Rupture Disk Correction	Kc	1	1
	Noise Level Distance	d	100 ft	100 ft
Valve Data	Gas Discharge Coefficient	KdGAS		0.818
	Outlet Diameter	Do		0.957 in
	Actual Valve Orifice Area	ATAG		0.122 in ²
	ASME Certified Flow Coefficient	KdTag		0.818

Calculations	Symbol	Equation	Equation Result
Flowing Pressure	P1	$P1 = Pset + Pover - Ploss + Patm$	164.7 psia
Total Back Pressure	P2	$P2 = Pvs + Pcs + Pbu + Patm$	20.4 psia
Pressure Ratio	PR	$PR = P1 / P2$	8.07
Critical Flow Nozzle Pressure	Pcf	$Pcf = P1 * [2 / (k + 1)]^{k / (k - 1)}$	91.555 psia
Sonic Flow Verification		$Pcf < Pback ==> SONIC FLOW$	
Gas Constant	C	$C = 520 * \{ k * [2 / (k + 1)]^{k / (k - 1)} \}^{0.5}$	341.6

Customer Name Joe Herauf
Company NEXT Compression
Location Rocky View County
Quote # 9004506
Reference
Valve PSV/Tag Number PSV-100

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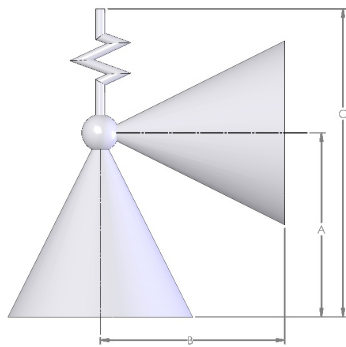
Calculations	Symbol	Equation	Equation Result
Total Required Area	A	A = AGAS	0.122 in ²
Selected Orifice		D ORIFICE	0.122 in ²
Tag Flowing Pressure	P1TAG	P1TAG = Pset + Povertag + Patm	152.2 psia
Tag Capacity	VTAG	VTAG = 18.331 * A * P1TAG * KdTAG	278 SCFM AIR
Maximum Gas Flow Rate	Vmax	Vmax = 6.32 * C * KdGAS * P1 * Kc * A / (T1 * Z * M) ^ 0.5	231.54 scfm
Mass Flow	W	W = Vmax * M / 6.32	1061.35 lb/hr

Noise Level Calculations

SoundPressureLevel	L	Calculated from Figure 18 in API 521	56.5 dB
Noise Level at 100 ft (30 m)	L100	L100 = L + 10 * log (0.214967 * W * k * T1 / M)	95.49 dB
Noise Level at distance d	Ld	Ld = L100 - 20 * log (d / 100)	95.49 dB

Reaction Forces

Outlet Static Pressure	Po	Po = Max Allowable Over Pressure	13.4 psia
Outlet Area	Ao	Ao = (π * Do ^ 2) / 4	0.719 in ²
Gas Reaction Force for Open Discharge	FrGas	FrGas = W / 366 * { (k * T1) / [(k + 1) * M] } ^ 0.5 + [(Po - Patm) * Ao]	11.44 lbf



Picture may not be representative of actual valve

A = 3.202 ± 0.062 in. (81.3 ± 1.6 mm.)

B = 2.312 ± 0.062 in. (58.7 ± 1.6 mm.)

Customer Name Joe Herauf
 Company Next
 Location
 Quote # 9004560
 Reference 100421A
 Valve PSV/Tag Number

Quote Revision
 Rev.: _____
 Quote Contact _____



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Please reference Quote Number on all corresponding Purchase Orders.
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MERCER VALVE CO., INC.[®]
 "AUTO SEAT TECHNOLOGY"[®]

Fluid Data	GAS/VAPOR	REQUIRED CAPACITY	Natural Gas	0.75 MMSCFD
	MOLECULAR WEIGHT	SPECIFIC GRAVITY	20.86	0.72
	GAS COEFFICIENT	k-RATIO OF SPECIFIC HEATS	341.6	1.244
	COMPRESSIBILITY FACTOR		0.997	
	REQUIRED AREA	FLOW COEFFICIENT	0.1252 in ²	0.798
	LIQUID 1	REQUIRED CAPACITY		
	SPECIFIC GRAVITY	DENSITY		
	VISCOSITY	VISCOSITY CORRECTION FACTOR		
	REQUIRED AREA	FLOW COEFFICIENT		
	LIQUID 2	REQUIRED CAPACITY		
	SPECIFIC GRAVITY	DENSITY		
	VISCOSITY	VISCOSITY CORRECTION FACTOR		
Process Conditions	SUPERIMPOSED CONST BP	SUPERIMPOSED VARIABLE BP	0 psig	0 psig
	BUILT-UP BP	TOTAL BACK PRESSURE	0 psig	0 psig
	OPERATING TEMP	RELIEVING TEMPERATURE	90 °F	200 °F
	OPERATING PRESSURE	ATMOSPHERIC PRESSURE	157 psig	13.4 psia
	SET PRESSURE	CDTP	245 psig	
	OVER PRESSURE	INLET PRESSURE LOSSES	24.5 psig / 10 %	0 psig / 0 %
		FLOWING PRESSURE		282.9 psia
	DISCHARGE COEFFICIENT AND AREAS	VALVE CERTIFICATION / DESIGN CODE	ASME Certified	ASME BPVC, SECTION VIII, DIVISION 1
	SYSTEM TYPE		Set on Air	Blocked Flow
Sizing Results	TOTAL REQUIRED AREA	Rupture Disk Correction	0.1252 in ²	1.0
	SELECTED ORIFICE AREA	SELECTED ORIFICE	0.212 in ²	1/2" Diam ORIFICE
	MAXIMUM CAPACITY OF GAS AT OVER PRESS.			1.27 MMSCFD
	MAXIMUM CAPACITY OF LIQUID 1 AT OVER PRESS.			
	MAXIMUM CAPACITY OF LIQUID 2 AT OVER PRESS.			
	TAG CAPACITY			881 SCFM AIR
	DECIBEL LEVEL	SINGLE OUTLET REACTION FORCE	102.11 dB @ 100 ft	50.67 lbf
Materials	INLET BASE / BODY MATERIAL		(5) - Carbon Steel / WCB Carbon Steel	
	SEAT	O-RINGS	(V) - FKM 90 DUROMETER	(1) - FKM & BUNA N
	SOUR SERVICE	TRIM MATERIALS	YES	(N1) - SOUR GAS SERVICE
	ADJ SCREW	ADJ BUSHING	STNLS STL	STNLS STL
	SPRING	DISK	MP35N	304 STNLS STL
	NOZZLE MATERIAL	NOZZLE TYPE	316 STNLS STL	Semi Nozzle
	CAP TYPE	INLET PIPE TAP	(1) - CLOSED CAP	NO
Valve Information	Valve Type		8100 SERIES SPRING OPERATED VALVE	
	Valve P/N:		81-17151V10N11	
	Repair Kit P/N:		11V1N11	
	Inlet and Outlet		(17) - 1" MNPT x 1" FNPT	
	Center to Face Dimensions		A = 3.202 ± 0.062 in. (81.3 ± 1.6 mm.)	B = 1.906 ± 0.062 in. (48.4124 ± 1.6 mm.)
	Valve Design Temp	Valve Design Pressure	-20°F to 400°F (-29°C to 204°C)	
Pricing Information	Quantity	Lead Time (ARO)	1	
	Price Per Valve (US\$)	Total Valve Price (US\$)		
Comments				

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Customer Name Joe Herauf
 Company Next
 Location
 Quote # 9004560
 Reference 100421A
 Valve PSV/Tag Number



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 Page 2 of 3

MERCER VALVE CO., INC.[®]
 "AUTO SEAT TECHNOLOGY"[®]

Fluid Properties	Variable Name	Symbol	Input Value	Equation Value
Gas	Molecular Weight	M	20.86	20.86
	Ratio of Specific Heats	k	1.244	1.244
	Compressibility	Z	0.997	0.997
Process Conditions	Gas Required Flow	V	0.75 MMSCFD	520.833 scfm
	Set Pressure	Pset	245 psig	245 psig
	Over Pressure	Pover	10 %	24.5 psig
	Inlet Line Loss	Ploss	0 %	0 psig
	Variable Superimposed Back Pressure	Pvs	0 psig	0 psig
	Constant Superimposed Back Pressure	Pcs	0 psig	0 psig
	Built-up Back Pressure	Pbu	0 psig	0 psig
	Atmospheric Pressure	Patm	13.4 psia	13.4 psia
	Relieving Temperature	T1	200 °F	659.67 °R
	Rupture Disk Correction	Kc	1	1
Noise Level Distance	d	100 ft	100 ft	
Valve Data	Gas Discharge Coefficient	KdGAS		0.798
	Outlet Diameter	Do		0.957 in
	Actual Valve Orifice Area	ATAG		0.212 in ²
	ASME Certified Slope	Slope		3.100

Calculations	Symbol	Equation	Equation Result
Flowing Pressure	P1	$P1 = Pset + Pover - Ploss + Patm$	282.9 psia
Total Back Pressure	P2	$P2 = Pvs + Pcs + Pbu + Patm$	13.4 psia
Pressure Ratio	PR	$PR = P1 / P2$	21.1
Critical Flow Nozzle Pressure	Pcf	$Pcf = P1 * [2 / (k + 1)] ^ { k / (k - 1) }$	157.308 psia
Sonic Flow Verification		$Pcf < Pback ==> SONIC FLOW$	
Gas Constant	C	$C = 520 * \{ k * [2 / (k + 1)] ^ { (k + 1) / (k - 1) } \} ^ { 0.5 }$	341.6
Gas Required Area	AGAS	$AGAS = V * (T1 * Z * M) ^ { 0.5 } / (6.32 * C * KdGAS * P1 * Kc)$	0.1252 in ²

Customer Name Joe Herauf
 Company Next
 Location
 Quote # 9004560
 Reference 100421A
 Valve PSV/Tag Number



MERCER VALVE CO., INC.
 "AUTO SEAT TECHNOLOGY"®

jalvarez

ENG-1047000

2.41

27-May-2021

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 Page 3 of 3

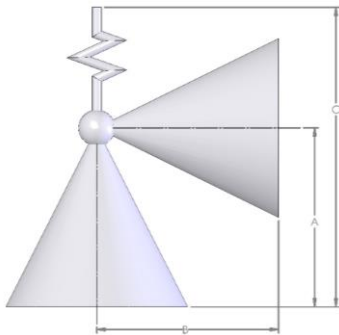
Calculations	Symbol	Equation	Equation Result
Total Required Area	A	A = AGAS	0.1252 in ²
Selected Orifice		1/2" Diam ORIFICE	0.212 in ²
Tag Flowing Pressure	P1TAG	P1TAG = Pset + Povertag + Patm	284.2 psia
Tag Capacity	VTAG	VTAG = slope * P1TAG	881 SCFM AIR
Maximum Gas Flow Rate	Vmax	Vmax = 6.32 * C * KdGAS * P1 * Kc * A / (T1 * Z * M) ^ 0.5	881.81 scfm
Mass Flow	W	W = Vmax * M / 6.32	2910.53 lb/hr

Noise Level Calculations

SoundPressureLevel	L	Calculated from Figure 18 in API 521	58.2 dB
Noise Level at 100 ft (30 m)	L100	L100 = L + 10 * log (0.214967 * W * k * T1 / M)	102.11 dB
Noise Level at distance d	Ld	Ld = L100 - 20 * log (d / 100)	102.11 dB

Reaction Forces

Outlet Static Pressure	Po	Po = 0.00245 * W / Do * [T / (k * M)] ^ 0.5	37.568 psia
Outlet Area	Ao	Ao = (π * Do ^ 2) / 4	0.719 in ²
Gas Reaction Force for Open Discharge	FrGas	FrGas = W / 366 * { (k * T1) / [(k + 1) * M] } ^ 0.5 + [(Po - Patm) * Ao]	50.67 lbf



Picture may not be representative of actual valve
 A = 3.202 ± 0.062 in. (81.3 ± 1.6 mm.)
 B = 1.906 ± 0.062 in. (48.4124 ± 1.6 mm.)



The Reliable Source

NEWCO - Forged Steel Valves

Gates • Globes • Swing Checks • Lift Checks

Product Line Technical Data



Corporate Headquarters Stafford, Texas

13127 Trinity Dr.

Stafford, TX 77477

Tel: 281.302.4900

Fax: 281.302.4801

Toll Free: 800.231.3505

www.NewmansValve.com

Manufacturer of

NEWCO

COOPER



QuadroSphere



Table of Contents

Introduction	1
NEWMANS History	
Mission Statement	
Company Profile	
Product Technology	
Newmans' Complete Product Range	2
Products & Services	2
VALVES	
Valves	
Manual Operations	
Valve Modification	
AUTOMATION	
Valve and Damper Actuation	
Automation Site Services	
Automation Shop Services	
Controls and Digital Communications	
Flange Dimensions - ANSI B16.5.....	3
Pressure Temperature Ratings ANSI B16.34 - 2004.....	4 & 5
NEWCO Forged Steel Valves Product Applications.....	8 & 9
Threaded, Socket Weld, & Butt Weld End Gate Valves	
Flanged End Gate Valves	
Extended Body Gate Valves	
Threaded, Socket Weld, & Butt Weld End Globe Valves	
Flanged End Globe Valves	
Threaded, Socket Weld, & Butt Weld End Swing & Lift Check Valves	
Flanged End Swing & Lift Check Valves	
Threaded, Socket Weld, & Butt Weld End Y-Pattern Globe Valves	
Valve & Identification Tag Overview.....	10
Body/Bonnet Materials.....	11
Trim Materials	11
NEWCO Features and Benefits.....	11
How To Order NEWCO Products.....	12
Forged Steel Bolted & Welded Bonnet Valves Dimensional Data and Expanded Views.....	13 thru 28
Gates..... 1/2" thru 2" Class 150 thru 1500.....	13 thru 18
Globes..... 1/2" thru 2" Class 150 thru 1500.....	19 thru 24
Swing Checks..... 1/2" thru 2" Class 150 thru 1500.....	25 thru 28
Forged Steel Cv Values.....	29
Limited Warranty.....	30
Applicable Standards	31
American Petroleum Institute (API)	
American Society of Mechanical Engineers (ASME)	
American Society Non-destructive Test (ASNT)	
American Society for Testing and Materials (ASTM)	
British Standards Institute (for reference only) (BS)	
Canadian Standards Association (CSA)	
International Organization for Standardization (ISO)	
Manufacturers Standardization Society (MSS)	
National Association of Corrosion Engineers (NACE)	
Terms and Conditions.....	32 & 33
Definitions	
General Terms and Conditions	
Service Terms	

Newmans History

Newco Valves, L.P., a Texas limited partnership, dba Newmans, and its wholly owned subsidiary, Newmans Valves, LTD, manufactures, markets and sells Gate, Globe, Check, Ball, and Triple Offset valves ranging in sizes from 1/4" thru 120" ANSI Class 125 thru 4500 lbs. The valves are manufactured to ASME, API, and MSS specifications from Carbon (cast and forged), Stainless (cast and forged including Duplex and Super Duplex products), and other alloys (low alloy steels, Inconel, Hastelloy, and noble alloys). "Newco", "OIC", and "Cooper Valves" brand name valves are used in various applications from low pressure processes to specialty applications within the refining, petrochemical, power, pulp and paper, and marine industries. The companies provide both standard product and special designs for their focused industries.

Newmans, L.P., also offers value added services including modifications or actuations and installation of by-passes, bore changes and gear operators for its valves. Some of these modifications include various trim changes covering stems, packing and gaskets, new bolting or changes in the flange surface. In addition, Company operations include marketing, product design, quality control, vendor qualification and value-added services for its product lines.

Timeline

1936: The Company's primary focus was wholesale plumbing and field salvage.

1946: The Company was incorporated under the Newmans name. At that time the focus was changed to the PVF industry until acquired by the Jordan Group in 1989.

1976: Newmans opened its Canadian branch under the name of Newmans Valve Limited.

1984: Precision Actuation Services (PAS) was opened to perform valve modification and actuation services.

1996: Precision Castparts Corporation (PCC) acquired Newmans. The business operated as part of the PCC Flow Technologies Division.

1997: In March, Newmans acquired "OIC" and added this trade mark to its business.

2003: On December 26th the business was purchased by the current group of partners that included the original owners of Newmans.

2005: In June, Newco Valves, L.P., purchased the operations of Cooper Valves from Dresser, Inc., and added specialty alloys and materials to its valve products line.

2006: Newmans opened its Shanghai, China office for service to the Far East market, direct shipments globally and service to the Far East for global project management.

2007: Completed two foundry operations, two process centers, and one ball valve facility in the China. Newmans also opened Bergamo, Italy office.

2008: Opened Atlanta, GA branch and a sales office in Chicago, Ill. Newmans formed a manufacturing joint venture for the Trinity Series Triple Offset valves 3" to 120" - 150 to 600 class.

2009: Opened Stafford, TX Corporate Office and Projects branch and stocking warehouse. Acquired Australian companies Keamy Engineering and The Valve Connection.

Over the years Newmans has established an excellent reputation for providing a broad product offering from world wide sources at competitive prices and a high level of quality and customer service. The company maintains seven (7) stocking warehouse locations in North America, one (1) in Shanghai, China, and one (1) in Melbourne, Australia. Newmans also has sales offices in Chicago, Ill., Bergamo, Italy, and Queensland, Australia.

Newmans services its markets through a network of distributors and direct sales personnel. The Companies utilize the Info Commerce@Work (C@W) information system. Commerce@Work is a fully integrated system allowing all Newmans' facilities to operate in an integrated and efficient manner.

Mission Statement

It is our goal to be known and respected in the Industry as "The Reliable Valve Source" for our extensive knowledge and superior service. Measured by keeping our word, we will deliver quality products on time at a fair value.

We achieve the above dealing with integrity in an open and flexible environment allowing people access to valuable information to make good and timely decisions. We believe that all this can be accomplished yielding great rewards for all involved while maintaining a balance in life.

Company Profile

Newmans is recognized as a global valve manufacturing company providing product to the market on a world-wide basis. The NEWCO, OIC and COOPER trademarks are recognized and respected the world over for their high quality and ability to meet the industry's most exacting standards. Newmans manufactures and markets one of the industry's broadest product lines suitable for most applications and market segments. Newmans is fully committed to engineering excellence and product innovation supported by a highly qualified technical engineering staff. Superior customer service is backed by the inventories of finished valves shipped daily from the six divisions located strategically throughout North America.

Product Technology

Newmans manufactures Gate, Globe, Check, Stop Check, Tilting Disc, Floating Ball, Trunnion Ball, QuadroSphere™ Ball, and Trinity Series Triple Offset valves in a full range of materials, valve styles, and pressure classes. Cast carbon steel and low-alloys, forged valves, cast iron and ductile iron valves are manufactured under the NEWCO trademark. 300 series stainless steel and Alloy 20 are produced and marketed under the OIC trademark. Other exotic alloys are manufactured under the Cooper trademark.

Newmans manufactures and stocks valves in sizes from 1/4" to 120" in diameter and in pressure classes from 125 to 4500 lbs. Larger sizes are available on request.

Newmans facilities operate under ISO 9001-2000 & 14001-2004 series registration. All valves are compliant to the industry standards of API, ASTM, and ASME. Inspection and testing is maintained throughout the manufacturing process to verify compliance to these standards as well as any specific customer requirements.

Customer service is further enhanced by complete modification and actuation capabilities. This capability allows Newmans to provide rapid deliveries of special valve requirements to meet the customer's delivery needs.

Newmans' Complete Product Range

Brand	Type	Size	Class	Ends	Available Material**
Newco	Cast Carbon	* 2" to 48"	150 - 2500	RF, RTJ, BW	WCB, LCC
Newco	Cast Alloy	2" to 24"	150 - 2500	RF, RTJ, BW	C5, WC6, WC9, C12, C12A
Newco	Forged Carbon	1/4" to 3"	150 - 4500	FLGD, THRD, SW	A105N, LF2
Newco	Forged Alloy	1/4" to 2"	150 - 4500	FLGD, THRD, SW	F5, F9, F11, F22, F91, F51
Newco	Forged Stainless	1/4" to 2"	150 - 4500	FLGD, THRD, SW	304/L, 316/L, 317/L, 321, 347, A20
Newco	Pressure Seal	2" to 24"	600 - 4500	RF, RTJ, BW	Cast - all grades
Newco	Trunnion Ball & QuadroSphere	2" to 36"	150 - 2500	RF, BW	A105, LF2, F316, F51
Newco	Floating Ball	1/2" to 18"	150 - 600	RF	WCB, LCC, CF8M
Newco	Trinity Triple Offset	3" to 120"	150 - 600	WFR, LUG, FLGD, BW	WCB, 316, Monel, Hastelloy, NiAlBr
OIC	Cast Stainless	1/2" to 24"	150 - 2500	RF, RTJ, BW	304/L, 316/L, 317/L, 321, 347/H, A20
OIC	Forged Stainless	1/4" to 2"	150 - 4500	FLGD, THRD, SW	304/L, 316/L, 317/L, 321, 347, A20
Cooper	Cast Alloy	1/4" to 24"	150 - 1500	FLGD, THRD, SW, BW	Monel, Inconel, Hastelloy, Titanium, Zirconium, Duplex
Cooper	Forged Alloy	1/4" to 3"	800 - 1500	FLGD, THRD, SW, BW	Monel, Inconel, Hastelloy, Titanium, Zirconium, Duplex
Cooper	Ball Valves	1/4" to 3"	1500 PSI	THRD, SW, BW	Monel, Inconel, Hastelloy, Titanium, Zirconium, Duplex
Cooper	Ball Valves	1/2" to 12"	150 - 900 PSI	FLGD	Monel, Inconel, Hastelloy, Titanium, Zirconium, Duplex

*Larger sizes available upon request. **Other materials available upon request.

Products & Services

VALVES

NEWCO

- Full Line of Gate, Globe, & Check Valves in Forged & Cast Steel
- Floating Ball Valves
- Trunnion Mounted Ball Valves
- QuadroSphere® Trunnion Mounted Ball Valves

OIC

- Gate, Globe, and Check Valves in Stainless Steel

COOPER

- Gate, Globe, and Check Valves Flanged, Threaded, and Socket Weld in Cast and Forged Exotic Alloy, and Stainless Steel
- Flanged and 3-Piece Ball Valves in Exotic Alloy

Manual Operations

- Worm Gears, Spur Gears, Bevel Gears, and Reach Rods
- Field and Shop Installation Services
- Table Stands, Extension Systems, and Brackets

Valve Modification

- By Passes, Bore Changes, Mounting Plates, Stem Extensions, Limit Switches, Trim Changes, etc.

AUTOMATION

Valve & Damper Actuation

- Capabilities and Support for all Actuators including: **Limitorque, Rotork, Auma, EIM, Bettis, Automax, Fisher, Miller, and Hanna**
- Electric, Hydraulic, and Pneumatic Automation
- New Applications and Field Retrofits
- Multi-turn, Quarter-turn, and Linear

Automation Site Services

- Experienced Field Technicians
- Commissioning and Repair Services
- Actuator Installation, Setting, Calibration, Start-up
- Automation and Control Surveys

Automation Shop Services

- Experienced Shop Technicians
- Special Wiring Diagrams and Control Schematic
- Complete Automated Valve Assemblies
- Shop Acuator Repairs on **Limitorque, Rotork, Auma, & EIM**

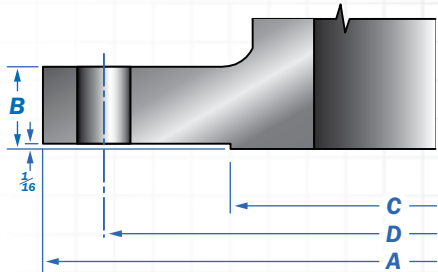
Controls & Digital Communications

- Pneumatic and Hydraulic Services
- Two-wire Integration, Field Bus, ModBus, ProfiBus, DeviceNet, EtherNet, Serial Communications, Network Control Systems
- Solenoid and Speed Control Valves; Limit Switches

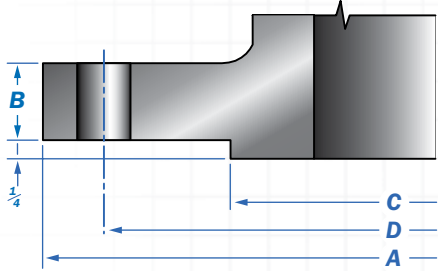
Specialists in Electric and Pneumatic Actuation - Authorized Limitorque Distributor and Service Center

Flange Dimensions - ASME B16.5

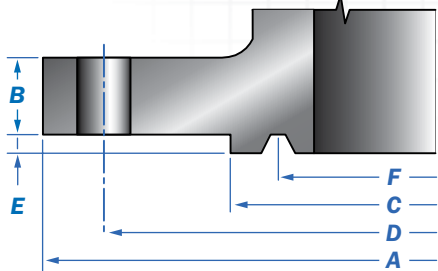
**Raised Face
Class 150 & 300**



**Raised Face
Class 600 thru 2500**



**RTJ
Class 600 thru 2500**



Flange Dimensions in Inches											
Class	Size in. mm	A	B	C	D	Ring Joint Facing			Ring No.	Bolt Holes	
						C	F	E		Size	No.
150	1/2	3.5	0.44	1.38	2.38	-	-	-	-	0.62	4
	15	89	11.58	34.9	60.3	-	-	-	-	16	4
	3/4	3.88	0.5	1.69	2.75	-	-	-	-	0.62	4
	20	98	13	42.9	69	-	-	-	-	16	4
	1	4.25	0.55	2	3.12	-	-	-	-	0.62	4
	25	108	14.5	50.8	79.4	-	-	-	-	16	4
	1-1/4	4.62	0.62	2.5	3.5	-	-	-	-	0.62	4
	32	117	16	68.5	88.9	-	-	-	-	16	4
	1-1/2	5	0.69	2.88	3.88	-	-	-	-	0.62	4
	40	127	17.5	73	98.4	-	-	-	-	16	4
300	2	6	0.75	3.62	4.75	-	-	-	-	0.75	4
	50	152	19.5	92.1	120.6	-	-	-	-	19	4
	1/2	3.75	0.56	1.38	2.62	-	-	-	-	0.62	4
	15	95	14.5	34.9	66.7	-	-	-	-	16	4
	3/4	4.62	0.62	1.69	3.25	-	-	-	-	0.75	4
	20	117	16	42.9	82.5	-	-	-	-	19	4
	1	4.88	0.69	2	3.5	-	-	-	-	0.75	4
	25	124	17.5	50.8	88.9	-	-	-	-	19	4
	1-1/4	5.25	0.75	2.5	3.88	-	-	-	-	0.75	4
	32	133	19.5	68.5	98.4	-	-	-	-	19	4
600	1-1/2	6.12	0.81	2.88	4.5	-	-	-	-	0.88	4
	40	156	21	73	114.3	-	-	-	-	22.5	4
	2	6.5	0.88	3.62	5	-	-	-	-	0.75	8
	50	165	22.5	92.1	127	-	-	-	-	19	8
	1/2	3.75	0.56	1.38	2.62	2	1.34	0.22	R 11	0.62	4
	15	95	14.5	34.9	66.7	51	34.14	5.6	R 11	16	4
	3/4	4.62	0.62	1.69	3.25	2.5	1.68	0.25	R 13	0.75	4
	20	117	16	42.9	82.5	63.5	42.88	6.3	R 13	19	4
	1	4.88	0.69	2	3.5	2.75	2	0.25	R 16	0.75	4
	25	124	17.5	50.8	88.9	70	50.8	6.3	R 16	19	4
1500	1-1/4	5.25	0.81	2.5	3.88	3.12	2.38	0.25	R 18	0.75	4
	32	133	21	63.5	98.4	79.5	60.32	6.3	R 18	19	4
	1-1/2	6.12	0.88	2.88	4.5	3.56	2.69	0.25	R 20	0.88	4
	40	156	22.5	73	114.3	90.5	68.28	6.3	R 20	22.5	4
	2	6.5	1	3.62	5	4.25	3.25	0.31	R 23	0.75	8
	50	165	25.5	92.1	127	108	82.55	7.9	R 23	19	8
	1/2	4.75	0.88	1.38	3.25	2.38	1.56	0.25	R 12	0.88	4
	15	121	22.5	34.9	82.5	60.5	39.67	6.3	R 12	22.5	4
	3/4	5.12	1	1.69	3.5	2.62	1.75	0.25	R 14	0.88	4
	20	130	22.5	42.9	88.9	66.5	44.45	6.3	R 14	22.5	4
2500	1	5.88	1.12	2	4	2.81	2	0.25	R 16	1	4
	25	149	29	50.8	101.6	71.5	50.8	6.3	R 16	25.5	4
	1-1/4	6.25	1.12	2.5	4.38	3.19	2.37	0.25	R 18	1	4
	32	159	29	63.5	111.1	81	60.32	6.3	R 18	25.5	4
	1-1/2	7	1.25	2.88	4.88	3.62	2.68	0.25	R 20	1.12	4
	40	178	32	73	123.8	92	68.28	6.3	R 20	28.5	4
	2	8.5	1.5	3.62	6.5	4.88	3.75	0.31	R 24	1	8
	50	216	38.5	92.1	165.1	124	95.25	7.9	R 24	25.5	8
	1/2	5.25	1.19	1.38	3.5	2.56	1.68	0.25	R 13	0.88	4
	15	133.5	30.5	34.9	88.9	65	42.88	6.3	R 13	22.5	4
3000	3/4	5.5	1.25	1.69	3.75	2.88	2	0.25	R 16	0.88	4
	20	139.5	32	42.9	95.3	73.2	50.8	6.3	R 16	22.5	4
	1	6.25	1.38	2	4.25	3.25	2.37	0.25	R 18	1	4
	25	159	35	50.8	108	82.5	60.32	6.3	R 18	25.5	4
	1-1/4	7.25	1.5	2.5	5.12	4	2.84	0.31	R 21	1.12	4
	32	184	38.5	63.5	130.2	101.6	72.24	7.9	R 21	28.5	4
	1-1/2	8	1.75	2.88	5.75	4.5	3.25	0.31	R 23	1.25	4
	40	203	44.5	73	146.1	114.3	82.55	7.9	R 23	32	4
	2	9.25	2	3.62	6.75	5.25	4	0.31	R 26	1.12	8
	50	235	51	92.1	171.5	133.4	101.6	7.9	R 26	28.5	8

Pressure Temperature Ratings - ASME B16.34 - 2004 (standard)

	°F / PSI	20 to 100	200	300	400	500	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
Class 150	A105*	285	260	230	200	170	140	125	110	95	80	65	50	35	20	-	-	-	-
	LF2*	290	260	230	200	170	140	125	110	95	80	65	50	35	20	-	-	-	-
	F11+	290	260	230	200	170	140	125	110	95	80	65	50	35	20	20**	20**	-	-
	F22+	290	260	230	200	170	140	125	110	95	80	65	50	35	20	20**	20**	-	-
	F5	290	260	230	200	170	140	125	110	95	80	65	50	35	20	20**	20**	20**	20**
	F9	290	260	230	200	170	140	125	110	95	80	65	50	35	20	20**	20**	20**	20**
	F91	290	260	230	200	170	140	125	110	95	80	65	50	35	20	20	20	20	20
Class 300	A105*	740	680	655	635	605	570	550	530	505	410	320	230	135	85	-	-	-	-
	LF2*	740	680	655	635	605	570	550	530	505	410	320	230	135	85	-	-	-	-
	F11+	750	750	720	695	665	605	590	570	530	510	485	450	320	215	145	95	65	40
	F22+	750	750	730	705	665	605	590	570	530	500	485	450	385	265	175	110	70	40
	F5	750	750	730	705	665	605	590	570	530	510	485	375	275	200	145	100	60	35
	F9	750	750	730	705	665	605	590	570	530	510	4185	450	375	255	170	115	75	50
	F91	750	750	730	705	665	605	590	570	530	510	485	450	385	365	360	300	225	145
Class 600	A105*	1480	1360	1310	1265	1205	1135	1100	1060	1015	825	640	460	275	170	-	-	-	-
	LF2*	1480	1360	1310	1265	1205	1135	1100	1060	1015	825	640	460	275	170	-	-	-	-
	F11+	1500	1500	1445	1385	1330	1210	1175	1135	1065	1015	975	900	640	430	290	190	130	80
	F22+	1500	1500	1455	1410	1330	1210	1175	1135	1065	1015	975	900	755	535	350	220	135	80
	F5	1500	1470	1400	1335	1290	1210	1175	1135	1065	1015	975	745	550	400	290	190	125	70
	F9	1500	1500	1455	1410	1330	1210	1175	1135	1065	1015	975	900	755	505	345	225	150	105
	F91	1500	1500	1455	1410	1330	1210	1175	1135	1065	1015	975	900	775	725	720	605	445	290
Class 800	A105*	1974	1810	1747	1689	1609	1515	1467	1414	1352	1098	850	613	365	227	-	-	-	-
	LF2*	1974	1810	1747	1689	1609	1515	1467	1414	1352	1098	850	613	365	227	-	-	-	-
	F11+	2000	2000	1925	1849	1774	1614	1569	1515	1419	1355	1298	1200	850	577	383	257	173	110
	F22+	2000	2000	1942	1880	1774	1614	1569	1515	1419	1355	1298	1200	1025	712	467	293	182	110
	F5	2000	1964	1876	1782	1724	1614	1569	1515	1419	1355	1298	995	733	530	383	257	165	93
	F9	2000	2000	1942	1880	1774	1614	1569	1515	1419	1355	1298	1200	1005	675	458	302	200	138
	F91	2000	2000	1942	1880	1774	1614	1569	1515	1419	1355	1298	1200	1032	968	960	805	595	383
Class 900	A105*	2220	2035	1965	1900	1810	1705	1650	1590	1520	1235	955	690	410	255	-	-	-	-
	LF2*	2220	2035	1965	1900	1810	1705	1650	1590	1520	1235	955	690	410	255	-	-	-	-
	F11+	2250	2250	2165	2080	1995	1815	1765	1705	1595	1525	1460	1350	955	650	430	290	195	125
	F22+	2250	2250	2185	2115	1995	1815	1765	1705	1595	1525	1460	1350	1160	800	525	330	205	125
	F5	2250	2210	2100	2005	1940	1815	1765	1705	1595	1525	1460	1120	825	595	430	290	185	105
	F9	2250	2250	2185	2115	1995	1815	1765	1705	1595	1525	1460	1350	1130	760	515	340	225	155
	F91	2250	2250	2185	2115	1995	1815	1765	1705	1595	1525	1460	1350	1160	1090	1080	905	670	430
Class 1500	A105*	3705	3395	3270	3170	3015	2840	2745	2665	2535	2055	1595	1150	685	430	-	-	-	-
	LF2*	3705	3395	3270	3170	3015	2840	2745	2665	2535	2055	1595	1150	685	430	-	-	-	-
	F11+	3750	3750	3610	3465	3325	3025	2940	2840	2660	2540	2435	2245	1595	1080	720	480	325	205
	F22+	3750	3750	3640	3530	3325	3025	2940	2840	2660	2540	2435	2245	1930	1335	875	550	345	205
	F5	3750	3680	3495	3345	3230	3025	2940	2840	2660	2540	2435	1870	1370	995	720	480	310	170
	F9	3750	3750	3640	3530	3325	3025	2940	2840	2660	2540	2435	2245	1885	1270	855	565	375	255
	F91	3750	3750	3640	3530	3325	3025	2940	2840	2660	2540	2435	2245	1930	1820	1800	1510	1115	720
Class 1690	A105*	4173	3824	3684	3571	3397	3199	3093	2999	2857	2316	1796	1295	772	484	-	-	-	-
	LF2*	4173	3824	3684	3571	3397	3199	3093	2999	2857	2316	1796	1295	772	484	-	-	-	-
	F11+	4225	4225	4067	3904	3746	3408	3313	3199	2996	2861	2744	2530	1796	1217	811	541	367	232
	F22+	4225	4225	4102	3977	3746	3408	3313	3199	2996	2861	2744	2530	2175	1505	985	619	388	232
	F5	4225	4146	3939	3768	3639	3408	3313	3199	2996	2861	2744	2107	1544	1120	811	541	349	192
	F9	4225	4225	4102	3977	3746	3408	3313	3199	2996	2861	2744	2530	2124	1431	964	637	423	288
	F91	4225	4225	4102	3977	3746	3408	3313	3199	2996	2861	2744	2530	2175	2050	2028	1701	1256	811
Class 2500	A105*	6170	5655	5450	5280	5025	4730	4575	4425	4230	3430	2655	1915	1145	715	-	-	-	-
	LF2*	6170	5655	5450	5280	5025	4730	4575	4425	4230	3430	2655	1915	1145	715	-	-	-	-
	F11+	6250	6250	6015	5775	5540	5040	4905	4730	4430	4230	4060	3745	2655	1800	1200	800	545	345
	F22+	6250	6250	6070	5880	5540	5040	4905	4730	4430	4230	4060	3745	3220	2230	1455	915	570	345
	F5	6250	6135	5830	5570	5385	5040	4905	4730	4430	4230	4060	3115	2285	1655	1200	800	515	285
	F9	6250	6250	6070	5880	5540	5040	4905	4730	4430	4230	4060	3745	3145	2115	1430	945	630	430
	F91	6250	6250	6070	5880	5540	5040	4905	4730	4430	4230	4060	3745	3220	3030	3000	2515	1855	1200
Class 2680	A105*	6615	6063	5843	5660	5386	5071	4905	4743	4534	3677	2847	2054	1227	766	-	-	-	-
	LF2*	6615	6063	5843	5660	5386	5071	4905	4743	4534	3677	2847	2054	1227	766	-	-	-	-
	F11+	6700	6700	6448	6191	5938	5403	5258	5071	4749	4534	4352	4015	2847	1930	1286	858	584	369
	F22+	6700	6700	6507	6303	5938	5403	5258	5071	4749	4534	4352	4015	3452	2390	1560	981	611	369
	F5	6700	6576	6249	5971	5772	5403	5258	5071	4749	4534	4352	3339	2450	1775	1286	858	552	306
	F9	6700	6700	6507	6303	5938	5403	5258	5071	4749	4534	4352	4015	3371	2267	1533	1013	675	461
	F91	6700	6700	6507	6303	5938	5403	5258	5071	4749	4534	4352	4015	3452	3248	3216	2696	1989	1286
Class 4500	A105*	11110	10185	9815	9505	9040	8515	8240	7960	7610	6170	4785	3455	2055	1285	-	-	-	-
	LF2*	11110	10185	9815	9505	9040	8515	8240	7960	7610	6170	4785	3455	2055	1285	-	-	-	-
	F11+	11250	11250	10830	10400	9965	9070	8825	8515	7970	7610	7305	6740	4785	3240	2160	1440	975	615
	F22+	11250	11250	10925	10585	9965	9070	8825	8515	7970	7610	7305	6740	5795	4010	2625	1645	1030	615
	F5	11250	11040	10490	10030	9690	9070	8825	8515	7970	7610	7305	5605	4115	2985	2160	1440	925	515
	F9	11250	11250	10925	10585	9965	9070	8825	8515	7970	7610	7305	6740	5655	3805	2570	1695	1130	770
	F91	11250	11250	10925	10586	9965	9070	8825	8515	7970	7610	7305	6740	5795	5450	5400	4525	3345	2160

* Not recommended for prolonged use above 800 ° F. + Not recommended for prolonged use above 1100 ° F. ** For weld end valves only. Flanged end ratings terminate at 1000 ° F.
Note: Packing, gasket, or bolting may limit temperature. Please advise service temperature if above 1000 ° F. Ratings from ASME B16.34 standard class valves. Special class weld end valves to ASME B16.34 are available on special order.

Pressure Temperature Ratings - ASME B16.34 - 2004 (metric)

	°C / BAR	29 to 38	100	150	200	250	300	350	375	400	425	450	475	500	538	575	600	625	650
Class 150	A105*	19.6	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	-	-	-	-
	LF2*	19.6	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	-	-	-	-
	F11*	19.8	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	1.4**	1.4**	1.4**	1.1**
	F22*	19.8	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	1.4**	1.4**	1.4**	1.1**
	F5	20.0	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	1.4**	1.4**	1.4**	0.9**
	F9	20.0	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	1.4**	1.4**	1.4**	1.4**
	F91	20.0	17.7	15.8	13.8	12.1	10.2	8.4	7.4	6.5	5.5	4.6	3.7	2.8	1.4	1.4**	1.4**	1.4**	1.4**
Class 300	A105*	51.1	46.6	45.1	43.8	41.9	39.8	37.6	36.4	34.7	28.8	23.0	17.4	11.8	5.9	-	-	-	-
	LF2*	51.1	46.6	45.1	43.8	41.9	39.8	37.6	36.4	34.7	28.8	23.0	17.4	11.8	5.9	-	-	-	-
	F11*	51.7	51.5	49.7	48.0	46.3	42.9	40.3	38.9	36.5	35.2	33.7	31.7	25.7	14.9	8.8	6.1	4.3	2.8
	F22*	51.7	51.5	50.3	48.6	46.3	42.9	40.3	38.9	36.5	35.2	33.7	31.7	28.2	18.4	10.5	6.9	4.5	2.8
	F5	51.7	51.5	50.3	48.6	46.3	42.9	40.3	38.9	36.5	35.2	33.7	27.9	21.4	13.7	8.9	6.2	4.0	2.4
	F9	51.7	51.5	50.3	48.6	46.3	42.9	40.3	38.9	36.5	35.2	33.7	31.7	28.2	17.5	10.5	7.2	5.0	3.5
	F91	51.7	51.5	50.3	48.6	46.3	42.9	40.3	38.9	36.5	35.2	33.7	31.7	28.2	25.2	24.0	19.5	14.6	9.9
Class 600	A105*	102.1	93.2	90.2	87.6	83.9	79.6	75.1	72.7	69.4	57.5	46.0	34.9	23.5	11.8	-	-	-	-
	LF2*	102.1	93.2	90.2	87.6	83.9	79.6	75.1	72.7	69.4	57.5	46.0	34.9	23.5	11.8	-	-	-	-
	F11*	103.4	103.0	99.5	95.9	92.7	85.7	80.4	77.6	73.3	70.0	67.7	63.4	51.5	29.8	17.6	12.2	8.5	5.7
	F22*	103.4	103.0	100.3	97.2	92.7	85.7	80.4	77.6	73.3	70.0	67.7	63.4	56.5	36.9	21.1	13.8	8.9	5.7
	F5	103.4	103.0	100.3	97.2	92.7	85.7	80.4	77.6	73.3	70.0	67.7	55.7	42.8	27.4	17.8	12.5	8.0	4.7
	F9	103.4	103.0	100.3	97.2	92.7	85.7	80.4	77.6	73.3	70.0	67.7	63.4	56.5	35.0	20.9	14.4	9.9	7.1
	F91	103.4	103.0	100.3	97.2	92.7	85.7	80.4	77.6	73.3	70.0	67.7	63.4	56.5	50.0	47.9	39.0	29.2	19.9
Class 800	A105*	136.0	124.7	120.4	116.3	110.8	104.4	101.1	97.4	93.1	75.7	58.6	42.3	25.2	15.6	-	-	-	-
	LF2*	136.0	124.7	120.4	116.3	110.8	104.4	101.1	97.4	93.1	75.7	58.6	42.3	25.2	15.6	-	-	-	-
	F11*	137.8	137.8	132.6	127.4	122.2	111.2	108.1	104.4	97.7	93.4	89.5	82.7	58.6	39.7	26.4	17.7	11.9	7.6
	F22*	137.8	137.8	133.8	129.5	122.2	111.2	108.1	104.4	97.7	93.4	89.5	82.7	70.6	49.0	32.2	20.2	12.5	7.6
	F5	137.8	135.3	128.6	122.8	118.8	111.2	108.1	104.4	97.7	93.4	89.5	68.6	50.5	36.5	26.4	17.7	11.4	6.4
	F9	137.8	137.8	133.8	129.5	122.2	111.2	108.1	104.4	97.7	93.4	89.5	82.7	69.3	46.5	31.6	20.8	13.8	9.5
	F91	137.8	137.8	133.8	129.5	122.2	111.2	108.1	104.4	97.7	93.4	89.5	82.7	71.1	66.7	66.2	55.5	41.0	26.4
Class 900	A105*	153.2	139.8	135.2	131.4	125.8	119.5	112.7	109.1	104.2	86.3	69.0	52.3	35.3	17.7	-	-	-	-
	LF2*	153.2	139.8	135.2	131.4	125.8	119.5	112.7	109.1	104.2	86.3	69.0	52.3	35.3	17.7	-	-	-	-
	F11*	155.1	154.4	149.2	143.9	139.0	128.6	120.7	116.5	109.8	105.1	101.4	95.1	77.2	44.7	26.4	18.3	12.8	8.5
	F22*	155.1	154.6	150.6	145.8	139.0	128.6	120.7	116.5	109.8	105.1	101.4	95.1	84.7	55.3	31.6	20.7	13.4	8.5
	F5	155.1	154.6	150.6	145.8	139.0	128.6	120.7	116.5	109.8	105.1	101.4	83.6	64.1	41.1	26.7	18.7	12.0	7.1
	F9	155.1	154.6	150.6	145.8	139.0	128.6	120.7	116.5	109.8	105.1	101.4	95.1	84.7	52.5	31.4	21.5	14.9	10.6
	F91	155.1	154.6	150.6	145.8	139.0	128.6	120.7	116.5	109.8	105.1	101.4	95.1	84.7	75.2	71.8	58.5	43.8	29.8
Class 1500	A105*	255.3	233.0	225.4	219.0	209.7	199.1	187.8	181.8	173.6	143.8	115.0	87.2	58.8	29.5	-	-	-	-
	LF2*	255.3	233.0	225.4	219.0	209.7	199.1	187.8	181.8	173.6	143.8	115.0	87.2	58.8	29.5	-	-	-	-
	F11*	258.6	257.4	248.7	239.8	231.8	214.4	201.1	194.1	183.1	175.1	169.0	158.2	128.6	74.5	44.0	30.5	21.3	14.2
	F22*	258.6	257.6	250.8	243.4	231.8	214.4	201.1	194.1	183.1	175.1	169.0	158.2	140.9	92.2	52.6	34.4	22.3	14.2
	F5	258.6	257.6	250.8	243.4	231.8	214.4	201.1	194.1	183.1	175.1	169.0	139.3	106.9	68.6	44.4	31.2	20.0	11.8
	F9	258.6	257.6	250.8	243.4	231.8	214.4	201.1	194.1	183.1	175.1	169.0	158.2	140.9	87.5	52.3	35.9	24.8	17.7
	F91	258.6	257.6	250.8	243.4	231.8	214.4	201.1	194.1	183.1	175.1	169.0	158.2	140.9	125.5	119.7	97.5	73.0	49.6
Class 1690	A105*	287.5	263.5	253.8	246.0	234.0	220.4	213.1	206.7	196.9	159.6	123.8	89.2	53.2	33.4	-	-	-	-
	LF2*	287.5	263.5	253.8	246.0	234.0	220.4	213.1	206.7	196.9	159.6	123.8	89.2	53.2	33.4	-	-	-	-
	F11*	291.1	291.1	280.2	269.0	258.1	234.8	28.3	220.4	206.4	197.1	189.0	174.3	123.8	83.8	55.9	37.3	25.3	16.0
	F22*	291.1	291.1	282.6	274.0	258.1	234.8	228.3	220.4	206.4	197.1	189.0	174.3	149.9	103.7	67.9	42.7	26.7	16.0
	F5	291.1	285.7	271.4	259.6	250.8	234.8	228.3	220.4	206.4	197.1	189.0	145.1	106.4	77.2	55.9	37.3	24.0	13.2
	F9	291.1	291.1	282.6	274.0	258.1	234.8	228.3	220.4	206.4	197.1	189.0	174.3	146.4	98.6	66.4	43.9	29.2	19.9
	F91	291.1	291.1	282.6	274.0	258.1	234.8	228.3	220.4	206.4	197.1	189.0	174.3	149.9	141.2	139.7	117.2	86.5	55.9
Class 2500	A105*	425.5	388.3	375.6	365.0	349.5	331.8	313.0	303.1	289.3	239.7	191.7	145.3	97.9	49.2	-	-	-	-
	LF2*	425.5	388.3	375.6	365.0	349.5	331.8	313.0	303.1	289.3	239.7	191.7	145.3	97.9	49.2	-	-	-	-
	F11*	430.9	429.0	414.5	399.6	386.2	357.1	335.3	323.2	304.9	291.6	281.8	263.9	214.4	124.1	73.4	50.9	35.5	23.6
	F22*	430.9	429.4	418.2	405.4	386.2	357.1	335.3	323.2	304.9	291.6	281.8	263.9	235.0	153.7	87.7	57.4	37.2	23.6
	F5	430.9	429.4	418.2	405.4	386.2	357.1	335.3	323.2	304.9	291.6	281.8	232.1	178.2	114.3	74.0	51.9	33.3	19.7
	F9	430.9	429.4	418.2	405.4	386.2	357.1	335.3	323.2	304.9	291.6	281.8	263.9	235.0	145.8	87.1	59.8	41.4	29.5
	F91	430.9	429.4	418.2	405.4	386.2	357.1	335.3	323.2	304.9	291.6	281.8	263.9	235.0	208.9	199.5	162.5	121.7	82.7
Class 2680	A105*	455.7	417.7	402.6	390.0	371.1	349.4	337.9	326.8	312.4	253.3	196.1	141.5	84.5	52.8	-	-	-	-
	LF2*	455.7	417.7	402.6	390.0	371.1	349.4	337.9	326.8	312.4	253.3	196.1	141.5	84.5	52.8	-	-	-	-
	F11*	461.6	461.6	444.3	426.6	409.1	372.2	362.3	349.4	327.2	312.4	299.9	276.6	196.1	132.9	88.6	59.1	40.2	25.4
	F22*	461.6	461.6	448.3	434.3	409.1	372.2	362.3	349.4	327.2	312.4	299.9	276.6	237.8	164.7	107.5	67.6	42.1	25.4
	F5	461.6	453.1	430.6	411.4	397.7	372.2	362.3	349.4	327.2	312.4	299.9	230.1	168.8	122.3	88.6	59.1	38.0	21.1
	F9	461.6	461.6	448.3	434.3	409.1	372.2	362.3	349.4	327.2	312.4	299.9	276.6	232.3	156.2	105.6	69.8	46.5	31.7
	F91	461.6	461.6	448.3	434.3	409.1	372.2	362.3	349.4	327.2	312.4	299.9	276.6	237.8	223.8	221.6	185.7	137.0	88.6
Class 4500	A105*	765.9	699.0	676.1	657.0	629.1	597.3	563.5	545.5	520.8	431.5	345.1	261.5	176.3	88.6	-	-	-	-
	LF2*	765.9	699.0	676.1	657.0	629.1	597.3	563.5	545.5	520.8	431.5	345.1	261.5	176.3	88.6	-	-	-	-
	F11*	775.7	772.2	746.2	719.4	694.8	642.6	603.3	581.8	548.5	524.7	507.0	474.8	385.9	223.4	132.0	91.6	63.9	42.6
	F22*	775.7	773.0	752.8	729.8	694.8	642.6	603.3	581.8	548.5	524.7	507.0	474.8	423.0	276.6	157.9	103.3	66.9	42.6
	F5	775.7	773.0	752.8	729.8														

“Reliable” is not just a word.

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In the pre-dawn hours of Saturday, September 13th our corporate headquarters in Houston, Texas took a direct hit from Hurricane Ike. The entire upper Texas Gulf coast was shut down in the wake of this storm... leaving homes and businesses in the dark. Newmans was prepared! Our modern Disaster Recovery Plan was in place - globally!

Our reputation as the Reliable Source was put to the test. Even though our Houston operation was momentarily crippled, seven of our eight locations, with 75% of our \$100 million inventory, were able to network seamlessly to maintain the

consistent high quality service to which our customers have been accustomed.

In the wake of the storm, Newmans proved once again that we are indeed **The Reliable Source!**

Newmans offers a complete line of valves in a full range of materials, sizes, styles, and pressure classes with complete actuation capabilities in sizes 1/4" thru 120" in classes ANSI 125 thru 4500 lbs.

For product details, visit our web site @ www.newmansvalve.com.



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Newco Forged Steel Valves Product Applications

The sole purpose of a valve is to regulate flow throughout a fluid processing/transport system whether it is starting, stopping, throttling, or simply controlling flow rate. Gate, Globe, Angle Globe, Swing and Lift Check valve configurations are designed to perform different functions within a fluid system. This section is designed to help you determine which Newmans valve will best address your application(s).

Threaded, Socket Weld, & Butt Weld End Gate Valves

Sizes: 1/4" thru 3" **Class:** 800 thru 4500

Gate Valves are ideal for bidirectional, full flow and tight seal shut-off. Due to the flow characteristics of the wedge-to-seat design, gate valves should be operated in the full-open or full-close position. Gate valves are utilized in applications where minimum pressure drop is necessary.



Flanged End Gate Valves

Sizes: 1/2" thru 2" **Class:** 150 thru 2500

Newmans' Flanged Gate Valves are suited to bi-directional flow. They are ideal for on - off duties where tight shut-off is required. Many of our designs feature integral body forging. Newmans offers flanged gate valves for wide service conditions.

Extended Body Gate Valves

Sizes: 1/2" thru 2" **Class:** 800 thru 1500

These valves are available in a variety of connections. Extended Body Valves have a welded or threaded connection and are used for pressure vessels and header lines for vents, drains or takeoff lines and instrumentation.



Threaded, Socket Weld, & Butt Weld End Globe Valves

Sizes: 1/4" thru 2" **Class:** 800 thru 4500

Globe Valves are ideal for unidirectional, controlled flow. The flow characteristic of a Globe valve is repeatable, consistent, and easy to control at any open position, which makes the design suitable for throttling applications.



Flanged End Globe Valves

Sizes: 1/2" thru 2" **Class:** 150 thru 2500

Flanged End Globe Valves offer flow characteristics that are repeatable, consistent, and easy to control at any open position. This makes them ideal for unidirectional, controlled flow and suitable for throttling applications.

Threaded, Socket Weld, & Butt Weld End Swing & Lift Check Valves

Sizes: 1/4" thru 2" **Class:** 800 thru 4500

Swing and Lift Check valves are available for a variety of services, and where high pressure application is needed. Quality manufacturing ensures that the valve will prevent flow reversal. Newmans offers swing, piston, and ball configurations for these valves.



Flanged End Swing & Lift Check Valves

Sizes: 1/2" thru 2" **Class:** 150 thru 1500

Newco Flanged End Swing and Lift Check Valves are designed for use in multiple applications. These valves are ideal for applications where flow characteristics of fluids require pressure control.

Threaded, Socket Weld, & Butt Weld Y-Pattern Globe Valves

Sizes: 1/2" thru 2" **Class:** 800 thru 4500

Y-Pattern Globe Valves are designed much the same as Angle Globe Valves. They are designed for a variety of service conditions and are used commonly for high pressure applications.

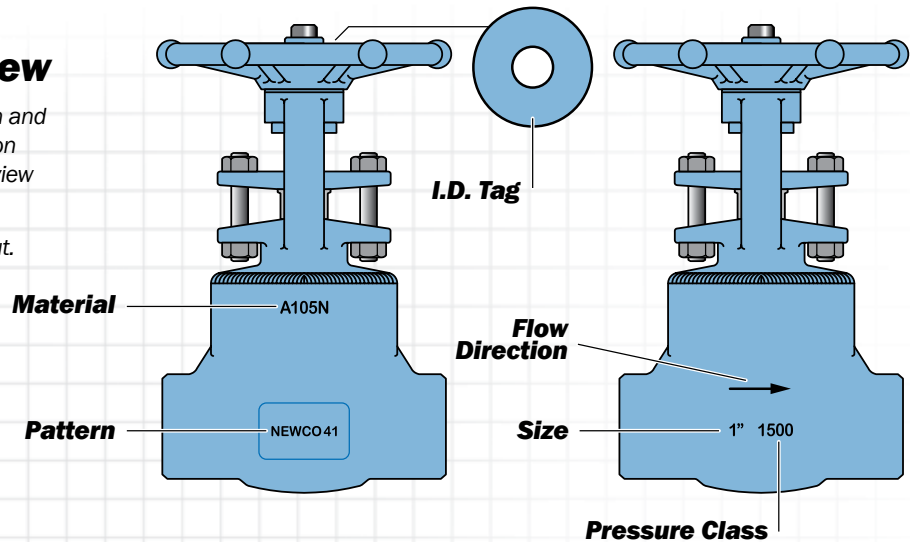


Valve & I.D. Tag Overview

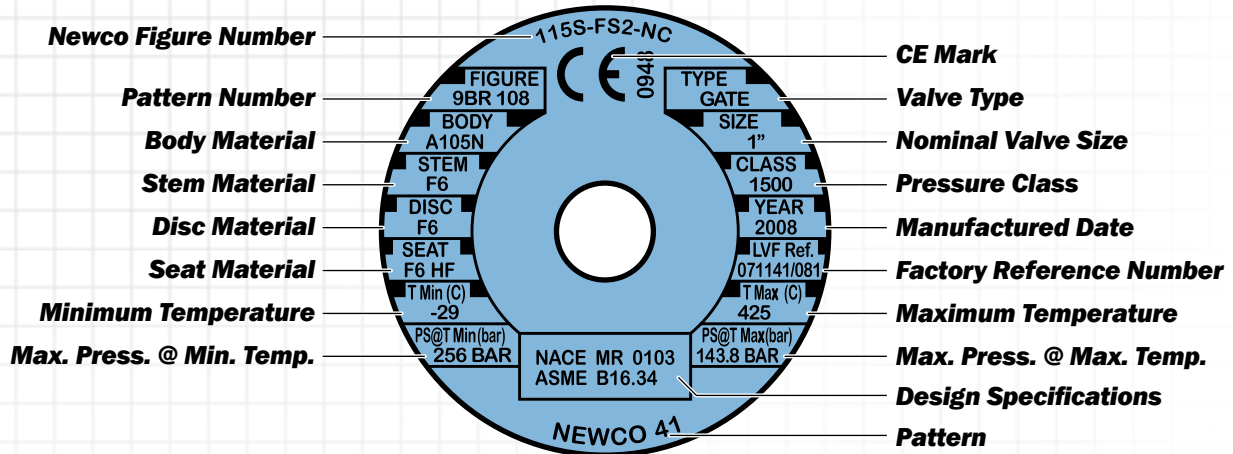
The identification tag displays all construction and tracking data regarding the respective valve on which it is attached. Below is a general overview of the identification tag components.

I.D. Tags are located under the handwheel nut.

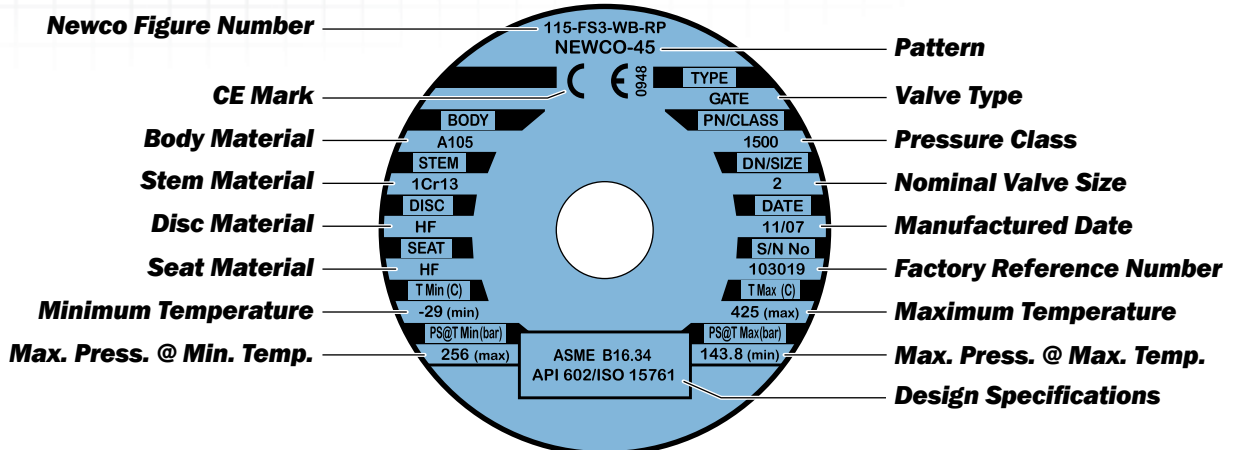
Globe and Check Valves will have a flow direction arrow on body for proper installation.



NEWCO 41 I.D. Tag



NEWCO 45 I.D. Tag



Body/Bonnet Materials

Newco forged steel valves are available in stock in a wide range of body/bonnet materials and optional trim materials. Listed below are some of the more popular materials. Additional materials are available. Please contact Newmans or your local distributor for details.

Newco Material Designation	Common Description	ASTM Specs.	Body/Bonnet Material Service Limitations *
FS	Carbon Steel	A105	Non-corrosive service water, oil, & gases at temperatures between -20° F & +800° F
LF2	Low Temp Carbon	A350	Low temperature service between -50° F & +800° F
F11	1.25% Chrome & .5% Moly	A182	Non-corrosive service water, oil, & gases at temperatures between -20° F & +1100° F
F22	2.25% Chrome & 1% Moly	A182	Non-corrosive service water, oil, & gases at temperatures between -20° F & +1100° F
F5	5% Chrome & .5% Moly	A182	Corrosive, non-corrosive, or erosive service at temperatures between -20° F & +1200° F
F9	9% Chrome & 1% Moly	A182	Corrosive, non-corrosive, or erosive service at temperatures between -20° F & +1200° F
F91	9% Chrome, 1% Moly, & V	A182	Corrosive, non-corrosive, or erosive service at temperatures between -20° F & +1200° F
F316	316	A182	Corrosive, cryogenic or high temperature service between -450° F & +1200° F

* Limitations are per 2004 Edition of ASME B16.34.

Trim Materials

The following are Newco's standard trim designations.

Newco Trim Number	Common Name	API 600 Trim No.	Seat Ring Facing (1)	Wedge or Disc Facing (1)	Stem	Other Trim Parts (2)	Service Limitations
1	13 Chrome	1	CR 13	CR 13	CR 13	CR 13	Non-corrosive applications. Steam, gas, & general service to 700° F. Oil & oil vapor to 900° F
2	Half Stellite	8	HF	CR 13	CR 13	CR 13	Steam, gas, & general service to 1000° F. Standard trim for gate valves
3	Full Stellite	5	HF	HF	CR 13	CR 13	Premium trim service to 1200° F. Excellent for high pressure water and steam service
4	316	10	316	316	316	316	Corrosive services to 850° F. Low temperature service standard for 316 SS valves
4/2	316/Half Stellite	12	HF	316	316	316	
4/3	316/Full Stellite	16	HF	HF	316	316	
5	Monel	9	NiCu	NiCu	NiCu	NiCu	Corrosive services to 750° F
5/2	Monel/Half Stellite	11	HF	NiCu	NiCu	NiCu	
5/3	Monel/Full Stellite	-	HF	HF	NiCu	NiCu	
6	Alloy 20	13	A20	A20	A20	A20	Corrosive services to 300° F
X	Special	Special	Special	Special	Special	Special	Customer to specify

(1) Facing is defined as the seating surface of a seat ring and wedge/disc

(2) Other trim parts are defined as small internal parts that are normally in contact with the service fluid. This includes the stem, etc. in gate and globe valves and the swing check disc nut

Newco Features and Benefits

- Material Test Reports
- International Organization for Standardization (ISO)
- Traceability
- Fugitive Emissions Tested
- API-598 Tested
- Major End-user Approved
- Ship from Multiple North American Locations
- Extensive Engineering Capabilities
- Excellent Customer Service
- Warranty
- Field Services for Start-up
- In-house Automation Capabilities

How to Order All Newco Products

Note: OIC and Cooper “How to Order” information can be found in their respective catalogs.

Figure Number

The figure number shown below identifies specific valve configuration details of Newco valves such as valve type, pressure class, end connections, body/bonnet & trim materials, and special features.

Please specify end connections, body materials, and trims not listed below.

When placing an order, please refer to the respective product section of the catalog for size availability. A detailed description must be included with any special orders.

Type	
1	= Gate, OS&Y
2	= Globe/Globe Stop Check, OS&Y
3	= Swing/Tilting Disc Check
4	= Piston Check
5	= Ball
6	= Gate, NRS
7	= Angle/Angle Stop Check, OS&Y

Pressure Class	
1	= 150
2	= 125
3	= 300
6	= 600
8	= 800
9	= 900
15	= 1500
16	= 1690
25	= 2500
26	= 2680
45	= 4500

End Connections	
F	= Flanged
J	= RTJ
S	= Socket Weld
T	= Threaded
W	= Butt Weld
X	= Threaded x Socket Weld

Trim Material	API Trim =
1 = CR13	1, 4, 8A
2 = CR13/HF**	8
3 = CR13/FHF**	5
4 = 316	10
4/2 = 316/HF**	12
4/3 = 316/FHF**	16
5 = Ni Cu (Monel***)	9
5/2 = Monel/HF**	11
6 = Alloy 20	13
7 = Bronze	N/A
A7 = Aluminum Bronze	N/A
8 = Iron	N/A
9 = Special (Customer to Specify)	

Fig. 18T-FS2_

Body/Bonnet Material	
A20 = ASTM A351, CN7M	= Cast Alloy 20
CB = ASTM A216, WCB	= Cast Carbon Steel
CC = ASTM A216, WCC	= Cast Carbon Steel
C5 = ASTM A217, C5	= Cast Alloy Steel (5% Chrome, .5% Moly)
C6 = ASTM A217, WC6	= Cast Alloy Steel (1.25% Chrome, .5% Moly)
C9 = ASTM A217, WC9	= Cast Alloy Steel (2.25% Chrome, 1% Moly)
C12 = ASTM A217, C12	= Cast Alloy Steel (9% Chrome, 1% Moly)
C12A = ASTM A217, C12A	= Cast Alloy Steel (9% Chrome, 1% Moly, V)
CF3 = ASTM A351, CF3	= Cast Stainless Steel
C3M = ASTM A351, CF3M	= Cast 316L Stainless Steel
CF8 = ASTM A351, CF8	= Cast 304 Stainless Steel
C7L = ASTM A351, CG3M	= Cast 317L Stainless Steel
C8M = ASTM A351, CF8M	= Cast 316 Stainless Steel
C8C = ASTM A351, CF8C	= Cast 347 Stainless Steel
CT = ASTM A351, CG8M	= Cast 317 Stainless Steel
DI = ASTM A395	= Cast Ductile Iron
FS = ASTM A105	= Forged Carbon Steel
F3M = ASTM A182, F316L	= Forged 316 Stainless Steel
F5 = ASTM A182, F5	= Forged Alloy Steel (5% Chrome, .5% Moly)
F7 = ASTM A182, 317	= Forged 317 Stainless Steel
F7L = ASTM A182, F317L	= Forged 317L Stainless Steel
F11 = ASTM A182, F11	= Forged Alloy Steel (1.25% Chrome, .5% Moly)
F22 = ASTM A182, F22	= Forged Alloy Steel (2.25% Chrome, 1% Moly)
F9 = ASTM A182, F9	= Forged Alloy Steel (9% Chrome, 1% Moly)
F91 = ASTM A182, F91	= Forged Alloy Steel (9% Chrome, 1% Moly, V)
F8 = ASTM A182, F304	= Forged 304 Stainless Steel
F8M = ASTM A182, F316	= Forged 316 Stainless Steel
F8C = ASTM A182, F321	= Forged 321 Stainless Steel
IB = ASTM A126, CLB	= Cast Iron
LCC = ASTM A352, LCC	= Cast Low Temperature Carbon Steel
LF2 = ASTM A350, LF2	= Forged Low Temperature Carbon Steel
MO = ASTM A414, M35	= Cast Ni Cu (Monel***)
SPL = Special (Customer to specify)	

Suffix Letters	
BP	= By Pass
BS	= Bellows Seal
CL	= Chlorine Service
CR	= Cryogenic Service
CW	= Chain Wheel
EB	= Extended Body
FP	= Full Port
FS	= Fire Safe
GI	= Grease Injection
GO	= Gear Operated
HB	= Horizontal Ball Check
HP	= Horizontal Piston Check
HO	= Hydraulic Operator
INT	= Integral Flanged
LD	= Locking Device
LL	= Locking Loop
LV	= Live Load Packing
MO	= Motor Operated
NC	= NACE MRO103 Compliant
OL	= Outside Weight & Lever
OX	= Oxygen Service
PO	= Pneumatic Operator
PS	= Pressure Seal Bonnet
PT	= PTFE Seats
QS	= QuadroSphere
RP	= Regular Port
SC	= Stop Check
SL	= Spring Loading
SPL	= Special (Customer to specify)
TD	= Tilting Disc Check
TF	= Teflon* Insert
TM	= Trunnion Mounted
VP	= Vertical Ball Check
VL	= Vertical Lift Check
VP	= V-Port Disc
VT	= Viton* Insert
WB	= Welded Bonnet
Y	= Y Pattern
*	= Viton and Teflon are registered trademarks of DuPont Company
**HF	= Hardfaced - AWS 5.13 Class C ₀ C ₁ A
***	= Monel is a registered trademark of International Nickel Company

Newco®

Forged Steel Bolted & Welded Bonnet Gate Valves

Manufactured by Newmans™

Sizes: 1/4" thru 3" • Pressure Class: 150 thru 4500



Typical Newco Forged Steel Bolted & Welded Bonnet Gate Valve Expanded View

1. Handwheel Nut: The handwheel nut secures the handwheel to the bonnet assembly.

2. Handwheel: The handwheel cycles the valve.

3. Stem Nut: The stem nut provides a precision guide for proper stem alignment.

4. & 11. Gland Bolts & Nuts: The gland bolt and nut allows for easy adjustments for packing compression.

5. Stuffing Box: The stuffing box contains the packing.

6. Bonnet Bolts: The bonnet bolts secure the bonnet to the body.

7. Yoke & Bonnet: Newco bonnet assemblies are built to the same standards as the bodies. Larger size gate valves utilize a multi-piece bonnet design.

8. Bonnet Gasket: The bonnet gasket creates a leakproof seal between the bonnet and body.

9. Body: Newco forged steel bodies provide low resistance flow and optimum strength and performance.

10. Seat Rings: To ensure a stable shutoff, seat rings are aligned and swaged into the valve, then precision ground for optimal seating.

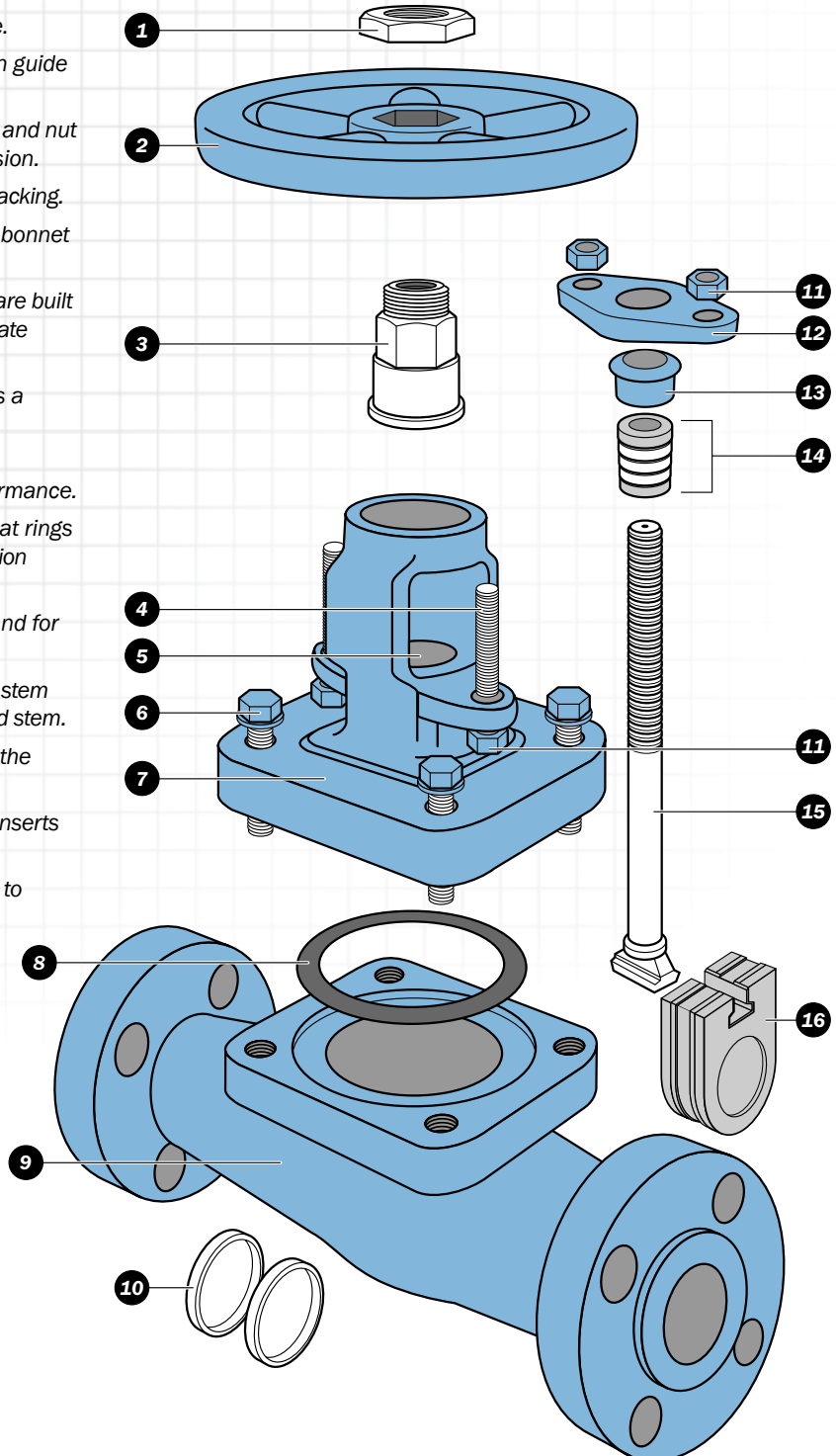
12. Gland Flange: Applies pressure to the gland for accurate packing adjustments.

13. Gland: Compresses the packing to create a stem seal above the back seat, between the bonnet and stem.

14. Packing: The packing creates a seal above the back seat, between the bonnet and stem.

15. Stem: The stem is precision machined and inserts into the horizontal channel in the disc.

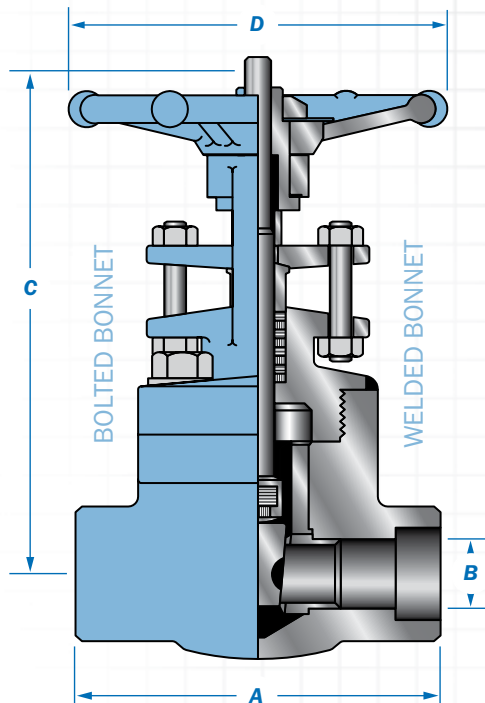
16. Wedge: Newmans solid wedge is machined to the tightest tolerances to ensure trouble free shutoff and cycling.



Forged Steel Bolted & Welded Bonnet Gates
Threaded, Socket Weld & Buttweld Ends
Conventional Port
Class 800 thru 2500
Sizes: 1/4" thru 3"

Design and Manufacturing Standards

Valve Design: API 602
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding & Threaded: ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*



Class 800 thru 2500
Bolted & Welded Bonnet Gates

Size in. mm	Class 800 WB					Class 800 BB														
	A		B		C		D		Wt.		A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/4	3.1	0.31	5.7	3.1	3.5	3.1	0.31	5.7	3.1	3.9										
6	80	8	145	80	1.6	80	8	145	80	1.8										
3/8	3.1	0.39	5.7	3.1	3.5	3.1	0.39	5.7	3.1	3.9										
9	80	10	145	80	1.6	80	10	145	80	1.8										
1/2	3.2	0.39	0.39	5.7	4.9	3.2	3.3	3.2	3.1	3.2	3.1	0.39	0.39	5.7	4.9	3.2	3.3	3.9	3.1	
15	80	78.7	10	10	145	124.5	80	83.8	1.6	1.4	80	78.7	10	10	145	124.5	80	83.8	1.8	1.4
3/4	3.5	3.6	0.55	0.55	6.1	5.2	3.2	3.3	4.4	3.7	3.5	3.6	0.55	0.55	6.1	5.2	3.2	3.3	4.6	3.7
20	90	91.4	14	14	155	132.1	80	83.8	2	1.7	90	91.4	14	14	155	132.1	80	83.8	2.1	1.7
1	4.3	4.4	0.71	0.71	7.3	6.7	3.9	4.7	7.1	6.6	4.3	4.4	0.71	0.71	7.3	6.7	3.9	4.7	7.9	6.6
25	110	111.8	18	18	185	170.2	100	119.4	3.2	3	110	111.8	18	18	185	170.2	100	119.4	3.6	3
1-1/4	5.0	4.7	0.95	0.95	8.6	7.6	4.7	5.9	10.7	11	5.0	4.7	0.95	0.95	8.6	7.6	4.7	5.9	11.2	11
32	127	119.4	24	24	218	193	120	149.9	4.8	5	127	119.4	24	24	218	193	120	149.9	5.3	5
1-1/2	5.0	4.7	1.22	1.22	10.0	8.3	5.5	5.9	14.3	12.3	5.0	4.7	1.22	1.22	10.0	8.3	5.5	5.9	15.4	12.3
40	127	119.4	30	30	255	210.8	140	149.9	6.5	5.6	127	119.4	30	30	255	210.8	140	149.9	7.5	5.6
2	5.1	5.5	1.44	1.44	10.9	9.3	5.5	6.7	18.7	20.3	5.1	5.5	1.44	1.44	10.9	9.3	5.5	6.7	20.0	20.3
50	130	139.7	36.5	36.5	277	236.2	140	170.2	8.5	9.2	130	139.7	36.5	36.5	277	236.2	140	170.2	9.8	9.2
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	184.2	53.98	393.7	285.8	11.3	56				
Size in. mm	Class 1500 WB					Class 1500 BB														
	A		B		C		D		Wt.		A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	3.5	4.4	0.39	0.55	6.07	7.8	3.2	4.9	5.0	9	3.5	4.4	0.39	0.55	6.07	7.8	3.2	4.9	5.5	9
15	90	111.8	10	13.97	152	198.1	80	124.5	2.2	4.1	90	111.8	10	13.97	152	198.1	80	124.5	2.5	4.1
3/4	4.3	4.4	0.55	0.55	7.1	7.8	3.9	4.9	8.4	9.5	4.3	4.4	0.55	0.55	7.1	7.8	3.9	4.9	8.4	9.5
20	110	111.8	14	13.97	180	198.1	100	124.5	3.6	4.3	110	111.8	14	13.97	180	198.1	100	124.5	3.8	4.3
1	4.7	4.5	0.75	0.71	8.6	8.6	4.7	6.2	12.6	13.5	4.7	4.5	0.75	0.71	8.6	8.6	4.7	6.2	11.9	13.5
25	120	114.3	18	18.03	218	218.4	120	157.5	5.2	6.1	120	114.3	18	18.03	218	218.4	120	157.5	5.4	6.1
1-1/4	5.1	4.7	0.95	0.95	9.8	9.3	5.5	6.2	14.6	19.2	5.1	4.7	0.95	0.95	9.9	9.3	5.5	6.2	17.6	19.2
32	130	119.4	24	24.13	250	236.2	140	157.5	7.5	8.7	130	119.4	24	24.13	252	236.2	140	157.5	8	8.7
1-1/2	5.1	5.5	1.16	1.14	10.8	10.8	5.5	7	22.0	26.9	5.1	5.5	1.16	1.14	10.8	10.8	5.5	7	22.4	26.9
40	130	139.7	29	28.95	275	274.3	140	177.8	10	12.2	130	139.7	29	28.95	275	274.3	140	177.8	10	12.2
2	5.9	6.4	1.44	1.44	12.6	12.6	6.7	7.9	33.0	39	5.9	6.4	1.44	1.44	12.6	12.6	6.7	7.9	33.0	39
50	150	162.6	36.5	36.57	320	320.0	170	200.7	14.5	17.7	150	162.6	37	36.57	320	320.0	170	200.7	15	17.7
Size in. mm	Class 2500 WB					Class 2500 BB														
	A		B		C		D		Wt.		A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	4.3	5.9	0.39	0.39	6.9	9.5	3.9	6.3	7.7	27.1	4.3	5.9	0.39	0.39	8.3	9.5	3.9	6.3	12.1	27.1
15	110	149.9	10	9.9	175	241.3	100	160	3.5	12.3	110	149.9	9.9	9.9	210	241.3	100	160	5.5	12.3
3/4	4.7	5.9	0.55	0.55	8.3	9.5	4.7	6.3	12.1	26.6	4.7	5.9	0.55	0.55	10.0	9.5	4.7	6.3	18.7	26.6
20	120	149.9	14	13.97	210	241.3	120	160	5.5	12.1	120	149.9	13.97	13.97	255	241.3	120	160	8.5	12.1
1	5.1	6.7	0.75	0.71	9.4	10.8	5.5	7.1	16.5	26	5.1	6.7	0.75	0.71	10.4	10.8	5.5	7.1	22.4	26
25	130	170.2	18	18.03	240	274.3	140	180.3	7.5	11.8	130	170.2	19.05	18.03	265	274.3	140	180.3	10.2	11.8
1-1/4	5.1	8.7	0.95	0.95	11.0	13.1	6.7	7.8	22	46	8.3	8.7	0.95	0.95	14.4	13.1	6.7	7.8	57.2	46
32	130	220.9	24	24.13	280	332.7	170	198.1	10	20.9	210	220.9	24.13	24.13	365	332.7	170	198.1	26	20.9
1-1/2	8.3	8.7	1.16	1.14	12.2	13.1	6.7	7.8	35.2	60.5	8.3	8.7	1.16	1.14	14.8	13.1	6.7	7.8	57.2	60.5
40	210	220.9	29	28.95	310	332.7	170	198.1	16	27.5	210	220.9	29.46	28.95	375	332.7	170	198.1	26	27.5
2	9.4	9.8	1.44	1.44	14	16.8	10.2	11.8	55	117.3	9.4	9.8	1.44	1.44	15.4	16.8	10.2	11.8	81.4	117.3
50	240	248.9	36.5	36.57	355	426.7	260	299.7	25	53.3	240	248.9	36.57	36.57	390	426.7	260	299.7	37	53.3

Typical Bill of Materials (See page 12 for available materials.)

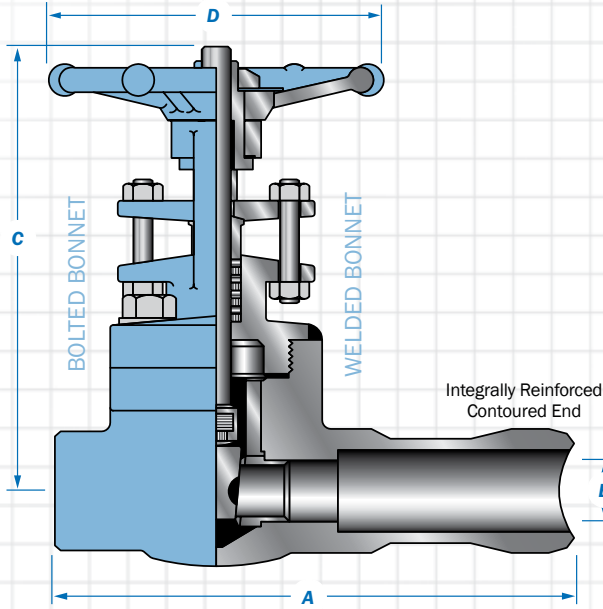
Component	Material	ASTM Spec	Component	Material	ASTM Spec
Body	Carbon Steel	A105N	Handwheel Nut	Carbon Steel	Commercial
Bonnet	Carbon Steel	A105N	Nameplate	Aluminum	Commercial
* Packing	Graphite W/Braided Carbon Fiber End Rings		Handwheel	Carbon Steel	A105N
* Gasket	Stainless Steel 316 Graphite		Yoke Sleeve	Stainless Steel	AISI 416
Stem	Stainless Steel	A479-410	Gland Nuts	Carbon Steel	A194 2H
Wedge	Stainless Steel	13 Chrome	Gland Flange	Carbon Steel	A105N
Seat Rings	Stainless Steel	A479-410	Gland Studs	Stainless Steel	AISI 410
Bonnet Bolt	Alloy Steel	A193 B7	Packing Gland	Stainless Steel	A479-316

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Dimensions are subject to change without notice.

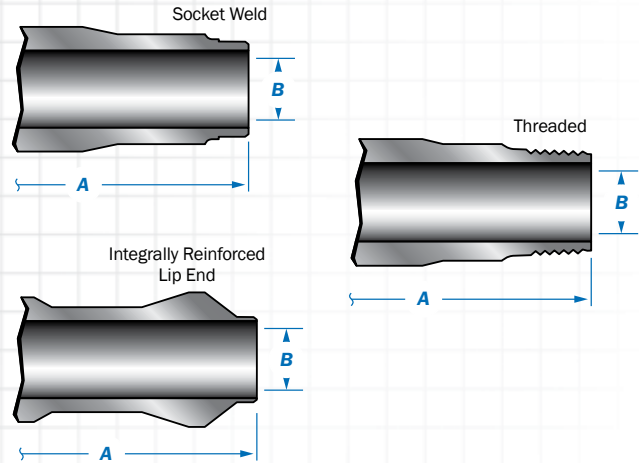
Forged Steel Extended Body Gates
Bolted & Welded Bonnet
Conventional Port
Class 800 thru 1500
Sizes: 1/2" thru 2"

Design and Manufacturing Standards

Valve Design: API 602
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding : ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*



Available Ends



Class 800 & 1500 Extended Body - Bolted & Welded Bonnet Gate

Size in. mm	Class 800 IR Contoured End					Class 800 IR - Lip End					Class 800 Threaded					Class 800 Socket Weld								
	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.				
	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	8.6	0.39	5.9	3.2	6	8.6	0.39	5.9	3.2	6	5.6	0.39	6.4	3.1	5.7	5.6	0.39	6.4	3.1	5.7				
15	207	9.9	150	81	3	207	9.9	150	81	3	141.5	10	162	80	2.6	141.5	10	162	80	2.6				
3/4	8.6	0.55	6.1	3.2	7	8.6	0.55	6.1	3.2	7	5.8	0.55	7.3	3.9	6.4	5.8	0.55	7.3	3.9	6.4				
20	218	13.9	155	81	3	218	13.9	155	81	3	146.5	14	185	100	2.9	146.5	14	185	100	2.9				
1	9.6	0.71	7.3	3.9	10	9.6	0.71	7.3	3.9	10	6.5	0.7	7.6	3.9	9.5	6.5	0.7	7.6	3.9	9.5				
25	245	18	185	99	5	245	18	185	99	5	166	18	192	100	4.3	166	18	192	100	4.3				
1-1/2	10.4	1.14	10.2	5.5	19	10.4	1.14	10.2	5.5	19	7.5	1.14	10	5.5	19.4	7.5	1.14	10	5.5	19.4				
40	263	28.9	259	140	9	263	28.9	259	140	9	191	29	255	140	8.8	191	29	255	140	8.8				
2	11.4	1.44	10.8	5.5	29	11.4	1.44	10.8	5.5	29	8.5	1.44	10.7	6.7	28.6	8.5	1.44	10.7	6.7	28.6				
50	289	36.6	274	140	13	289	36.6	274	140	13	216	36.5	273	170	13	216	36.5	273	170	13				
Size in. mm	Class 1500 Re-Out-Forced					Class 1500 Re-In Forced					Class 1500 Threaded					Class 1500 Socket Weld								
	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.				
	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	8.6	0.39	5.4	3.2	6	8.6	0.39	5.4	3.2	6	5.7	0.39	6.5	3.2	6.4	5.7	0.39	6.5	3.2	6.4				
15	218	9.9	138	80	3	218	9.9	138	80	3	146	10	165	80	2.9	146	10	165	80	2.9				
3/4	9.6	0.55	6.3	3.9	10	9.6	0.55	6.3	3.9	10	6.5	0.55	7.1	3.9	9.5	6.5	0.55	7.1	3.9	9.5				
20	245	13.9	161	100	5	245	13.9	161	100	5	166	14	180	100	4.3	166	14	180	100	4.3				
1	10.4	0.75	8.6	4.7	15	10.4	0.75	8.6	4.7	15	7.5	0.7	9.4	5.5	19.4	7.5	0.7	9.4	5.5	19.4				
25	264	19	218	120	7	264	19	218	120	7	191	18	240	140	8.8	191	18	240	140	8.8				
1-1/2	10.5	1.16	9.4	5.5	25	10.5	1.16	9.4	5.5	25	8.5	1.14	10.6	6.7	29.7	8.5	1.14	10.6	6.7	29.7				
40	267	29.5	238	140	11	267	29.5	238	140	11	216	29	270	170	13.5	216	29	270	170	13.5				
2	12.8	1.44	10.9	6.7	35	12.8	1.44	10.9	6.7	35	9.8	1.44	12.6	10.2	41.1	9.8	1.44	12.6	10.2	41.1				
50	325	36.6	276	170	16	325	36.6	276	170	16	250	36.5	320	260	18.7	250	36.5	320	260	18.7				

Typical Bill of Materials (See page 12 for available materials.)

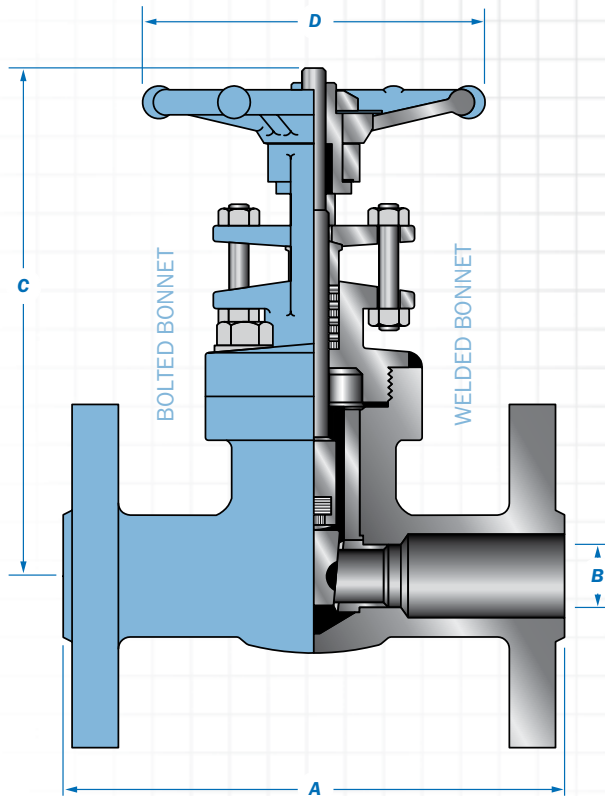
Component	Material	ASTM Spec	Component	Material	ASTM Spec
Body	Carbon Steel	A105N	Handwheel Nut	Carbon Steel	Commercial
Bonnet	Carbon Steel	A105N	Nameplate	Aluminum	Commercial
* Packing	Graphite W/Braided Carbon Fiber End Rings		Handwheel	Carbon Steel	A105N
* Gasket	Stainless Steel 316 Graphite		Yoke Sleeve	Stainless Steel	AISI 416
Stem	Stainless Steel	A479-410	Gland Nuts	Carbon Steel	A194 2H
Wedge	Stainless Steel	13 Chrome	Gland Flange	Carbon Steel	A105N
Seat Rings	Stainless Steel	A479-410	Gland Studs	Stainless Steel	AISI 410
Bonnet Bolt	Alloy Steel	A193 B7	Packing Gland	Stainless Steel	A479-316

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Dimensions are subject to change without notice.

**Forged Steel Flanged End Gates
Bolted & Welded Bonnet
Conventional Port
Class 150 thru 1500
Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)**

Design and Manufacturing Standards

Valve Design: API 602
Flange Dimensions: ASME B16.5
Face-to-Face Dimensions: ASME B16.10
Tested in Accordance with: API 598
Recommended Spare Parts*



**Class 150 thru 1500
Bolted & Welded Bonnet Flanged Gates**

Size in. mm	Class 150 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	4.3	0.39	0.39	6.8	4.9	3.2	6.8	6.6		
15	108	10	10	173	125	80	3.1	3		
3/4	4.6	0.55	0.55	7.1	5.2	3.2	8.6	7.7		
20	118	14	14	180	132	80	4	3.5		
1	5.0	0.71	0.71	8.1	6.7	4.0	12.1	12.1		
25	127	18	18	205	170	100	5.7	5.5		
1-1/4	5.5	0.94	0.95	9.3	7.6	4.8	18.1	15		
32	140	24	24	235	193	120	8.2	6.8		
1-1/2	6.5	1.22	1.14	10.2	8.3	5.5	23.4	22.9		
40	165	30	29	260	211	140	10.5	10.4		
2	7.0	1.44	1.44	11.7	9.3	5.5	32.0	31.7		
50	178	37	37	296	236	170	15.4	14.4		
Size in. mm	Class 300 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	5.5	0.39	0.39	6.9	4.9	3.2	7.3	7.9		
15	140	10	10	174	125	80	4	3.6		
3/4	6.0	0.55	0.55	7.1	5.2	3.2	10.8	10.8		
20	153	14	14	180	132	80	5.4	4.9		
1	6.5	0.71	0.71	8.1	6.7	3.9	14.7	15.4		
25	165	18	18	205	170	100	6.5	7		
1-1/4	7.0	0.94	0.95	10.2	7.6	4.7	21.1	20.7		
32	178	24	24	260	193	140	12.5	9.4		
1-1/2	7.5	1.22	1.14	10.4	8.3	5.5	29.5	29.3		
40	191	30	29	265	211	140	13	13.3		
2	8.5	1.44	1.44	11.7	9.3	6.7	35.9	39.6		
50	216	37	37	296	236	170	17.5	18		
Size in. mm	Class 600 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	6.5	0.39	0.39	5.7	4.9	3.2	7.7	9.2		
15	165	10	10	145	125	80	4.2	4.2		
3/4	7.5	0.55	0.55	6.1	5.2	3.2	11.7	12.8		
20	191	14	14	155	132	80	5.6	5.8		
1	8.5	0.71	0.71	7.3	6.7	4.0	15.7	19.4		
25	216	18	18	185	170	100	7.2	8.8		
1-1/4	9.0	1.14	0.95	9.8	7.6	5.5	30.9	26.6		
32	229	29	24	248	193	140	14.5	12.1		
1-1/2	9.5	1.22	1.14	9.8	8.3	5.5	30.9	34.3		
40	241	30	29	248	211	140	14.5	15.6		
2	11.5	1.44	1.44	10.7	9.3	5.6	40.8	34.3		
50	292	37	37	273	236	170	18	19.5		
Size in. mm	Class 1500 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	8.5	0.55	0.55	8.3	7.8	3.9	22	9		
15	216	14	14	210	198	100	10	4		
3/4	9	0.71	0.55	10.0	7.8	4.7	33	9.5		
20	229	18	14	255	198	120	15	4.3		
1	10	0.94	0.71	10.8	8.6	5.5	37.4	13.5		
25	254	24	18	275	218	140	17	6		
1-1/4	-	-	0.95	-	9.3	-	-	19.2		
32	-	-	24	-	236	-	-	8.7		
1-1/2	12	1.44	1.14	15	10.8	6.8	77	26.9		
40	305	36.5	29	380	274	172	35	12		
2	14.5	1.57	1.44	15.3	12.6	10.2	121	39		
50	368	40	37	388	320	260	55	17.7		

Typical Bill of Materials (See page 12 for available materials.)

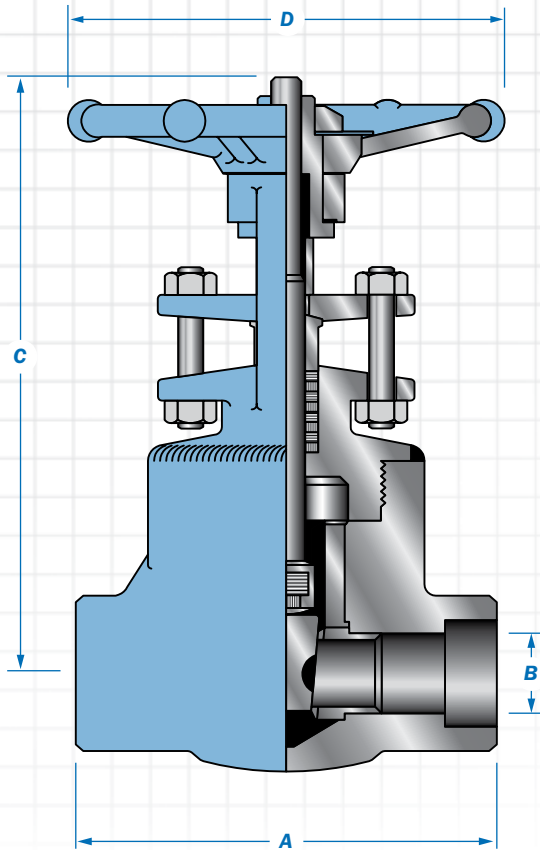
Component	Material	ASTM Spec
Body	Carbon Steel	A105N
Bonnet	Carbon Steel	A105N
* Packing	Graphite W/Braided Carbon Fiber End Rings	
* Gasket	Stainless Steel 316 Graphite	
Stem	Stainless Steel	A479-410
Wedge	Stainless Steel	13 Chrome
Seat Rings	Stainless Steel	A479-410
Bonnet Bolt	Alloy Steel	A193 B7
Handwheel Nut	Carbon Steel	Commercial
Nameplate	Aluminum	Commercial
Handwheel	Carbon Steel	A105N
Yoke Sleeve	Stainless Steel	AISI 416
Gland Nuts	Carbon Steel	A194 2H
Gland Flange	Carbon Steel	A105N
Gland Studs	Stainless Steel	AISI 410
Packing Gland	Stainless Steel	A479-316

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

**Forged Steel High Pressure
Welded Bonnet Gate
Conventional Port
Class 4500
Sizes: 1/2" thru 2"**

Design and Manufacturing Standards

Valve Design: ASME B16.34
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding: ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*



**Class 4500
Welded Bonnet Gate**

Size	A	B	C	D	Wt.
1/2	4.7	0.47	10.4	5.5	17.6
15	120	12	265	140	8
3/4	5.1	0.47	10.4	5.5	19.8
20	130	12	265	140	9
1	5.1	0.47	10.4	6.7	19.8
25	130	12	265	170	9
1-1/4	8.3	0.63	12.4	6.7	31.9
32	210	16	315	170	14.5
1-1/2	8.3	0.63	12.4	10.2	33
40	210	16	315	260	15
2	9.4	0.83	15.4	10.2	41.8
50	240	21	390	260	19

Typical Bill of Materials (See page 12 for available materials.)

Component	Material	ASTM Spec
Body	Carbon Steel	A105N
Bonnet	Carbon Steel	A105N
* Packing	Graphite W/Braided Carbon Fiber End Rings	
* Gasket	Stainless Steel 316 Graphite	
Stem	Stainless Steel	A479-410
Wedge	Stainless Steel	13 Chrome
Seat Rings	Stainless Steel	A479-410
Bonnet Bolt	Alloy Steel	A193 B7
Handwheel Nut	Carbon Steel	Commercial
Nameplate	Aluminum	Commercial
Handwheel	Carbon Steel	A105N
Yoke Sleeve	Stainless Steel	AISI 416
Gland Nuts	Carbon Steel	A194 2H
Gland Flange	Carbon Steel	A105N
Gland Studs	Stainless Steel	AISI 410
Packing Gland	Stainless Steel	A479-316

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

Newco[®]

Forged Steel Bolted & Welded Bonnet Globe Valves

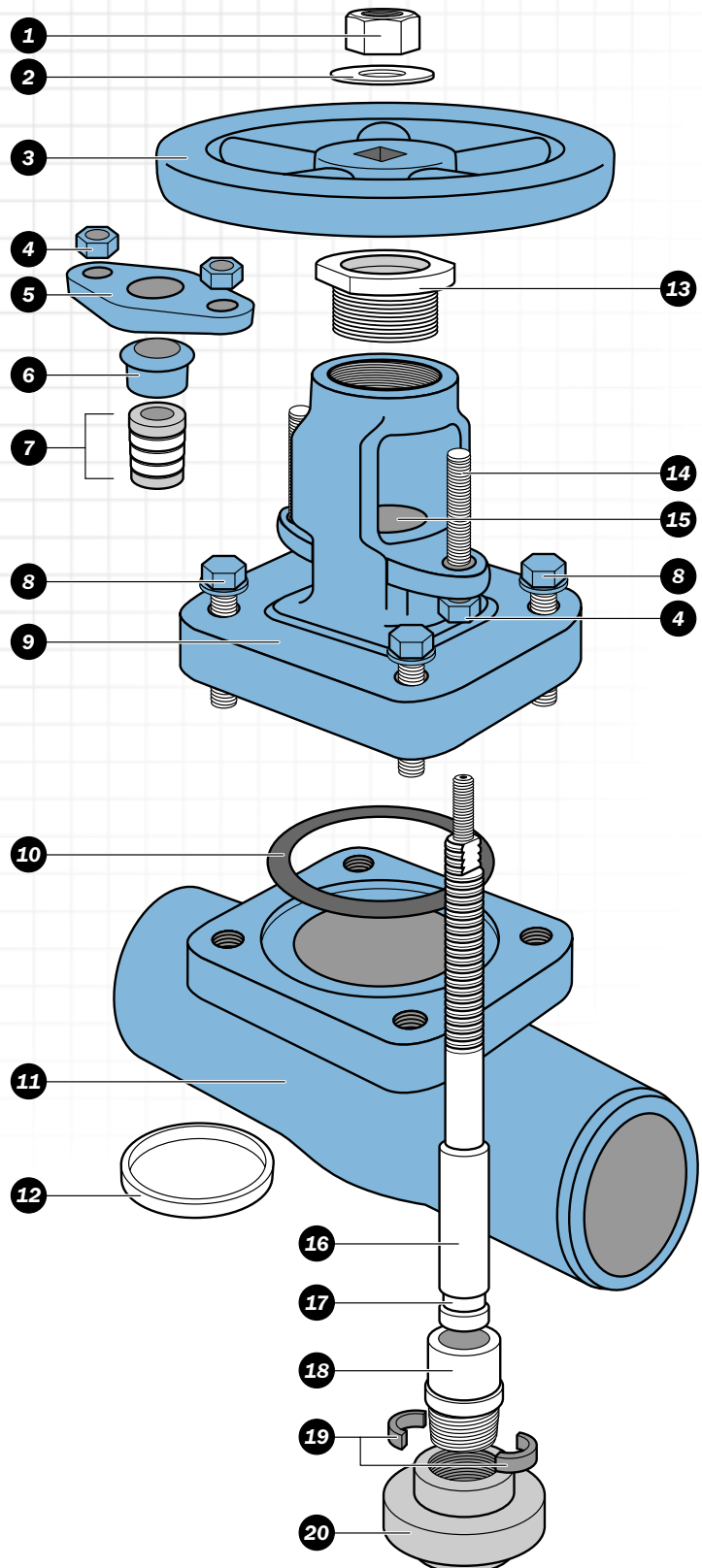
Manufactured by Newmans™

Sizes: 1/2" thru 2" • Pressure Class: 150 thru 4500



Typical Newco Forged Steel Bolted & Welded Bonnet Globe Valve Expanded View

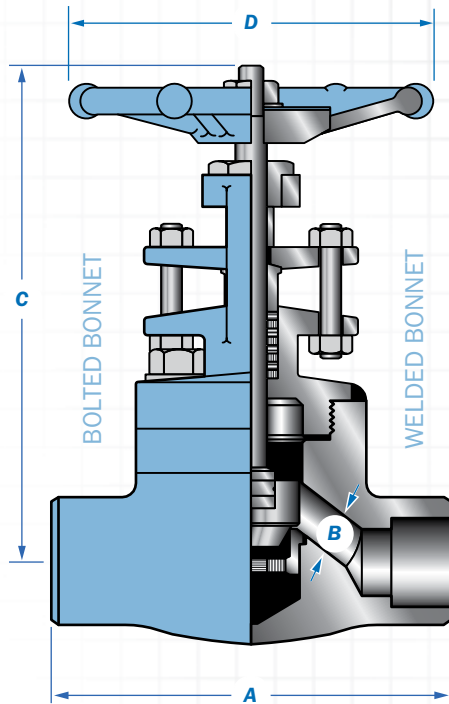
- 1. Handwheel Nut:** The handwheel nut secures the handwheel to the bonnet assembly.
- 2. Handwheel Washer:** The washer helps to prevent loosening.
- 3. Handwheel:** The handwheel cycles the valve.
- 4. & 14. Gland Bolts & Nuts:** The gland bolt and nut allows for easy adjustments for packing compression.
- 5. Gland Flange:** Applies pressure to the gland for accurate packing compression.
- 6. Gland:** Compresses the packing to create a stem seal above the back seat, between the bonnet and stem.
- 7. Packing:** The packing creates a seal above the back seat, between the bonnet and stem.
- 8. Bonnet Bolts:** The bonnet bolts secure the bonnet to the body.
- 9. Bonnet:** Newco bonnet assemblies are built to the same standards as the bodies.
- 10. Bonnet Gasket:** The bonnet gasket creates a leakproof seal between the bonnet and body.
- 11. Body:** Newco forged steel bodies provide low resistance flow and optimum strength and performance
- 12. Seat Ring:** To ensure a stable shutoff, the seat ring is aligned into the valve, then precision ground for optimal seating.
- 13. Stem Nut:** The stem nut provides a precision guide for proper stem alignment.
- 15. Stuffing Box:** The stuffing box contains the packing.
- 16. Stem:** The stem inserts vertically into the disc.
- 17. Lock Groove:** The lock groove receives the split lock ring which allows the disc nut to lift the disc during cycling.
- 18. Disc Nut:** The disc nut, in conjunction with the split lock ring, secures the disc to the stem.
- 19. Split Ring:** The split ring allows the disc nut to lift the disc during cycling.
- 20. Disc:** Newmans plug type disc is machined to the tightest tolerances to ensure trouble free shutoff and cycling.



Forged Steel Bolted & Welded Bonnet Globes
Threaded, Socket Weld & Buttweld Ends
Conventional Port
Class 800 thru 2500
Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)

Design and Manufacturing Standards

Valve Design: API 602
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding: ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*



Class 800 thru 1500
Bolted & Welded Bonnet Globes

Size	Class 800 WB						Class 800 BB													
	A		B		C		D		Wt.		A		B		C		D		Wt.	
in.	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	3.2	3.1	0.35	6.3	5.2	3.2	3.3	4	2.9	3.2	3.1	0.35	6.3	5.2	3.2	3.3	4	2.9	3.2	3.1
15	80	78.7	9	160	132.1	80	83.8	1.8	1.3	80	78.7	9	160	132.1	80	83.8	1.8	1.3	80	78.7
3/4	3.5	3.6	0.49	6.7	5.4	3.2	3.3	4.4	3.7	3.5	3.6	0.49	6.7	5.4	3.2	3.3	4.4	3.7	3.5	3.6
20	90	91.4	12.5	170	137.2	80	83.8	2	1.7	90	91.4	12.5	170	137.2	80	83.8	2	1.7	90	91.4
1	4.3	4.4	0.68	7.9	7	3.9	4.7	7.3	6.4	4.3	4.4	0.68	7.9	7	3.9	4.7	7.3	6.4	4.3	4.4
25	110	111.8	17.5	200	177.8	100	119.4	3.3	2.9	110	111.8	17.5	200	177.8	100	119.4	3.3	2.9	110	111.8
1-1/4	5	4.7	0.88	9.3	8.3	4.7	5.9	11.9	15.9	5	4.7	0.88	9.3	8.3	4.7	5.9	11.9	15.9	5	4.7
32	127	119.4	22.5	235	210.8	120	149.9	5.4	7.2	127	119.4	22.5	235	210.8	120	149.9	5.4	7.2	127	119.4
1-1/2	6.1	6	1.14	9.3	8.4	5.5	5.9	17.4	14.9	6.1	6	1.14	9.3	8.4	5.5	5.9	17.4	14.9	6.1	6
40	155	152.4	29	270	213.4	140	149.9	7.9	6.8	155	152.4	29	270	213.4	140	149.9	7.9	6.8	155	152.4
2	6.7	6.8	1.37	11.4	10.3	6.7	6.7	23.8	23.4	6.7	6.8	1.37	11.4	10.3	6.7	6.7	23.8	23.4	6.7	6.8
50	170	172.7	35	290	261.6	170	170.2	10.8	10.6	170	172.7	35	290	261.6	170	170.2	10.8	10.6	170	172.7
Size	Class 1500 WB						Class 1500 BB													
in.	A		B		C		D		Wt.		A		B		C		D		Wt.	
mm	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	3.5	4.4	0.35	0.39	6.5	8.1	3.2	4.9	4.2	4.4	3.5	4.4	0.35	0.39	6.5	8.1	3.2	4.9	4.4	4.4
15	90	111.8	9	9.9	165	205.7	80	124.5	1.9	2	90	111.8	9	9.9	165	205.7	80	124.5	2	2
3/4	4.3	4.4	0.43	0.51	7.7	8.1	4.7	4.9	7	8.4	4.3	4.4	0.43	0.51	7.7	8.1	4.7	4.9	7.3	8.4
20	110	111.8	11	12.95	195	205.7	120	124.5	3.2	3.8	110	111.8	11	12.95	195	205.7	120	124.5	3.3	3.8
1	4.7	5.1	0.57	0.66	9.3	9.4	5.5	6.2	12.1	9.3	4.7	5.1	0.57	0.66	9.1	9.4	5.5	6.2	12.1	9.3
25	120	129.5	14.5	16.76	235	238.8	140	157.5	5.5	4.2	120	129.5	14.5	16.76	230	238.8	140	157.5	5.5	4.2
1-1/4	5.1	5.9	0.75	0.9	10.4	10.2	5.5	6.2	17.6	17.6	5.1	5.9	0.75	0.9	10.2	10.2	5.5	6.2	19.8	17.6
32	130	149.9	19	22.86	265	259.1	140	157.5	8	8	130	149.9	19	22.86	260	259.1	140	157.5	9	8
1-1/2	6.7	6.8	1.06	1.18	11	11.4	6.7	6.2	24.2	29.1	6.7	6.8	1.06	1.18	11.2	11.4	6.7	6.2	26.4	29.1
40	170	172.7	27	29.97	280	289.6	170	157.5	11	13.2	170	172.7	27	29.97	285	289.6	170	157.5	12	13.2
2	8.3	8.7	1.22	1.49	13.2	13.3	6.7	7.1	39.6	37	8.3	8.7	1.22	1.49	13	13.3	6.7	7.1	39.6	37
50	210	220.9	31	37.85	335	337.8	170	180.3	18	16.8	210	220.9	31	37.85	330	337.8	170	180.3	18	16.8
Size	Class 2500 WB						Class 2500 BB													
in.	A		B		C		D		Wt.		A		B		C		D		Wt.	
mm	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45
1/2	4.3	0.43	7.7	4.7	8.6	4.3	0.43	10.6	4.7	11										
15	110	11	195	120	3.9	110	11	270	120	5										
3/4	4.7	0.55	8.9	5.5	14.1	4.7	0.55	10.8	5.5	17.6										
20	120	14	225	140	6.4	120	14	275	140	8										
1	5.1	0.75	10	5.5	19.9	5.1	0.75	11.4	5.5	23.5										
25	130	19	255	140	9	130	19	290	140	10.7										
1-1/4	8.3	0.94	12.8	6.7	44	8.3	0.94	15.4	6.7	52.8										
32	210	24	325	170	20	210	24	390	170	24										
1-1/2	8.3	1.1	13	6.7	48.4	8.3	1.1	16.3	10.2	70.4										
40	210	28	330	170	22	210	28	415	260	32										
2	9.5	1.42	14.6	10.2	61.6	9.5	1.42	16.7	10.2	81.4										
50	240	36	370	260	28	240	36	425	260	37										

Typical Bill of Materials (See page 12 for available materials.)

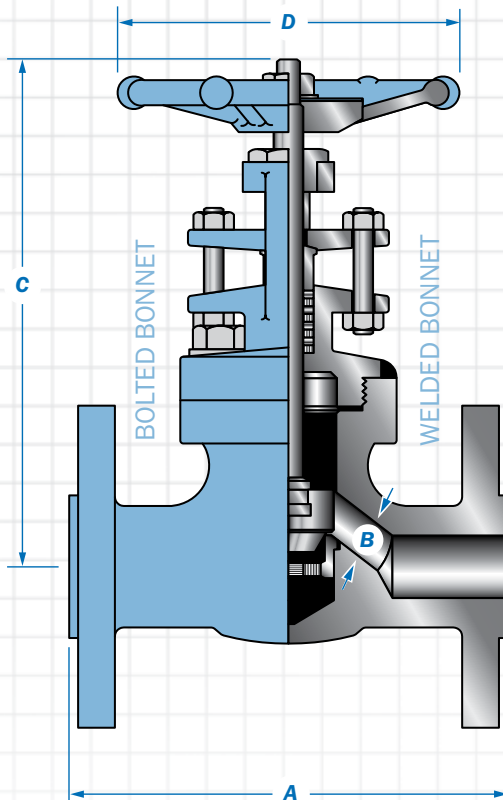
Component	Material	ASTM Spec	Component	Material	ASTM Spec
Body	Carbon Steel	A105N	Handwheel Nut	Carbon Steel	Commercial
Bonnet	Carbon Steel	A105N	Nameplate	Aluminum	Commercial
* Packing	Graphite W/Braided Carbon Fiber End Rings		Handwheel	Carbon Steel	Commercial
* Gasket	Stainless Steel 316 Graphite		Yoke Sleeve	Stainless Steel	AISI 416
Stem	Stainless Steel	A479-410	Gland Nuts	Carbon Steel	A194 2H
Disc	Stainless Steel	13 Chrome	Gland Flange	Carbon Steel	A105N
Seat Rings	Stainless Steel	A479-410	Gland Studs	Stainless Steel	AISI 410
Bonnet Bolt	Alloy Steel	A193 B7	Packing Gland	Stainless Steel	AISI 416
Washer	Carbon Steel	Commercial			

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

Forged Steel Flanged End Globes
Bolted & Welded Bonnet
Conventional Port
Class 150 thru 1500
Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)

Design and Manufacturing Standards

Valve Design: API 602
Flange Dimensions: ASME B16.5
Face-to-Face Dimensions: ASME B16.10
Tested in Accordance with: API 598
Recommended Spare Parts*



Class 150 thru 1500
Bolted & Welded Bonnet Flanged Globes

Size in. mm	Class 150 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	4.25	0.35	0.39	7.3	6.8	3.1	7	9.9		
15	108	9	9.9	185	173	80	3.1	4.5		
3/4	4.63	0.47	0.39	7.6	7.0	3.1	8	15.2		
20	118	12.5	9.9	192	178	80	4	6.9		
1	5.00	0.67	0.69	8.7	8.3	4.0	17	21.6		
25	127	17.5	17.5	220	211	100	5.7	9.8		
1-1/2	6.50	1.10	1.18	10.4	9.2	5.5	25	42.9		
40	165	29	30	265	234	140	10.6	19.5		
2	8.00	1.34	1.46	12.2	10.4	6.7	35	61.6		
50	203	35	37.1	310	264	170	15.4	28		
Size in. mm	Class 300 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	6.00	0.35	0.39	6.3	6.26	3.1	8	10.6		
15	152.5	9	9.9	160	159	80	3.5	4.8		
3/4	7.00	0.47	0.39	6.6	6.26	3.1	11	16.9		
20	178	12.5	9.9	168	159	80	4.8	7.7		
1	8.00	0.67	0.69	7.9	7.6	4.0	15	24.2		
25	203	17.5	17.5	200	193	100	7.2	11		
1-1/2	9.00	1.10	1.18	10.6	9.2	5.5	30	46.6		
40	229	29	30	268	234	140	14.5	21.2		
2	10.5	1.34	1.46	11.4	10.4	6.7	40	71.7		
50	267	35	37.1	290	264	170	18	32.6		
Size in. mm	Class 600 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	6.50	0.35	0.39	6.3	6.26	3.1	8.2	12.3		
15	165	9	9.9	160	159	80	3.7	5.6		
3/4	7.50	0.47	0.39	6.6	6.26	3.1	11.7	17.2		
20	190.5	12.5	9.9	168	159	80	5.3	7.8		
1	8.50	0.67	0.69	7.9	7.6	4.0	18.1	27.5		
25	216	17.5	17.5	200	193	100	8.2	12.5		
1-1/2	9.51	1.10	1.18	10.6	8.7	5.5	33.1	51.7		
40	241.5	29	30	268	221	140	15	23.5		
2	11.5	1.34	1.46	11.4	10.4	6.7	47.4	85.4		
50	292	35	37.1	290	264	170	21.5	38.8		
Size in. mm	Class 1500 BB & WB									
	A		B		C		D		Wt.	
	41	45	41	45	41	45	41	45	41	45
1/2	8.5	.43	0.5	8.86	8.1	4.72	3.93	22.0	17.6	
15	216	11	13	225	207	120	100	10.0	8.0	
3/4	9.0	.57	0.7	10.63	9.4	5.51	4.92	33.0	29.0	
20	229	14.5	18	270	240	140	125	15.0	13.2	
1	10.0	.75	0.9	11.22	10.2	5.51	6.29	37.4	38.3	
25	254	19	24	285	258	140	160	17.0	17.4	
1-1/4	11.0	-	1.1	-	11.4	-	6.29	-	42.0	
32	279	-	29	-	290	-	160	-	19.0	
1-1/2	12.0	1.22	1.4	15.75	13.3	6.69	7.08	79.2	54.0	
40	305	31	36.5	400	337	170	180	36.0	24.5	
2	14.5	1.48	1.8	16.54	14.0	10.24	9.45	121.0	68.2	
50	368	37.5	46.5	420	354	260	240	55.0	31.0	

Typical Bill of Materials (See page 12 for available materials.)

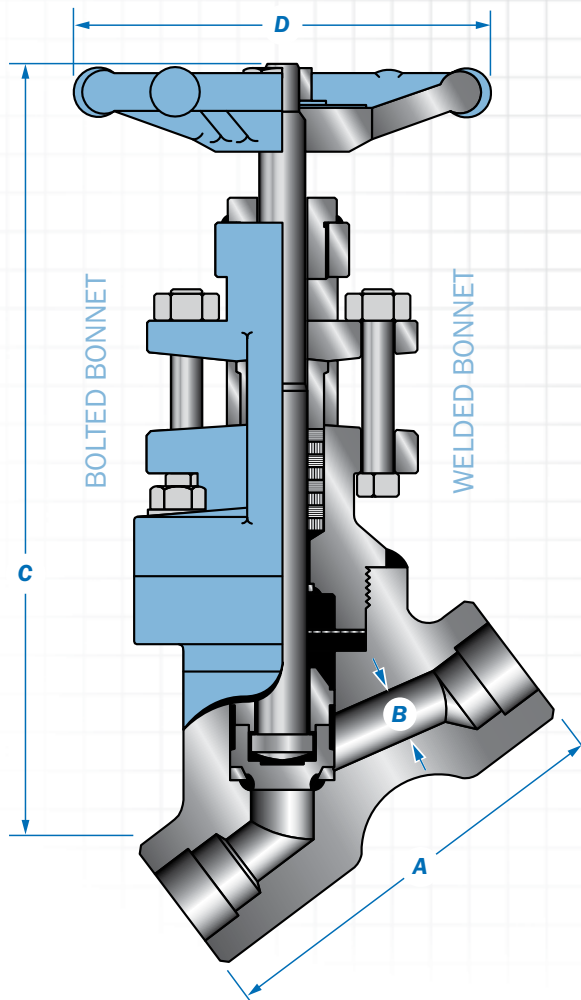
Component	Material	ASTM Spec
Body	Carbon Steel	A105N
Bonnet	Carbon Steel	A105N
* Packing	Graphite W/Braided Carbon Fiber End Rings	
* Gasket	Stainless Steel 316 Graphite	
Stem	Stainless Steel	A479-410
Disc	Stainless Steel	13 Chrome
Seat Rings	Stainless Steel	A479-410
Bonnet Bolts	Alloy Steel	A193 B7
Washer	Carbon Steel	Commercial
Handwheel Nut	Carbon Steel	Commercial
Nameplate	Aluminum	Commercial
Handwheel	Carbon Steel	Commercial
Yoke Sleeve	Stainless Steel	AISI 416
Gland Nuts	Carbon Steel	A194 2H
Gland Flange	Carbon Steel	A105N
Gland Studs	Stainless Steel	AISI 410
Packing Gland	Stainless Steel	AISI 416

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

**Forged Steel Y-Pattern
Bolted & Welded Bonnet Globe
Conventional Port
Class 800 thru 2680
Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)**

Design and Manufacturing Standards

Valve Design: ASME B16.34
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding: ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*



**Class 800
Bolted & Welded Bonnet Globe**

Size	A	B	C	D	Wt.
1/2	3.6	0.39	7.5	3.7	4.4
15	92	10	190	95	2
3/4	3.6	0.51	7.5	3.7	4.4
20	92	13	190	95	2
1	4.4	0.69	9.3	4.3	9
25	111	17.5	235	110	4.1
1-1/4	6	0.94	11.2	5.5	19.8
32	152	24	286	140	9
1-1/2	6	1.22	11.2	5.5	19.8
40	152	31	286	140	9
2	6.8	1.46	12.8	6.7	30.4
50	172	37	325	200	13.8

**Class 1500 & 1690
Welded Bonnet Globe**

Size	A	B	C	D	Wt.
1/2	3.9	0.51	7.3	3.9	6.6
15	100	13	185	100	3
3/4	4.3	0.69	9.1	5.5	8.8
20	110	17.5	230	140	4
1	4.9	0.89	9.4	5.5	11
25	125	22.5	240	140	5
1-1/4	5.9	1.1	12	6.7	20.9
32	150	28	305	170	9.5
1-1/2	6.3	1.38	13.4	7.9	24.2
40	160	35	340	200	11
2	7.5	1.73	15.7	10.2	37.4
50	190	44	400	260	17

**Class 2500 & 2680
Welded Bonnet Globe**

Size	A	B	C	D	Wt.
1/2	3.9	0.47	9.1	4.7	8.8
15	100	12	230	120	4
3/4	4.9	0.59	9.4	5.5	11
20	125	15	240	140	5
1	6.3	0.79	12	6.7	20.9
25	160	20	305	170	9.5
1-1/4	6.3	0.98	12	6.7	23.1
32	160	25	305	170	10.5
1-1/2	7.5	1.22	13.6	7.9	37.4
40	190	31	345	200	17
2	8.3	1.49	15.7	10.2	50.6
50	210	38	400	260	23

Typical Bill of Materials (See page 12 for available materials.)

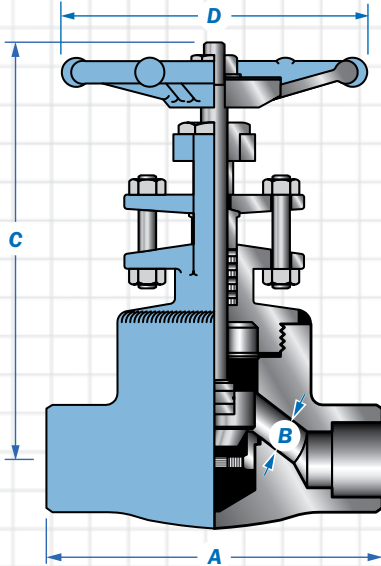
Component	Material	ASTM Spec	Component	Material	ASTM Spec
Body	Carbon Steel	A105N	Handwheel Nut	Carbon Steel	Commercial
Bonnet	Carbon Steel	A105N	Nameplate	Aluminum	Commercial
* Packing	Graphite W/Braided Carbon Fiber End Rings		Handwheel	Carbon Steel	Commercial
* Gasket	Stainless Steel 316 Graphite		Yoke Sleeve	Stainless Steel	AISI 416
Stem	Stainless Steel	A479-410	Gland Nuts	Carbon Steel	A194 2H
Disc	Stainless Steel	13 Chrome	Gland Flange	Carbon Steel	A105N
Seat Rings	Stainless Steel	A479-410	Gland Studs	Stainless Steel	AISI 410
Bonnet Bolts	Alloy Steel	A193 B7	Packing Gland	Stainless Steel	AISI 416
Washer	Carbon Steel	Commercial			

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

**Forged Steel High Pressure
Welded Bonnet Globe
Conventional Port
Class 4500
Sizes: 1/2" thru 2"**

Design and Manufacturing Standards

Valve Design: ASME B16.34
Pipe Threads, General Purpose, Inch: ASME B1.20.1
Socket Welding: ASME B16.11
Tested in Accordance with: API 598
Recommended Spare Parts*

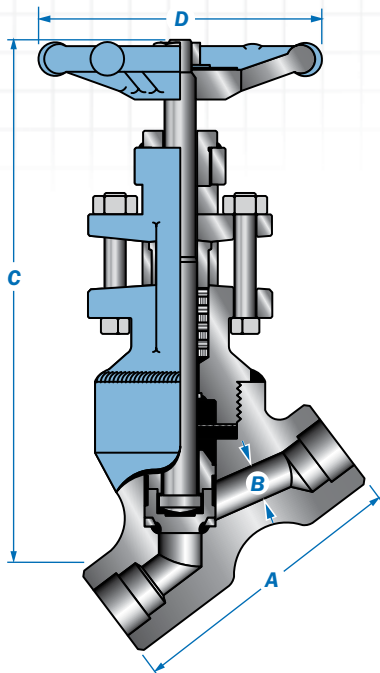


**Class 4500
Welded Bonnet Globe**

Size	A	B	C	D	Wt.
1/2	4.7	0.31	8.9	4.7	17.6
15	120	8	228	120	8
3/4	6.1	0.47	10.8	5.5	4
20	155	12	275	140	11
1	6.1	0.59	11	5.5	41.8
25	155	15	280	140	19
1-1/4	8.3	0.79	16.1	10.2	50.6
32	210	20	410	260	23
1-1/2	8.3	0.98	16.1	10.2	50.6
40	210	25	410	260	23
2	9.4	1.1	16.5	10.2	50.6
50	240	28	420	260	23

Typical Bill of Materials (See page 12 for available materials.)

Component	Material	ASTM Spec	Component	Material	ASTM Spec
Body	Carbon Steel	A105N	Handwheel Nut	Carbon Steel	Commercial
Bonnet	Carbon Steel	A105N	Nameplate	Aluminum	Commercial
* Packing	Graphite W/Braided Carbon Fiber End Rings		Handwheel	Carbon Steel	Commercial
* Gasket	Stainless Steel 316 Graphite		Yoke Sleeve	Stainless Steel	AISI 416
Stem	Stainless Steel	A479-410	Gland Nuts	Carbon Steel	A194 2H
Disc	Stainless Steel	13 Chrome	Gland Flange	Carbon Steel	A105N
Seat Rings	Stainless Steel	A479-410	Gland Studs	Stainless Steel	AISI 410
Bonnet Bolts	Alloy Steel	A193 B7	Packing Gland	Stainless Steel	AISI 416
Washer	Carbon Steel	Commercial			



**Class 4500
Welded Bonnet Y-Pattern Globe**

Size	A	B	C	D	Wt.
1/2	4.9	0.31	9.4	5.5	12.1
15	125	8	240	140	5.5
3/4	6.3	0.43	11.2	6.7	22
20	160	11	285	170	10
1	7.5	0.59	12.6	7.9	37.4
25	190	15	320	200	17
1-1/4	7.5	0.71	12.6	7.9	37.4
32	190	18	320	200	17
1-1/2	8.3	0.79	12.6	10.2	41.8
40	210	20	360	260	19
2	11	0.98	17.7	14.6	52.8
50	280	25	450	370	24

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

Rev: 072109

Newco[®]

Forged Steel Bolted & Welded Bonnet Check Valves

Manufactured by Newmans™

Sizes: 1/2" thru 2" • Pressure Class: 150 thru 1500



Typical Newco Forged Steel Bolted Check Valve Expanded View

1. Body: Newco forged steel bodies provide low resistance flow and optimum strength and performance.

2. Cover Studs: The cover studs secure the bonnet to the body.

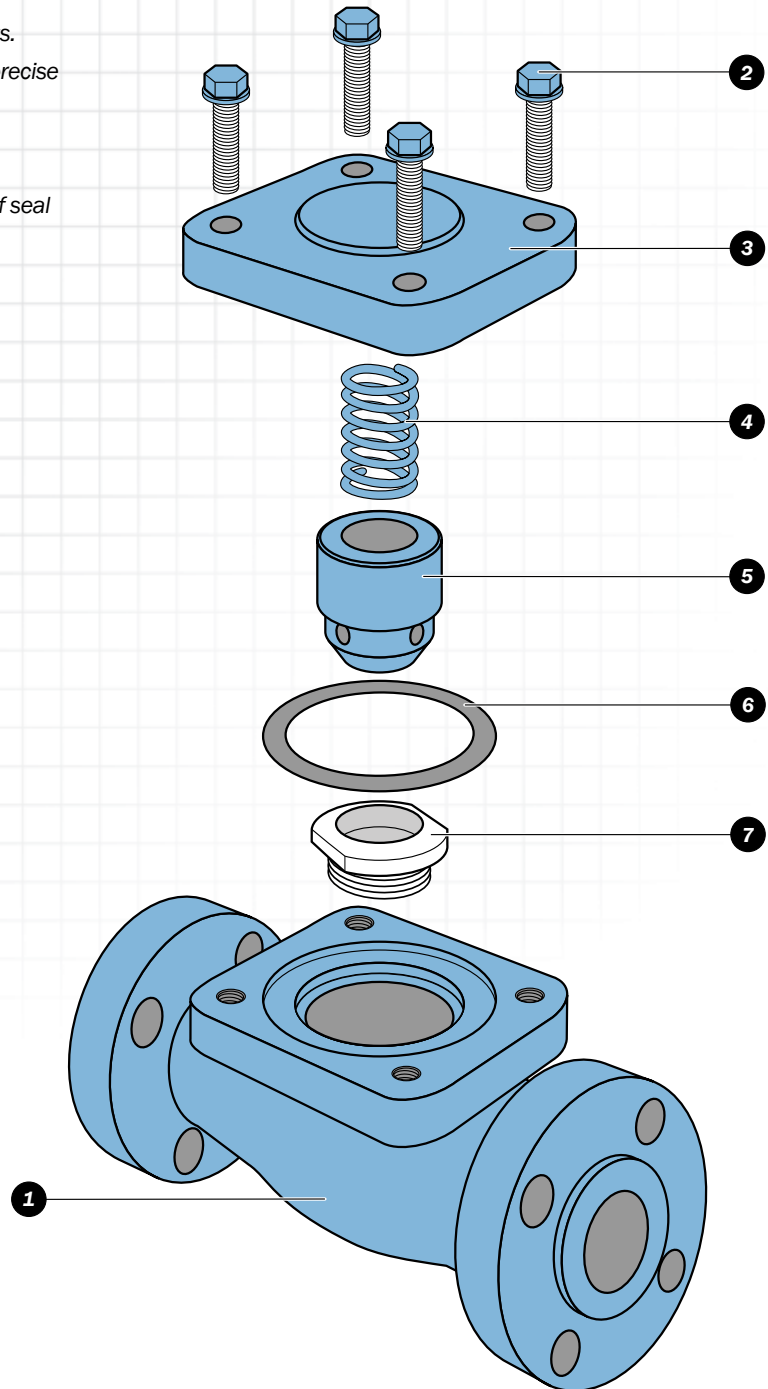
3. Cover: The cover allows access to internal components.

4. Spring: The spring is precision made and loaded for precise pressures.

5. Piston: Newmans piston is machined to the tightest tolerances to ensure trouble free shutoff and cycling.

6. Cover Gasket: The cover gasket creates a leak-proof seal between the bonnet and the body.

7. Seat: The seat ensures a stable shutoff. The seat is precision ground for optimal seating.



Forged Steel Lift & Swing Checks
Bolted & Welded Cover
Conventional Port
Class 800 thru 1500

Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)

Design and Manufacturing Standards

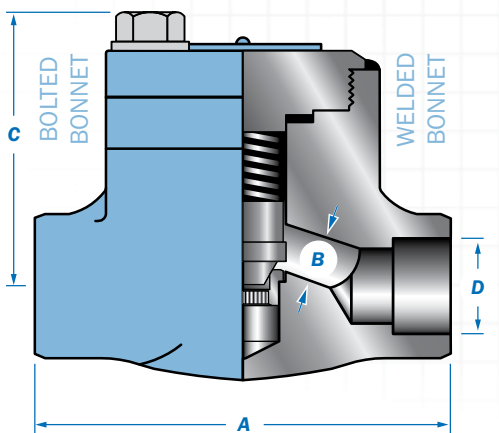
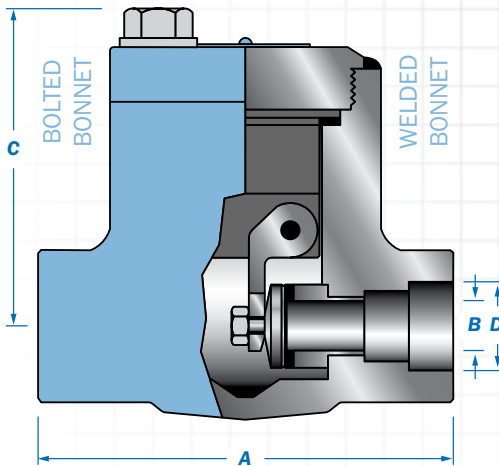
Valve Design: API 602

Pipe Threads, General Purpose, Inch: ASME B1.20.1

Socket Welding: ASME B16.11

Tested in Accordance with: API 598

Recommended Spare Parts*

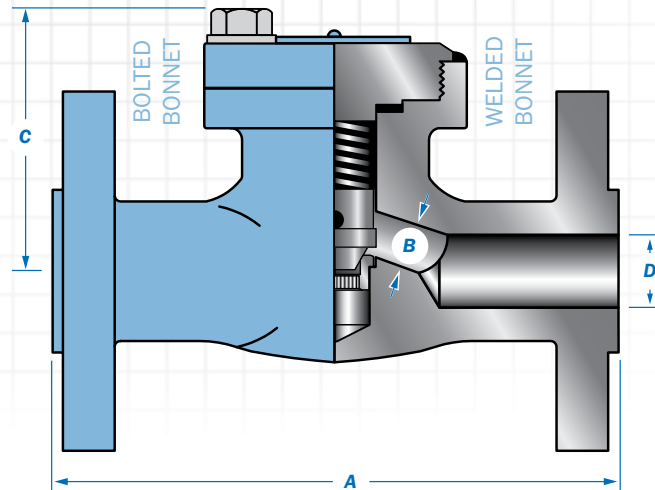
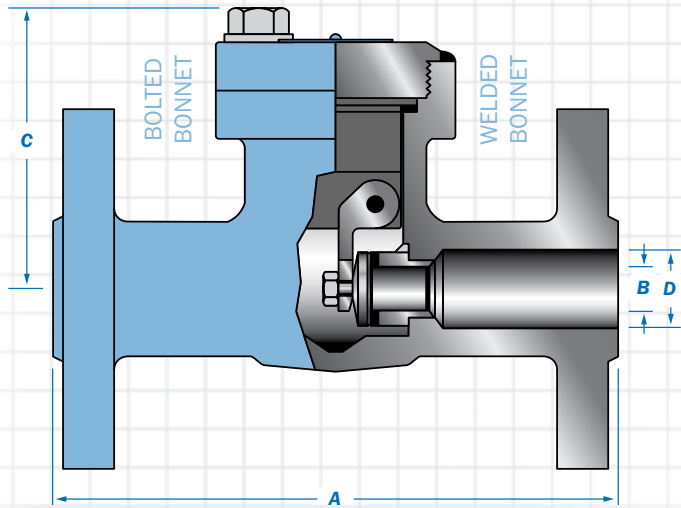


Class 800 thru 1500																																					
Bolted & Welded Bonnet Lift & Swing Check																																					
Size	Class 800 BB Lift										Class 800 BB Swing																										
	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.																	
mm	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45					
1/2	3.2	3.1	0.35	0.39	1.9	1.9	0.85	2.4	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2.4	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2.4	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2.4	2.1	
15	80	78.7	9	9.9	49	49	21.6	1.1	1	80	78.7	9	9.9	49	40.6	21.6	1.1	1	80	78.7	9	9.9	49	40.6	21.6	1.1	1	80	78.7	9	9.9	49	40.6	21.6	1.1	1	
3/4	3.5	3.6	0.49	0.54	2.2	2.1	1.07	4	2.6	3.5	3.6	0.49	0.55	2.2	1.8	1.07	4	2.5	3.5	3.6	0.49	0.55	2.2	1.8	1.07	4	2.5	3.5	3.6	0.49	0.55	2.2	1.8	1.07	4	2.5	
20	90	91.4	12.5	13.9	55	53.3	27.2	1.8	1.2	90	91.4	12.5	13.9	55	45.7	27.2	1.8	1.1	90	91.4	12.5	13.9	55	45.7	27.2	1.8	1.1	90	91.4	12.5	13.9	55	45.7	27.2	1.8	1.1	
1	4.3	4.4	0.68	0.69	2.8	2.7	1.33	5.7	4.3	4.3	4.4	0.68	0.71	2.8	2.3	1.33	5.7	3.9	4.3	4.4	0.68	0.71	2.8	2.3	1.33	5.7	3.9	4.3	4.4	0.68	0.69	2.8	2.7	1.33	5.7	4.3	4.3
25	110	111.8	17.5	17.5	70	68.6	33.8	2.6	2	110	111.8	17.5	18	70	58.4	33.8	2.6	1.8	110	111.8	17.5	18	70	58.4	33.8	2.6	1.8	110	111.8	17.5	17.5	70	68.6	33.8	2.6	2	
1-1/4	5	4.7	0.88	0.9	3	3.3	1.67	7.9	11.5	5	4.7	0.88	0.95	3	3.3	1.67	7.9	10.6	5	4.7	0.88	0.95	3	3.3	1.67	7.9	10.6	5	4.7	0.88	0.9	3	3.3	1.67	7.9	11.5	5
32	127	119.4	22.5	22.9	77	83.8	42.4	3.6	5.2	127	119.4	22.5	24.1	77	83.8	42.4	3.6	4.8	127	119.4	22.5	24.1	77	83.8	42.4	3.6	4.8	127	119.4	22.5	22.9	77	83.8	42.4	3.6	5.2	
1-1/2	6.1	6	1.14	1.18	4.1	3.7	1.92	12.1	9.9	5	4.7	1.14	1.41	4.1	3.1	1.92	12.1	8.8	5	4.7	1.14	1.41	4.1	3.1	1.92	12.1	8.8	5	4.7	1.14	1.18	4.1	3.7	1.92	12.1	9.9	5
40	155	152.4	29	29.9	105	94	48.8	5.5	4.5	155	152.4	29	29	105	78.7	48.8	5.5	4	155	152.4	29	29	105	78.7	48.8	5.5	4	155	152.4	29	29.9	105	94	48.8	5.5	4.5	
2	6.7	6.8	1.38	1.45	4.7	4.4	2.41	18.5	17	5.1	5.5	1.44	1.44	4.7	3.7	2.41	18.5	13.2	5.1	5.5	1.44	1.44	4.7	3.7	2.41	18.5	13.2	5.1	5.5	1.38	1.45	4.7	4.4	2.41	18.5	17	
50	170	172.7	35	36.8	120	111.8	61.2	8.4	7.7	170	172.7	35	36.6	119	94	61.2	8.4	7.8	170	172.7	35	36.6	119	94	61.2	8.4	7.8	170	172.7	35	36.8	120	111.8	61.2	8.4	7.7	
Size	Class 800 WB Lift										Class 800 WB Swing																										
	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.																	
mm	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45					
1/2	3.2	3.1	0.35	0.39	1.9	1.9	0.85	2	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2	2.1	3.2	3.1	0.35	0.39	1.9	1.6	0.85	2	2.1	
15	80	78.7	9	9.9	49	49	21.6	0.9	1	80	78.7	9	9.9	49	40.6	21.6	0.9	1	80	78.7	9	9.9	49	40.6	21.6	0.9	1	80	78.7	9	9.9	49	40.6	21.6	0.9	1	
3/4	3.5	3.6	0.49	0.54	2.2	2.1	1.07	2.6	2.6	3.5	3.6	0.49	0.55	2.2	1.8	1.07	2.6	2.5	3.5	3.6	0.49	0.55	2.2	1.8	1.07	2.6	2.5	3.5	3.6	0.49	0.54	2.2	2.1	1.07	2.6	2.6	
20	90	91.4	12.5	13.9	56	53.3	27.2	1.2	1.2	90	91.4	12.5	13.9	56	45.7	27.2	1.2	1.1	90	91.4	12.5	13.9	56	45.7	27.2	1.2	1.1	90	91.4	12.5	13.9	56	53.3	27.2	1.2	1.2	
1	4.3	4.4	0.68	0.69	2.7	2.7	1.33	4.6	4.3	4.3	4.4	0.68	0.71	2.7	2.3	1.33	4.6	3.9	4.3	4.4	0.68	0.71	2.7	2.3	1.33	4.6	3.9	4.3	4.4	0.68	0.69	2.7	2.7	1.33	4.6	4.3	4.3
25	110	111.8	17.5	17.5	69	68.6	33.8	2.1	2	110	111.8	17.5	18	69	58.4	33.8	2.1	1.8	110	111.8	17.5	18	69	58.4	33.8	2.1	1.8	110	111.8	17.5	17.5	69	68.6	33.8	2.1	2	
1-1/4	5	4.7	0.88	0.9	3.2	3.3	1.67	7.5	11.5	5	4.7	0.88	0.95	3.2	3.3	1.67	7.5	10.6	5	4.7	0.88	0.95	3.2	3.3	1.67	7.5	10.6	5	4.7	0.88	0.9	3.2	3.3	1.67	7.5	11.5	5
32	127	119.4	22.5	22.9	80	83.8	42.4	3.4	5.2	127	119.4	22.5	24.1	80	83.8	42.4	3.4	4.8	127	119.4	22.5	24.1	80	83.8	42.4	3.4	4.8	127	119.4	22.5	22.9	80	83.8	42.4	3.4	5.2	
1-1/2	6.1	6	1.14	1.18	3.7	3.7	1.92	11.7	9.9	5	4.7	1.14	1.41	3.7	3.1	1.92	11.7	8.8	5	4.7	1.14	1.41	3.7	3.1	1.92	11.7	8.8	5	4.7	1.14	1.18	3.7	3.7	1.92	11.7	9.9	5
40	155	152.4	29	29.9	95	94	48.8	5.3	4.5	155	152.4	29	29	95	78.7	48.8	5.3	4	155	152.4	29	29	95	78.7	48.8	5.3	4	155	152.4	29	29.9	95	94	48.8	5.3	4.5	
2	6.7	6.8	1.38	1.45	4.1	4.4	2.41	17.2	17	5.1	5.5	1.38	1.44	4.1	3.7	2.41	17.2	13.2	5.1	5.5	1.38	1.44	4.1	3.7	2.41	17.2	13.2	5.1	5.5	1.38	1.45	4.1	4.4	2.41	17.2	17	
50	170	172.7	35	36.8	105	111.8	61.2	7.8	7.7	170	172.7	35	36.6	105	94	61.2	7.8	7.8	170	172.7	35	36.6	105	94	61.2	7.8	7.8	170	172.7	35	36.8	105	111.8	61.2	7.8	7.7	
Size	Class 1500 BB Lift										Class 1500 BB Swing																										
	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.	A	B	C	D	Wt.																	
mm	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45	41	45					
1/2	3.5	4.4	0.35	0.39	2.2	3.1	0.85	4.8	7.5	3.5	4.4	0.35	0.55	2.2	3.1	0.85	4.8	7.9	3.5	4.4	0.35	0.55	2.2	3.1	0.85	4.8	7.9	3.5	4.4	0.35	0.39	2.2	3.1	0.85	4.8	7.5	
15	90	111.8	9	9.9	55	78.7	21.6	2.2	3.4	90	111.8	9	13.97	55	78.7	21.6	2.2	3.6	90	111.8	9	13.97	55	78.7	21.6	2.2	3.6	90	111.8	9	9.9	55	78.7	21.6	2.2	3.4	
3/4	4.3	4.4	0.43	0.51	2.8	3.1	1.07	6.8	10.6	4.3	4.4	0.43	0.55	2.8	3.1	1.07	6.8	9.5	4.3	4.4	0.43	0.55	2.8	3.1	1.07	6.8	9.5	4.3	4.4	0.43	0.51	2.8	3.1	1.07	6.8	10.6	
20	110	111.8	11	12.95	70	78.7	27.2	3.1	4.8	110	111.8	11	13.97	70	78.7	27.2	3.1	4.3	110	111.8	11	13.97	70	78.7	27.2	3.1	4.3	110	111.8	11	12.95	70	78.7	27.2	3.1	4.8	
1	4.7	5.1	0.57	0.66	3	3.8	1.33	9.2	15.2	4.7	4.5	0.57	0.71	3	3.8	1.33	9.2	23.5	4.7	4.5	0.57	0.71	3	3.8	1.33	9.2	23.5	4.7	4.5	0.57	0.66	3	3.8	1.33	9.2	15.2	
25	120	129.5	14.5	16.76	77	96.5	33.8	4.2	6.9	120	129.5	14.5	18.03	77	96.5	33.8	4.2	10.7	120	129.5	14.5	18.03	77	96.5	33.8	4.2	10.7	120	129.5	14.5	16.76	77	96.5	33.8	4.2	6.9	
1-1/4	5.1	-	0.74	-	4.1	-	1.67	12.8	-	5.1	-	0.74	-	4.1	-	1.67	12.8	-	5.1	-	0.74	-	4.1	-	1.67	12.8	-	5.1	-	0.74	-	4.1	-	1.67	12.8	-	
32	130	-	19	-	105	-	42.4	5.8	-	130	-	19	-	105	-	42.4	5.8	-	130	-	19	-	105	-	42.4	5.8	-	130	-	19	-	105	-	42.4	5.8	-	
1-1/2	6.7	6.8	1.06	1.18	4.5	4.7	1.92	20.7	19.4	5.1	5.5	1.06	1.14	4.5	4.7	1.92	20.7	27.7	5.1	5.5	1.06	1.14	4.5	4.7	1.92												

Forged Steel Lift & Swing Checks
Bolted & Welded Cover
Conventional Port
Class 150 thru 1500
Sizes: 1/2" thru 2" (1/4" & 3/8" available upon request)

Design and Manufacturing Standards

Valve Design: ASME B16.34
Flange Dimensions: ASME B16.5
Face-to-Face Dimensions: ASME B16.10
Tested in Accordance with: API 598
Recommended Spare Parts*



Class 150 thru 1500
Bolted & Welded Bonnet - Lift & Swing Check

Size in. mm	Class 150												
	A		B (lift)		B (swing)		C		D		Wt.		
	41	45	41	45	41	45	41	45	41	45	41	45	
1/2	4.3		0.35		0.4		2.8	1.6	0.5		6.2		
15	108		9		10		70	40.6	12.7		2.8	3.4	
3/4	4.6		0.49		0.4		3.2	1.8	0.75		8.8		
20	118		12.5		10		80	45.7	19.1		4	4.4	
1	5		0.68		0.7		3.6	2.3	1		11.7		
25	127		17.5		18		92	58.4	25.4		5.3	8.2	
1-1/2	6.5		1.14		1.2		3.9	3.1	1.5		19.8		
40	165		29		29.5		100	78.7	38.1		9	12	
2	8		1.37		1.4		5.5	3.7	2		33		
50	203		35		36.5		140	94	50.8		15	14.3	
Size in. mm	Class 300												
	A (lift)		A (swing)		B (lift)		B (swing)		C		D	Wt.	
	41	45	41	45	41	45	41	45	41	45	41	45	
1/2	6		6		0.35		0.4		2	1.6	0.5	6.2	8.1
15	152.5		152.5		9		10		50	40.6	12.7	2.8	3.7
3/4	7		7		0.49		0.6		2.2	1.8	0.75	10.3	10.6
20	178		178		12.5		14		55	45.7	19.1	4.7	4.8
1	8		8.5		0.68		0.7		2.8	2.3	1	12.5	19.4
25	203		216		17.5		18		70	58.4	25.4	5.7	8.8
1-1/2	9		9.5		1.14		1.2		3.9	3.1	1.5	26	30.1
40	229		241		29		30		98	78.7	38.1	11.8	13.7
2	10.5		10.5		1.37		1.4		4.3	3.7	2	37.4	39.2
50	267		267		35		36.5		110	94	50.8	17	17.8
Size in. mm	Class 600												
	A		B (lift)		B (swing)		C		D		Wt.		
	41	45	41	45	41	45	41	45	41	45	41	45	
1/2	6.5		0.35		0.4		2	1.6	0.5		6.4	8.8	
15	165		9		10		50	40.6	12.7		2.9	4	
3/4	7.5		0.49		0.6		2.2	1.8	0.75		10.6	12.8	
20	191		12.5		14		55	45.7	19.1		4.8	5.8	
1	8.5		0.68		0.7		2.8	2.3	1		21.3	20.9	
25	216		17.5		18		70	58.4	25.4		9.7	9.5	
1-1/2	9.5		1.14		1.2		3.9	3.1	1.5		26.4	34.3	
40	241		29		30		98	78.7	38.1		12	15.6	
2	11.5		1.37		1.4		4.3	3.7	2		38.1	53.9	
50	292		35		36.5		110	94	50.8		17.3	24.5	
Size in. mm	Class 1500												
	A		B (lift)		B (swing)		C		D		Wt.		
	41	45	41	45	41	45	41	45	41	45	41	45	
1/2	8.5		0.43		0.6		3.5		0.5		16.7		
15	216		11		14		90		12.7		7.6		
3/4	9		0.57		0.7		4.1		0.69		23.8		
20	229		14.5		18		105		17.5		10.8		
1	10		0.74		0.9		4.7		0.87		31.9		
25	254		19		24		120		22.1		14.5		
1-1/2	12		1.22		1.4		6.3		1.37		68.2		
40	305		31		36		160		34.8		31		
2	14.5		1.48		1.6		6.7		1.87		94.6		
50	368		37.5		40		170		47.5		43		

Typical Bill of Materials

(See page 12 for available materials.)

Component	Material	ASTM Spec
Body	Carbon Steel	A105N
Seat Ring	Stainless Steel	A479-410
Piston	Stainless Steel	A479-410
Rivet	Brass	Commercial
Spring	Stainless Steel	A479-316
Nameplate	Aluminum	Commercial
* Gasket	Stainless Steel 316 W/Graphite Spiral Wound	
Cap	Carbon Steel	A105N
Cap Bolt	Alloy Steel	A193-B7

Note: Dimensions: Inches/Millimeters - Weights: Pounds/Kilograms. Larger sizes available on request. Dimensions are subject to change without notice.

Forged Steel Cv Values Gates, Globes, Checks

Newco Forged Steel Gate Valves Cv Values	NPS	150 - 800 Full Bore	150 - 800 Reduced Bore	1500 Full Bore	1500 Reduced Bore	2500 Full Bore
	1/2	12	6	13	6	5
	3/4	23	10	24	11	12
	1	43	26	44	27	23
	1-1/4	57	44	59	45	43
	1-1/2	98	65	100	66	56
	2	200	103	*	99	97

* 40mm = >155

Newco Forged Steel Globe Valves Cv Values	NPS	150 - 800 Full Bore	150 - 800 Reduced Bore	1500 Full Bore	1500 Reduced Bore
	1/2	3	2	3	2
	3/4	6	4	6	3
	1	12	6	12	6
	1-1/4	15	10	-	-
	1-1/2	21	18	20	16
	2	38	22	24	20

Newco Forged Steel Y-Pattern Globe Valves Cv Values	NPS	800	1500	2500
	1/2	5	5	3
	3/4	11	11	6
	1	14	15	12
	1-1/4	-	-	-
	1-1/2	37	35	27
	2	68	68	36

Newco Forged Steel Swing Check Valves Cv Values	NPS	150 - 800 Full Bore	150 - 800 Reduced Bore	1500 Full Bore	1500 Reduced Bore
	1/2	5	4	-	-
	3/4	12	6	-	-
	1	17	13	-	-
	1-1/4	26	18	-	-
	1-1/2	54	28	-	-
	2	101	55	-	-

Newco Forged Steel Lift Check Valves Cv Values	NPS	150 - 800 Full Bore	150 - 800 Reduced Bore	1500 Full Bore	1500 Reduced Bore
	1/2	3	1	3	2
	3/4	5	3	6	3
	1	11	6	11	5
	1-1/4	-	-	-	-
	1-1/2	18	15	19	11
	2	32	18	22	19

Table Applies to Both Piston and Ball Check Valves

Newco Forged Steel Y-Pattern Lift Check Valves Cv Values	NPS	800	1500	2500
	1/2	4	4	3
	3/4	11	11	6
	1	13	14	12
	1-1/4	-	-	-
	1-1/2	36	34	27
	2	67	67	36

Table Applies to Both Piston and Ball Check Valves

Limited Warranty

Newmans warrants to the original purchaser, for a period of one year from and after the date of delivery to the original customer, that its products will be free from defects in workmanship and materials, not caused or resulting from improper usage or application, improper installation, improper maintenance, repair modification or alterations.

In the event the original purchaser shall determine that a product purchased from Newmans shall be defective in workmanship or materials, the customer shall notify the Newmans Warranty Representative by telephone (713) 675-8631 within 24 hours from such determination, followed by written notice to such effect within 7 days therefrom, addressed to:

Newmans
1300 Gazin Street
Houston, Texas 77020

In the event Newmans shall determine that the product is defective as a result of factory workmanship, based upon such examination of the product which Newmans may deem appropriate, Newmans shall thereupon, at its sole option, (a) cause the defective product to be repaired, (b) replaced with a substantially identical product, or (c) accept the return of a defective product and refund the purchasing price to the original purchaser. Newmans shall bear all normal surface transportation costs to the original purchaser but shall in no event bear any installation, re-installation, engineering or other costs incurred in connection with repair or replacement.

Unless Newmans shall have provided engineering and/or suitability of application or installation services for a purchaser, for which a separate charge shall have been specifically identified and made, the selection, suitability, installation and fitness of all products sold by Newmans shall be deemed to have been determined exclusively by and within the sole discretion of the purchaser. Accordingly, Newmans disclaims any obligation, warranty or guarantee in any manner relating to or resulting from the selection, application, suitability, fitness or installation of its products.

The foregoing constitutes the sole obligation of Newmans with respect to defective products purchased from it and in no manner shall Newmans assume or be liable for any other expenses, incidental or consequential damages, losses, lost profits, down time or otherwise, whether directly or indirectly suffered, or in any other manner relating to or as the result of any defect or failure or any product that it may sell.

Except as otherwise provided herein, NEWMANS MAKES NO WARRANTIES OR REPRESENTATIONS, WHETHER EXPRESSED OR IMPLIED, OF ANY KIND WHATSOEVER WITH RESPECT TO GOODS AND PRODUCTS SOLD BY IT, INCLUDING WITHOUT LIMITATION, ANY WARRANTIES WITH RESPECT TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NO PERSON IS AUTHORIZED TO GRANT OR EXTEND ANY WARRANTY OR REPRESENTATION ON BEHALF OF NEWMANS OTHER THAN AS SET FORTH HEREIN.

Industry Standards Typically Used in Valve Manufacturing

(For Reference Only)

ISO 9001: 2000
 RWTUV approved Newmans for design, manufacture, sales, & service of industrial valves under certificate registration number #08-1016
 ISO 14001: 2004

The Newmans/Yancheng Manufacturing Team has passed the TUV-USA ISO 14001:2004 Certification Audit. All facilities inclusive of two (2) Foundries (Lost Wax and Sand Cast), Ball Valve Factory, Final Processing Center and Warehouses 15 & 16.

American Petroleum Institute (API)

API RP 574 (1998) - Inspection practices for piping system components
 API 589 (1998) - Fire test for evaluation of valve stem packing
 API RP 591 (2003) - Process valve qualification procedure
 API 594 (2004) - Check valves-flanged, lug, wafer & buttwelding
 API 597 (1981) - Steel venturi gate valves, flanged, buttwelding ends
 API 598 (2004) - Valve inspection & testing
 API 599 (2002) - Metal plug valves - flanged, welding ends
 API 601 (1988) - Metallic gaskets for raised-face pipe flanges & flanged connections (double-jacketed corrugated & spiral wound)
 API 600 (2001) - Bolted bonnet steel gate valves for petroleum & natural gas industries "ISO adoption from ISO 10434"
 API 602 (2005) - Steel gate, globe, & check valves for sizes DN100 and smaller for the petroleum & natural gas industries
 API 603 (2001) - Corrosion-resistant, bolted bonnet gate valves-flanged & buttweld ends
 API 604 (1981) - Ductile iron gate valves, flanged ends
 API 605 (1988) - Large-diameter carbon steel flanges (nominal pipe sizes 26" through 60", classes 75, 150, 300, 400, 600, & 900 (replaced by ANSI/ASME B16.47)
 API 606 (1989) - Compact steel gate valves, extended body (included in API 602) fire test for soft-seated quarter-turn valves "ISO adoption from ISO 10497-5 2004"
 API 607 (2005) - Fire test for soft-seated quarter-turn valves "ISO adoption from ISO 10497-5 2004"
 API 608 (2002) - Metal ball valves, flanged, threaded, & welding ends
 API 609 (2004) - Butterfly valves-double flanged, lug- & wafer-type
 API RP 941 (2004) - Steel for hydrogen service at elevated temperatures & pressures in petroleum refineries & petrochemical plants
 API RP 520 (2000), Part 1 - Sizing, selection & installation of pressure relieving devices in refineries
 API RP 520 (2003), Part 2 - Sizing, selection & installation of pressure relieving devices in refineries devices in refineries
 API Spec 6A (2005) - Specification for wellhead & christmas tree equipment
 API Spec 6D (2005) - Specifications for pipeline valves
 API Spec 14D (1994) - Specifications for wellhead surface safety valves & underwater safety valves for offshore service
 API 5B (2004) - Threading, gauging thread inspection of coring, tubing, & line pipe threads
 API 6AM (2003) - Material toughness
 API 6FA (1999) - Fire test for valves
 API 6FC (1999) - Fire test for valves with backseats
 API 6FD (1995) - Specification for fire test for check valves
 API Q1 (2003) - Specification for quality programs for the petroleum, petrochemical, & natural gas

American Society of Mechanical Engineers (ASME)

ASME Code (1997 addenda) - Boiler & pressure vessel code
 ASME A13.1 (1996) - Scheme for the identification of piping systems
 ASME B1.1 (2003) - Unified inch screw threads, UN, & UNR thread form
 ASME B1.5 (1997) - ACME screw threads
 ASME B1.7M (1984) - Nomenclature, definitions, & letter symbols for screw threads
 ASME B1.8 (1988) - Stub ACME screw threads
 ASME B1.12 (1987) - Class 5 interference - fit thread
 ASME B1.20.1 (1983) - Pipe threads, general purpose, inch
 ASME B1.20.3 (1976) - Dry-seal pipe threads, inch
 ANSI/ASME B16.1 (1998) - Cast iron pipe flanges & flanged fittings
 ANSI/ASME B16.5 (2003) - Pipe flanges & flanged fittings: NPS 1/2" through 24"
 ASME B16.9 (2003) - Factory made wrought steel buttwelding fittings
 ANSI/ASME B16.10 (2002) - Face-to-face & end-to-end dimensions of valves
 ASME B16.11 (2001) - Forged fittings, socket welding & threaded
 ASME B16.20 (1998) - Metallic gaskets for pipe flanges: ring joint spiral wound & jacketed
 ASME B16.21 (2005) - Non-metallic flat gaskets for pipe flanges
 ASME B16.25 (2003) - Buttwelding ends
 ANSI/ASME B16.33 (2002) - Manually operated metallic gas valves for use in gas piping systems up to 125 PSI (sizes NPS 1/2" through 2")
 ANSI/ASME B31.1 (2004) - Power piping
 ANSI/ASME B31.3 (2004) - Process piping
 ANSI/ASME B16.34 (2004) - Valves flanged, threaded & welding end
 ANSI/ASME B16.36 (1996) - Orifice flanges
 ANSI/ASME B16.38 (1985) - Large metallic valves for gas distribution (manually operated, NPS 2-1/2" through 12", 125 PSIG maximum)
 ANSI/ASME B16.42 (1998) - Ductile iron pipe flanges & flanged fittings: classes 150 & 300
 ANSI/ASME B16.47 (1996) - Large diameter steel flanges
 ANSI B17.1 (1967, R' 89) - Keys & keyseats
 ANSI B18.2.2 (1987) - Square & hex nuts
 ASME B31.4 (2002) - Pipeline transportation systems for liquid hydrocarbons & other ammonia & alcohols
 ANSI/ASME B31.8 (2003) - Gas transmission & distribution piping systems
 ANSI/ASME B36.10 (2004) - Welded & seamless wrought steel pipe
 ANSI/ASME B36.19 (2004) - Stainless steel pipe
 ANSI FCI-2 (1991) - Control valve seat leakage

American Society Non-destructive Test (ASNT)

ASNT-TC-1A (1996) - Recommended practice no. SNT-TC-1A 1996

American Society for Testing and Materials (ASTM)

British Standards Institute (BS)

BS 1414 (1975, R' 91) - Gate, wedge & double disk valves: steel
 BS 1868 (1975, R' 91) - Check valves: steel
 BS 1873 (1975, R' 91) - Globe & check valves: steel
 BS 2080 (1989) obsolete - Flanged & buttweld end steel valves
 BS 5146 - (withdrawn) Replaced by BS 6755 p.1 steel valves testing (1986) & BS 6755 p.2 (1984)
 BS 5152 (1974, R' 91) - Globe & check: cast iron
 BS 5153 (1974, R' 91) - Check: cast iron
 BS 5159 (1974, R' 91) - Ball: cast iron & carbon steel
 BS 5160 (1974, R' 91) - Globe & check: steel
 BS 5163 (1986, R' 91) - Gate, wedge & double disk: cast iron
 BS 5351 (1986, R' 91) - Ball: steel
 BS 5352 (1986, R' 91) - Globe & check: steel
 BS 5418 - (withdrawn) Replaced by BS EN 19 (1992) marking: general purpose industrial
 BS 5840 (1980, R' 91) - Valve mating details for actuator operation
 BS 6364 (1984, R' 91) - Cryogenic
 BS 6683 (1985, R' 91) - Guide: installation & use of valves
 BS 6755: Part 1 (1986, R' 91) - Specification for production pressure testing requirements
 BS 6755: Part 2 (1987) - Specification for fire type-testing requirements
 BS EN 19 (1992) - Marking of general purpose industrial valves

Canadian Standards Association

B51-97 - Boiler, pressure vessel, & pressure piping code
 Z245.15-96 - Steel valves
 CAN3-z299.4-85 (reaffirmed 1997) - Quality assurance program - Category 4
 CAN3-z299.3-85 (reaffirmed 1997) - Quality assurance program - Category 3

International Organization for Standardization

ISO 5211/1 (2001) - Industrial valves- part-turn actuator attachments
 ISO 5211/2 (2001) - Part-turn valve actuator attachment-flange & coupling performance characteristics
 ISO 5211/3 (2001) - Part-turn valve actuator attachment-dimensions of driving components
 ISO 5752 (1982) - Metal valves for use in flanged pipe systems face-to-face & center-to-face dimensions
 ISO 9000 (2005) - Quality management systems and fundamentals & vocabulary
 ISO 10012-1 (1992) - Quality assurance requirements for measuring equipment

Manufacturers Standardization Society

SP-6 (2001) - Standard finishes for contact faces of pipe flanges & connecting-end flanges of valves & fittings
 SP-9 (2005) - Spot facing for bronze, iron & steel flanges
 SP-25 (1998) - Standard marking system for valves, fittings, flanges & unions
 SP-42 (2004) - Class 150 corrosion resistant gate, globe, angle, & check valves with flanged & buttweld ends
 SP-44 (2001) - Steel pipeline flanges
 SP-45 (2003) - Bypass & drain connections
 SP-51 (2003) - Class 150/w corrosion resistant cast flanges & flanged fittings
 SP-53 (2002) - Quality standard for steel castings & forgings for valves, flanges, & fittings & other piping components: magnetic particle exam method
 SP-54 (2002) - Quality standard for steel castings for valves, flanges, & fittings and other piping components: radiographic examination method
 SP-55 (2001) - Quality standard for steel castings for valves, flanges other piping components-visual method for evaluation of surface irregularities
 SP-60 (2004) - Connecting flange joint between tapping sleeves & tapping valves
 SP-61 (2003) - Pressure testing of steel valves
 SP-65 (2004) - High pressure chemical industry flanges & threaded stubs for use with lens gaskets
 SP-67 (2000A) - Butterfly valves
 SP-69 (2003) - ANSI/MSS edition pipe hangers & supports, selection & application
 SP-70 (1998) - Cast iron gate valves, flanged & threaded ends
 SP-71 (1997) - Gray iron swing check valves, flanged & threaded ends
 SP-72 (1999) - Ball valves with flanged or butt-welding ends for general service
 SP-79 (2004) - Socket-welding reducer inserts
 SP-81 (2001) - Stainless steel, bonnetless, flanged knife gate valves
 SP-82 (1992) - Valve pressure testing methods
 SP-84 (1990) - Valves - socket welding & threaded ends
 SP-85 (2002) - Cast iron globe & angle valves, flanged & threaded ends
 SP-86 (2002) - Guidelines for metric data in standards for valves, flanges, fittings & actuators
 SP-88 (r2001) - Diaphragm valves
 SP-91 (1992) - Guidelines for manual operation of valves
 SP-92 (1999) - MSS valve user guide
 SP-93 (r2004) - Quality standard for steel castings & forgings for valves, flanges & fittings & other piping components- liquid penetrant exam method
 SP-94 (r2004) - Quality standard for ferritic & martensitic steel castings for valves, flanges, & fittings and others piping components - ultrasonic exam method
 SP-96 (r2005) - Guidelines on terminology for valves & fittings
 SP-98 (2001) - Protective coatings for the interior of valves, hydrants, & fittings
 SP-99 (r2005) - Instrument valves
 SP-101 (r2001) - Part-turn valve actuator attachment-flange and driving component dimensions & performance characteristics
 SP-102 (r2001) - Multi-turn valve actuator attachment: flange and driving component dimensions & performance characteristics
 SP-110 (1996) - Ball valves threaded, socket-welding, solder joint, grooved, & flared ends
 SP-117 (2002) - Bellows seals for globe & gate valves
 SP-118 (2002) - Compact steel globe and check valves-flanged, flangeless, threaded & welding ends (chemical & petroleum refinery service)
 SP-120 (2002) - Flexible graphite packing system for rising stem steel valves (design requirements)
 SP-121 (R2002) - Qualification testing methods for stem packing for rising stem steel valves

National Association of Corrosion Engineers (NACE)

MR0175 (2005) - Sulfide stress cracking resistant metallic materials for oil field equipment
 MR0103 (2005) - Materials resistant to sulfide stress cracking in corrosive petroleum refining environments

Terms & Conditions

Definitions

1) Supplier

"Supplier" refers to NEWCO Valves LP dba NEWMANS, a Texas (USA) limited partnership, and all of its affiliated or related entities, including, but not limited to, its parent, subsidiary, affiliated companies, their officers, directors, employees and agents, individually and collectively.

2) Customer

"Customer," refers to all of the following:

- any party acting as agent for the Customer, the party ordering goods or services on behalf of himself, herself or itself and others;
- the person signing Supplier's credit application, service order, bill of lading, delivery receipt or ticket;
- the store, factory, warehouse, shipping company, accepting agent, contractor or subcontractor of the job site, store, warehouse, transportation company, accepting agent;
- the person accepting and/or ordering Supplier's goods and services acknowledges that he or she has the actual and apparent agency authority to bind the Customer and owner of the property the product will improve, to the terms and conditions of this agreement, all of whom are included in the term "Customer"; and
- the person paying the invoices of Supplier, signing Supplier's service orders, delivery tickets, bills of lading or other Supplier contracts, acknowledges that he or she is the agent of the Customer and/or any entity who is benefited by the Supplier's product, and that they are said person's agent.

3) Equipment

"Equipment" refers to any goods and service, item of supply or equipment or property ordered or purchased by Customer or the Customer's agent from Supplier or provided by Supplier, including, but not limited to: valves, pipe, fittings, product or general equipment, supplies, parts, materials, supplies and/or merchandise sold by Supplier or provided in connection with Supplier's provider capabilities or needed by Supplier to assist Supplier in the performance and delivery of its product to Customer, but "Equipment" excludes "Services" as defined below.

4) Services

"Service(s)" refers to all employees or agents furnished by Supplier as consultants and/or to perform any function, including the operation of equipment which performs any function, trucks or other merchandise necessary to perform any function when operated by Customer's employees or agents or the Supplier's employees or agents on Customer's job or to satisfy the Customer's order or orders.

5) Claims

"Claim(s)" refers to all of the following:

- any liability of Supplier to Customer; b) loss of equipment, time, money, or profit of Supplier; and c) claim, demand, cause of action, proceeding, damage to person, damage to personal or real property, damage and penalty, including attorney's fees, costs and expenses.

6) Price Book, Price List, Manual, & Credit Application

Customer agrees to be bound by all relevant provisions of the following:

- "Supplier's Price Book" and "Price Book" refer to the current book published by Supplier which may list the Supplier's contractual terms and conditions, lists prices for Equipment and Services offered by Supplier, including all amendments;
- "Supplier's Manual," "Manual" and "Employee Manual" refer to any manual of Supplier governing, which may contain its contractual terms and conditions, the procedures for pricing Equipment and Services of Supplier, or the manner in which Supplier is to provide goods or services plus all amendments and updates. Customer agrees to be bound by such terms and conditions, procedures; and
- "Supplier's Credit Application" and "Credit Application" refer to any application or request submitted by Customer to Supplier for the purpose of seeking the extension of credit by Supplier and which may contain the Supplier's terms and conditions all of which shall be binding on the Customer.

General Terms & Conditions

Customer acknowledges that it has reviewed and agrees to be bound by the above and following (Definitions, Terms and Conditions and all of the language contained herein and in related documents described elsewhere herein) whenever it or its employees, transportation and/or warehouse company, its customer or end user, and/or agent either: i) accepts the Equipment or Services of Supplier; or ii) signs a Credit Application, service order, delivery ticket, bill of lading or contract for goods or services; or iii) receives an invoice from Supplier and/or orders more Equipment or Services from Supplier.

1) Entire Contract

The Terms and Conditions herein, in the invoice, acknowledgement or acceptance of Customer's order, Price Book, Manual and Credit Application as defined above and elsewhere herein, the other documents aforementioned, all of which are incorporated herein by reference for all purposes, constitute the entire contract ("Contract") between the parties and may not be amended except in writing signed by Supplier's authorized representative.

2) Controlling Terms and Conditions

Equipment or Services furnished to Customer by Supplier or its agents will be controlled only by the Terms and Conditions contained herein and contained in the other documents of Supplier mentioned herein and these are the only terms and conditions to which these parties shall be bound. In the event that Customer writes any letters or uses any other document generated by Customer to order or accept Supplier's Equipment or Services, the Terms and Conditions contained herein shall control and this document does hereby serve as an objection thereto.

3) Failure of Any Party to Enforce

The failure of either party to enforce any provision hereof will not constitute a waiver or preclude subsequent enforcement thereof.

4) Invalidity of Any Term or Condition Contained Herein

No partial invalidity of this Contract will affect the remainder. In the event that any term or condition contained herein is found to be invalid, the parties agree that the remainder of Supplier's contract shall remain valid.

5) Jurisdiction and Venue; Construction of Terms and Conditions

The Parties hereto agree that the terms and conditions of Supplier's documents mentioned herein and the Terms and Conditions of this document shall be construed in accordance with the laws of the State of Texas or, if offshore, in accordance with General Maritime Law of the United States, without giving effect to respective conflicts of law principals, or Supplier at its exclusive option may choose the Jurisdiction to interpret the terms and conditions contained herein and in the other documents mentioned herein. In the event of litigation between Customer and Supplier, Customer hereby waives any claim it may have to any jurisdiction and venue other than that chosen by Supplier. Customer agrees that it is to perform its obligations herein in Houston, Harris County, Texas, non-exclusively to include payment. Canada: Whenever the facts of a particular contract would in the sole opinion of the Supplier be best litigated in Canada, the parties agree that Supplier can choose that jurisdiction and that Supplier can choose any venue it deems appropriate in Canada. All the other terms and conditions contained in this document shall then apply in Canada as if this agreement was in the United States of America.

6) Credit

Terms are cash in advance unless credit is approved in writing prior to the sale. If credit is approved, Customer must maintain credit satisfactory to Supplier. When Customer or its agent signs any of Supplier's documents in the process of ordering or receiving Equipment or Services from Supplier, it states for Supplier's reliance that it has the current ability to pay for the Equipment or Services ordered or accepted and it further agrees that Supplier reserves the right to require Customer to furnish security for performance of Customer's obligations. Payments shall be made in U.S. Dollars net 30 days at Supplier's address in Houston, Harris County, Texas. If credit terms are not met or Customer otherwise fails to follow the Terms and Conditions contained herein, in addition to its other legal rights, Supplier may and Customer hereby authorizes Supplier to: a) defer or cancel further shipments of Equipment or Services and/or otherwise decline to provide its product to Customer; b) enter upon any property or job site on which the Equipment of Supplier is located by taking any necessary action, including, but not limited to, opening gates, cutting locks, cutting chains; c) authorize any other company to remove its equipment from any location, to the extent needed for Supplier to be able to remove its equipment, and said company moving its equipment shall send its bill for the same to Customer or Supplier may pay said bill and include the same in its bill to Customer; d) take any action needed to remove its equipment from the job site; e) act as stated herein at the expense of Customer and Customer hereby indemnifies and holds harmless Supplier from any harm arising from said actions, including, but not limited to, environmental harm, harm to the real property and personal property and harm to the real and personal property of any third party; and f) charge Customer interest on any unpaid balance at the lesser of: i) eighteen percent (18%) per annum, or ii) the maximum rate permitted by applicable law.

7) Taxes

Customer shall be responsible for all customs fees, duties, and foreign, federal, state or local taxes (including, sales, use, excise or similar taxes and foreign withholding taxes).

8) Transportation

For Equipment sold, Customer may arrange shipment and will pay all crating, handling and shipping costs. Risk of loss passes to Customer at the time Customer and/or any carrier takes possession of the Equipment from Supplier. For Equipment sold where Customer does not timely furnish shipping instructions or requests that Supplier arrange shipment, such transportation shall be in a commercially reasonable manner at Customer's risk and invoiced to Customer at current freight rates, plus all handling incurred, or at the prevailing mileage rate for any vehicles used by Supplier's personnel. Risk of loss will then pass to Customer at the time the Equipment leaves Supplier's premises, warehouse or store. All claims for shortages, damages, corrections or deductions must be made in writing within 10 days from receipt of goods and if shipper fails to comply, it waives its right to make a claim.

9) Consequential and Incidental Damages

Supplier will not be responsible for consequential or incidental damages of any kind, which shall include, but not be limited to, loss of profits, use or business opportunity, damages for failure to meet deadlines, pollution damage and/or wreck or debris removal expense and Customer holds harmless and indemnifies Supplier from all harm arising from any claims made against Supplier from out of any of these things.

10) Force Majeure

Supplier will not be liable for any damages, including special and consequential damages, as stated above, caused by events of force majeure or any other occurrences beyond Supplier's reasonable control subject to all of the limitations contained herein. In such event, the time for performance will be extended automatically for such reasonable time as is necessary to permit performance hereof.

11) Disclaimer Of All Warranties Except Those Specifically Granted Herein Supplier hereby disclaims all warranties except those specifically granted and states as follows:

- Supplier makes no warranties of any kind regarding its equipment and/or services;
- technical information and any assistance in equipment installation or technical or engineering information concerning equipment or services provided by Supplier will be advisory only, at Customer's sole cost and on an "as is" basis;
- no warranty is given with respect to such services or information and Supplier will not be liable for any claims arising from its furnishing or Customer's use of such assistance or information;
- Supplier specifically disclaims all implied warranties, the warranty of merchantability, warranty of fitness for a particular purpose and any warranty that the equipment or service provided by Supplier will actually accomplish the goal(s) desired by Customer. Supplier grants to Customer only a limited warranty as follows: Supplier grants only to Customer only a 1-year warranty on material and workmanship on its new products commencing at date of shipment.

12) Insurance

The parties agree that the indemnities provided by Customer to Supplier herein shall be supported either by available insurance or that Customer shall voluntarily become self-insured, in whole or part and upon request of Supplier prove that Customer is good for the loss and that Customer is sufficiently self insured. In addition, Customer shall, at its expense, maintain adequate insurance to fully protect any Equipment or Services or personnel supplied by Supplier and shall supply to Supplier, upon request, satisfactory evidence of sufficient insurance coverage to protect Supplier, Supplier's property, Supplier's personnel and Supplier's liability.

13) Prices

All Supplier's, terms, conditions, prices, rates and charges are subject to change without notice.

14) Assignment

Customer may not assign any rights or obligations hereunder, without Supplier's prior written consent.

15) Amendment of Indemnities to Conform to Law

The indemnities provided by Customer herein shall be limited to the extent necessary for compliance with applicable state and federal laws.

16) Termination/Cancellation

Unless provided otherwise in writing herein, Customer cannot terminate or cancel any order once Supplier has accepted the order. No termination shall relieve Customer of any liability incurred and Customer's obligations shall survive such termination, including all hold harmless and all indemnities and all warranties & non-warranties contained herein which are made expressly for the benefit of Supplier.

- Termination Policy: No goods or products supplied pursuant hereto may be returned without Supplier's written permission. Supplier assumes no responsibility without Supplier's written permission. All returns shall be made freight prepaid. Supplier will charge to Customer a 25% Restocking Charge upon the return of goods by Customer.
- Special Orders: A special order is an order for any product of Supplier or which comes from Supplier's sources which is non standard requiring separate/additional manufacturing, engineering, modification, tooling and machining. If Supplier agrees in writing that a Special Order can be terminated, Special Orders cannot be cancelled unless Customer agrees in writing to pay for all work including engineering completed up to the time of cancellation.

17) Default

If Customer ever defaults on or breaches any Term or Condition contained herein or in any other document of Supplier mentioned above, all charges for all Equipment and Services provided by Supplier for Customer's benefit shall automatically accelerate and shall immediately become due and payable, notwithstanding any other provision which would afford Customer, under normal circumstances, any stated amount of time in which to pay for said charges. In addition, all discounts which may have been offered to Customer shall automatically and immediately be revoked and become fully due and owing with no action or notice from Supplier, notwithstanding any other provision to the contrary. If Customer ever disputes any charges of Supplier, Customer shall tender to Supplier all amounts for all charges which are not disputed by Customer. Customer hereby indemnifies and holds Supplier harmless for and agrees to reimburse Supplier for all costs of collections, including, but not limited to, actual attorney's fees and costs incurred in connection with the collection of past due amounts and defending against any counterclaims. Notwithstanding any other provision in this document or any other document or check, Customer agrees that all payments received by Supplier on Customer's account may be applied first to all outstanding interest and then to the oldest amounts owed by Customer to Supplier, and this provision is not waived by Supplier by accepting any check from Customer containing contrary language.

18) Customer Holds Harmless and Indemnifies Supplier

Customer shall hold harmless, defend, indemnify, release and hold Supplier harmless from and against any and all claims by Customer, Customer's customer, owner, or any other person or entity against Supplier of every kind or character, whatsoever, whether such claims are based on theories of contract law, tort law, or otherwise, direct or indirect, including incidental, special and consequential damages caused by Supplier arising out of delivery, pick-up, repair, use or operation of equipment or services relating to execution, completion or termination of this contract or on account of bodily injury or death or property damage, destruction or economic loss (including, but not limited to release of radioactive materials, contamination or damage to real property or personal property, land, buildings, vehicles, or property rights) because of purchase, delivery, installation, possession, operation, use, condition or return of goods, people, services and/or equipment used, purchased, or used during the term of this contract, or on account of infringement of any patent, design, copyright, or trade name or mark, whether by Supplier, Customer or otherwise, irrespective of whether Supplier was concurrently negligent or at fault for any such claims where the damage, injury or death was caused by the sole or partial negligence of Supplier.

19) Inspection

Customer's acceptance of delivery and signature of its representative on any delivery tickets or other Supplier documents is conclusive evidence that Customer found the Equipment to be suitable for its needs and in good condition and that the signor was the agent for Customer or Customer's Customer, building or land owner, contractor, sub contractor and operator. Customer also has a duty to inspect Equipment prior to use and to notify Supplier immediately of any defects and before use of the Supplier's product. SALE TERMS: The following are in addition to and a part of all other Terms and Conditions provided for herein.

20) Limited Liability/Disclaimer

- Supplier does warrant Equipment sold by Supplier to Customer to be free from defects in material or workmanship.
- In the event that a court finds that Supplier is liable for any breach of contract or any breach of warranty, Supplier's liability for said breach is expressly limited to the repair or replacement, at its sole option, of any Equipment which proves to be defective during any period declared by the court to be a period of warranty. All such Equipment shall be repaired or replaced F.O.B. Supplier's plant, warehouse, store or premises.
- In the event that a court finds that Supplier has an obligation to repair or replace equipment, said repair or replacement constitutes agreed and liquidated damages for any breach of Supplier's actual or court-declared warranty.
- The remedies stated above for any such breach thereof, shall be in lieu of all other

warranties, express or implied, including all other warranties for merchantability or fitness for any particular purpose which Supplier has specifically disclaimed herein, and in lieu of liability for Supplier's negligence or fault and Customer's rights and remedies under the Texas deceptive trade practices consumer protection act (chapter 17, Texas business and commerce code).

21) Prices

- Prices for standard equipment will be the sales price shown on Supplier's current product sales price list ("Price List") or Price Book, F.O.B. Supplier's plant, warehouse, district stock points, or premises.
- Requests for quotations for nonstandard Equipment should be sent to the appropriate Supplier office. Quoted prices are valid for 30 days after the date of the quotation, unless otherwise noted on the quotation or unless canceled by Supplier prior to Customer's acceptance.
- Cost of additional labor, materials or outside services for modification of such procedures or specifications requested by Customer will be charged to Customer at Supplier's prevailing rate.
- Services required to install Equipment will be based on the prevailing rates at the time of installation.

22) Delivery/Disclaimer

- Supplier will use its best efforts to have Equipment ready for shipment, subject to receipt of all necessary Customer information, including approved drawings. HOWEVER, SUPPLIER ASSUMES NO LIABILITY FOR DAMAGES INCURRED AS A RESULT OF ITS LATE DELIVERY OF EQUIPMENT, SUPPLIES, PRODUCT, PERSONAL PROPERTY, REGARDLESS OF CAUSE.
- Title and risk of loss will pass to Customer upon delivery of Equipment, F.O.B. Supplier's plant, warehouse or premises.
- If unable to deliver, Supplier may charge Customer its customary storage rates and Customer will maintain all-risk property insurance on Equipment, at its replacement value. Supplier will not be liable for deterioration of Equipment, personal property, product resulting from atmospheric conditions, acts of God, or other events regardless of whether they are within Supplier's reasonable control while in Supplier's possession or in transit to Customer's destination or location.

Service Terms

The following are in addition to and a part of all other Terms and Conditions provided for herein.

1) Limited Liability/Disclaimer

- Supplier will use its best efforts to ensure that all personnel furnished are competent and that Equipment, supplies, personal property or product furnished is in good condition; however, Customer agrees that the Equipment and personnel come without warranty or guarantee of any kind whatsoever except as provided herein.
- Supplier's personnel will attempt to perform the work requested by Customer; however, because of the nature of the work to be accomplished and because of the unpredictable conditions which always exist, such results as required by Customer or Customer's Customer cannot be and are not guaranteed or warranted and Customer agrees that Supplier makes no warranties of any kind and that Supplier does not guarantee any particular result as from furnishing people, goods, product, personal property, equipment or services.
- Supplier reserves the right not to do work if, in its sole discretion, job conditions render such action inadvisable for any reason or unsafe for any reason.
- Customer agrees that any employee(s) furnished by Supplier shall not be responsible for any final decision made on any job. Rather, Customer shall retain complete control and supervision of the job, building site, project and performance of operations in and about the job site.
- Customer shall pay Supplier for Equipment and Services regardless of whether the desired results are achieved without any deduction or offset of any kind, irrespective of any Claims which Customer may assert or allege against Supplier or any Supplier and/or manufacturer of Equipment and/or Services, at the rates indicated in the Customer's document, manual, delivery documents or Price Book in effect at the time of delivery.
- Customer will be invoiced at the sales rate or service rates in effect at the beginning of the invoice period.
- Supplier makes no warranty or representation of any kind, express or implied, as to the quality, performance or function of its people, as to the design, operation, condition or quality of the material or workmanship of equipment or performance of equipment delivered to Customer, it being agreed that all such risks as between Supplier and Customer are to be borne by Customer, regardless of whether such equipment is operated under Supplier's supervision, and all equipment, services and people are accepted by Customer "as is" except as provided elsewhere herein. Customers desiring different standards than those contained herein should, at Customer's expense, obtain an inspection of goods, services, equipment and people prior to use and the benefits of any and all implied warranties of Supplier are hereby waived by Customer except as elsewhere provided herein.

2) Charges

All charges are on a daily basis for a 24-hour day or any part stated therein.

- Services
 - all Services are on a daily or hourly basis, subject to any minimum charge, all of which are specified by Supplier in Supplier's documents mentioned herein;
 - charges begin when each Service person departs Supplier's store location where said person or Equipment is based and the charges shall continue until returned to that store;
 - Customer shall furnish quarters and meals for Supplier's personnel or reimburse Supplier for reasonable living expenses incurred at the prevailing rate from the time each Service person leaves the Supplier's location until return to Supplier's location;
 - if personnel and/or Equipment are dispatched at Customer's request, but are later canceled, Customer will be invoiced for a "dead call" as provided in the Price Book or other Supplier documents mentioned herein.
- Standby Charges: Standby rates may be applied under conditions specified in the Price Book.

3) Trade Discount

Trade discounts, if any, apply only to Equipment, goods, or services which are paid for within 30 days of the invoice date. In the event payment is not timely made, with time being deemed to be of the absolute essence, all discounts granted are automatically revoked and reversed on Customer's account and are fully due and owing.



The Reliable Source

The Reliable Source

www.NewmansValve.com

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Newco COOPER OTC QuadroSphere Trinity

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* = Canadian 800 numbers work only in Canada.

**“Quality in Design”
“Durability in Construction”**

**Toll Free: 1.800.231.3505
www.NewmansValve.com**

Maintenance Bulletin - International H-Series

(1 1/4" to 3" NPT, BSPF, BSPT Sizes only)

MB-143

Compressed Air
and Gas Filters

INSTALLATION

Finite H-Series filters should be installed in a level pipeline, mounted vertically, the bowl downward with one bowl length clearance for element removal. The filter should be installed at the highest pressure point available, and as near as possible to the equipment to be protected and have a drip leg immediately upstream. The coalescers and particulate filters should be visible and easily accessible for periodic draining and maintenance. Filters should be piped according to these instructions also following the flow direction label on the filters.

Filters up to and including 2" connection sizes flow as follows:

- Coalescers/WS:** from port 1 to port 2
- Interceptors:** from port 2 to port 1
- Adsorbers:** from port 2 to port 1.

Filters with connection sizes 2 1/2" and 3" flow as follows:

- Coalescers/WS:** from port 1 to port 2
- Interceptors:** from port 1 to port 2
- Adsorbers:** from port 1 to port 2.

The following are recommended filter locations relative to other compressed air equipment (unless specific instructions are given to the contrary):

- (1) COALESCERS and WATER SEPARATORS (WS) (liquid removal) are placed before the dryer.
- (2) The INTERCEPTOR (particulate removal) should be installed ahead of the COALESCER when prefiltration is required.
- (3) The INTERCEPTOR (particulate removal) can also be installed downstream of desiccant dryers to prevent desiccant migration.
- (4) The ADSORBER (vapor removal) is always preceded by a COALESCER.

When Coalescer or Interceptor differential pressure reaches clogged condition (6-10 PSID) replace element immediately. DO NOT ATTEMPT TO CLEAN FILTER TUBE. System contamination can result. DO NOT BY-PASS THE COALESCER unless the by-pass line is also filtered.

OPERATION

Air coalescing is a continuous, balanced, steady-state process occurring at or below rated flow, which depends on two factors for high performance: (1) The bowl must be kept free of waste liquid buildup and (2) The element must be replaced when the differential pressure reaches 6-10 psid, 12 psid Maximum. Differential pressure can be sensed at the inlet and outlet ports by two gauges, or by Finite's DPI-13 differential pressure indicator, DPG-15 differential pressure gage, or by observing system characteristics.

Bowl draining is accomplished by opening the manual drain valve (standard on all housings), at least once every 8 hours depending on the liquid load. The Finite Auto-Drain AD-12 is a useful tool that replaces manual draining. Finite has an assortment of electrically timed drain valves that can be used to drain the bowl automatically.

A Finite coalescer, under normal system conditions, will operate for 6 to 12 months before reaching its Maximum differential pressure. A "PU" series Interceptor, or a "QU" series coalescing element with a pleated prefilter can be employed ahead of the coalescer to increase its life. The interceptor should be replaced when its differential pressure reaches 8 - 10 PSID.

Finite coalescers are designed for nominal operation with 10-20 wt. oil. Any viscosity increase over that of 20 wt. oil must be offset by a proportionate oversizing of the filter element. Consult your Finite representative.



DANGER

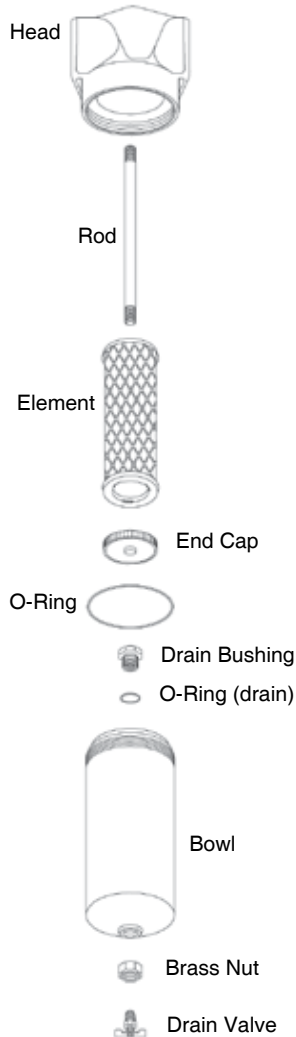
Filter housings must be depressurized before performing any maintenance activities.

TROUBLESHOOTING CHART

Problem	Probable Cause	Solution
Too High Initial Pressure Drop	Air flow Excessive for housing size. Filter media grade too fine.	Install larger filter. Install coarser element.
	Too much oil/water from compressor.	Precoalesce with grade 10 - oversize housing.
Premature Clogging (Air Flow Drops Off)	Lubricant improperly selected for compressor, causing varnish or carbonizing of lubricant.	Change oil, consult with lubricant supplier.
	Excessive inlet particulate contamination.	Prefilter with Interceptor.
	Excessive lubricants present on element caused by either high lubricant viscosity or very high inlet aerosol level.	Prefilter with Grade 10 and oversize coalescer to compensate.
	Oil/water emulsion forming on element.	Remove water by drip leg, aftercooler. Install mechanical separator upstream.
Oil Present Downstream of Filter	Ice forming or oil viscosity too high due to Excessively low unit temperature.	Raise temperature.
	Bowl not properly drained of waste liquids.	Drain regularly, use auto drain.
	Element not sealing.	Replace element.
	Filter piped backwards.	See "INSTALLATION"; Re-pipe.
	Filter being by-passed by valving.	Close valve.
	Contaminated air entering system from second source downstream.	Change pipe or relocate filter.
	Oil vapors condensing downstream.	Install an adsorber.
Excessive inlet oil level.	Precoalesce with Grade 10 and possibly oversize.	
Element damaged, chemically attacked or not installed in housing.	Change and consult distributor or factory for other than neutral pH.	
	Oil present in precontaminated downstream piping.	Clean piping.
	Excessive flow surges.	Relocate filter, precoalesce with grade 10 and oversize coalescers.

Assembly Drawing/Parts List

1 1/4" to 3" NPT/BSPF/BSPT



Part Name Port Size	H_5S 1 1/4"	H_6S 1 1/2"	H_8E 2"	H_8S 2"	H_8L 2"	H_OL 2 1/2"	H_12L 3"
Head - NPT	41328	41329	41330	41330	41330	41331	41332
Head (DPI) - NPT*	41333	41334	41335	41335	41335	41336	41337
Head, Δ P Ports NPT	41338	41339	41340	41340	41340	41341	41342
Head - BSPF	41434	41435	41436	41436	41436	41437	41438
Head (DPI), BSPF	41444	41445	41446	41446	41446	41447	41448
Head, Δ P Ports BSPF	41452	41453	41454	41454	41454	41455	41456
Head - BSPT	41478	41479	41480	41480	41480	41481	41482
Head (DPI) - BSPT*	41488	41489	41490	41490	41490	41491	41492
Head, Δ P Ports BSPT	41498	41499	41500	41500	41500	41501	41502
Head (DPI) - SAE32	N/A	N/A	42106	42106	42106	N/A	N/A
Elements:							
□CU		□CU25-130	□CU25-187	□CU25-235	□CU35-280		
□DV		□DV25-130	□DV25-187	□DV25-235	□DV35-280		
□QU		□QU25-130	□QU25-187	□QU25-235	□QU35-280		
7CVP		7CVP25-130	7CVP25-187	7CVP25-235	7CVP35-280		
3PU		3PU25-130	3PU25-187	3PU25-235	3PU35-280		
100WS		100WS25-130	100WS25-187	100WS25-235	100WS35-280		
AU		AU25-130	AU25-187	AU25-235	AU35-280		
Rod		41347	41348	41349	41585		
End Cap			45079		45080		
End Cap (high temp)			41040		45080		
O-Ring			76246		75046		
O-Ring (high temp)			76246V		75046V		
Brass Drain Bushing			23054				
O-Ring (drain)			76114V				
Bowl Only		41464	41465	41466	41467		
Bowl Assy. w/Manual Drain		41533	41534	41535	41536		
Brass Nut			23041				
Drain Valve			70010				
Manual Drain Kit (includes Drain Valve, Brass Nut, Brass Drain Bushing and O-Ring) EBD-12							

□=insert grade 2, 4, 6, 8 or 10

* DPI-13 or DPG-15 Differential pressure indicator required.

Optional Accessories

Differential Pressure Indicator Options

(When installed - Max. Operating pressure = 250 PSIG @ 175°F)
DPI-13 includes all parts listed out below plus a base plate (41117) for remote mounting.

Also available:

Kit 2095 (DPI hole block off kit)

Kit 2003 (contains all DPI-13 parts listed below)

Also available DPI-13 Spare Parts:

Cap Screws - (2) 70005



Bracket - 40894



Shell - 40605



Spring - 40006



Piston - 40604



Diaphragm - 41569



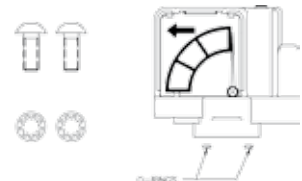
Automatic Drain Valve AD-12



(When installed - Max. Operating Pressure = 250 PSIG @ 175°F)

Differential Pressure Gauge DPG-15

(When installed - Max. Operating Pressure = 500 PSIG @ 175°F)



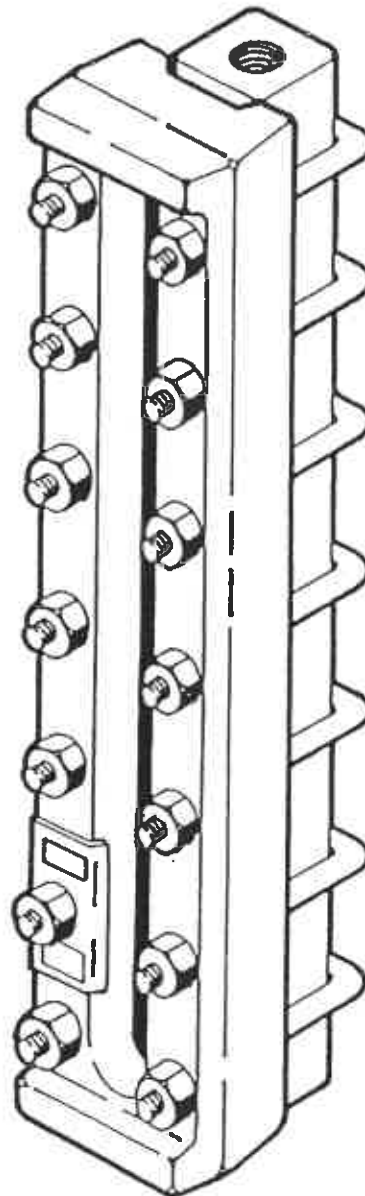
Note: DPG-15 comes with two o-rings and two screws (shown above) for mounting.

PENBERTHY®

Section 2000
Instal. Instr. 2950M
Issued 9/96
Replaces 6/95

Flat Glass Gages

Series M



Installation/Operation/Maintenance Instructions

TABLE OF CONTENTS

Product Warranty	i
1.0 About the Manual	1
2.0 Introduction	1
2.1 System Description	1
3.0 Available Models	2
3.1 Design Ratings at Maximum and Minimum Operating Temperature	2
4.0 Inspection	4
4.1 Glass Inspection	4
4.2 User Rating Inspection	4
5.0 Installation	5
5.1 Piping Strain	5
5.2 Differential Thermal Expansion	5
5.3 Mirror Viewing	5
5.4 Nut Retorquing	5
5.5 Belleville Washers	6
6.0 Operation	7
6.1 Hydrostatic Test	7
7.0 Maintenance	8
7.1 Maintenance Procedures	8
7.2 Troubleshooting	9
8.0 Removal - Disassembly - Reassembly	9
8.1 Disassembly	10
8.2 Inspection of Glass Seating Surfaces	10
8.3 Reassembly	11
9.0 Disposal at End of Useful Life	12
10.0 Telephone Assistance	12
11.0 Exploded Parts Drawing	14

TABLES AND FIGURES

	<u>page</u>
Table 1 Design Ratings of RM Gage	2
Table 2 Design Ratings of TM Gage	3
Table 3 Bolt Torque Values	6
Table 4 Conical Spring Height for Belleville Washers	7
Figure 1 Nut Tightening Sequence	6
Figure 2 Belleville Washer Height	7
Figure 3 Nut Loosening Sequence	10

PRODUCT WARRANTY

Penberthy Inc., warrants its products as designed and manufactured by Penberthy to be free of defects in material and workmanship for a period of one year after the date of installation or eighteen months after the date of manufacture, whichever is earliest. Penberthy will, at its option, replace or repair any products which fail during the warranty period due to defective material or workmanship.

Prior to submitting any claim for warranty service, the owner must submit proof of purchase to Penberthy and obtain written authorization to return the product. Thereafter, the product shall be returned to Penberthy in Prophetstown, Illinois, with freight prepaid.

This warranty shall not apply if the product has been disassembled, tampered with, repaired or altered outside of the Penberthy factory, or if it has been subjected to misuse, neglect or accident.

Penberthy's responsibility hereunder is limited to repairing or replacing the product at its expense. Penberthy shall not be liable for loss, damage, or expenses directly or indirectly related to the installation or use of its products, or from any other cause or for consequential damages. It is expressly understood that Penberthy is not responsible for damage or injury caused to other products, building, property or persons, by reason of the installation or use of its products.

THIS IS PENBERTHY'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This document and the warranty contained herein may not be modified and no other warranty, expressed or implied, shall be made by or on behalf of Penberthy unless modified or made in writing and signed by the President or a Vice President of Penberthy.

1.0 About the Manual

This manual has been prepared as an aid and guide for personnel involved in installation or maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation, or maintenance. Failure to follow *any* instruction could possibly result in a malfunction of the gage or glass breakage with resulting sudden release of pressure, property damage or physical injury to personnel.

SAFETY INSTRUCTIONS

Penberthy does not have any control over the manner in which its liquid level gage is handled, installed or used. Penberthy cannot and will not guarantee that a liquid level gage is suitable or compatible for the user's specific application.



WARNING



Contained fluids may be pressurized and can unexpectedly exit vessel connections due to apparatus or material failure. Safety glasses should be worn when installing a liquid level gage. Failure to do so could result in serious physical injury to personnel.

2.0 Introduction

Penberthy liquid level gages are used to allow direct visualization of liquid level in vessels. By peering through the glass, it is possible to monitor color, clarity, and level of a gas/liquid interface. Gages are available in varying lengths and configurations (end connect, side connect, multiple sections, NPT or flange connections, etc.). Visual indication can be enhanced by using reflex glass or illuminators (accessory).

2.1 System Description

Penberthy gages are comprised of six basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the gage. Use the exploded parts view in Section 11 as additional reference material.

Chamber - provides a pressure retaining metallic channel for the liquid to enter and be viewed. Slot(s) are machined into the chamber to provide direct visualization of the process fluid.

Gaskets - seal the gap and prevent leakage between the chamber and the glass. Gaskets are available in a variety of materials for compatibility with the media in the gage.

Glass - glass allows for visual observation of the process fluid in the chamber

Cushion - acts as a protective buffer between the glass and the cover. For proper sealing cushions must be as hard as or harder than the gasket material.

Cover - protects the glass assembly from external hits and provides a flat, rigid surface that is used to evenly compress the gage assembly.

Bolting - compresses the components between the covers (transparent gages) or cover and chamber (reflex gages).

Shield (optional) - used to prevent the process media from contacting the glass.

3.0 Available Models

Penberthy medium (Series M) pressure liquid level gage are designed for applications other than steam/water: 1) requiring pressure ratings lower than that of Penberthy Series H liquid level gages, 2) where pressure ratings are greater than those possible using low pressure (Series L) liquid level gages, or 3) for Series L pressure ranges where iron covers are not allowed.

3.1 Design Ratings at Maximum and Minimum Operating Temperatures

Gasket Material	Glass Size	Model RM Reflex	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoil® (standard) or Non-Asbestos	1 2 3 4 5 6 7 8 9	-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
		3000 PSIG (20685 KPa)	2220 PSIG (15305 KPa)
		2910 PSIG (20065 KPa)	2150 PSIG (14825 KPa)
		2820 PSIG (19445 KPa)	2080 PSIG (14340 KPa)
		2725 PSIG (18790 KPa)	2040 PSIG (14065 KPa)
		2630 PSIG (18135 KPa)	1950 PSIG (13445 KPa)
		2535 PSIG (17480 KPa)	1875 PSIG (12930 KPa)
		2440 PSIG (16825 KPa)	1805 PSIG (12445 KPa)
		2345 PSIG (16170 KPa)	1740 PSIG (12000 KPa)
		2250 PSIG (15515 KPa)	1660 PSIG (11445 KPa)
PTFE/ Top-Chem 2000®	1 - 9	3000 PSIG (6205 KPa) at -20°F (-29°C) to 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F (37°C) 450 PSIG (3105 KPa) at 500°F (260°C)	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	

TABLE 1

NOTE:

Lower temperatures are possible with metallic material variation. (e.g., 316 Stainless construction, Grafoil® gaskets/cushions useable to -325°F [198°C])

Gasket Material	Glass Size	Model TM Transparent	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoil® (standard) or Non-Asbestos	1 2 3 4 5 6 7 8 9	-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
		2500 PSIG (17235 KPa)	1850 PSIG (12755 KPa)
		2315 PSIG (15960 KPa)	1720 PSIG (11860 KPa)
		2130 PSIG (14685 KPa)	1575 PSIG (10860 KPa)
		1940 PSIG (13375 KPa)	1435 PSIG (9895 KPa)
		1750 PSIG (12065 KPa)	1295 PSIG (8930 KPa)
		1565 PSIG (10790 KPa)	1160 PSIG (8000 KPa)
		1375 PSIG (9480 KPa)	1015 PSIG (7000 KPa)
		1190 PSIG (8205 KPa)	880 PSIG (6070 KPa)
		1000 PSIG (6895 KPa)	740 PSIG (5100 KPa)
PTFE/ Top-Chem 2000®	1 - 9	2500 PSIG (6205 KPa) at -20°F (-29°C) to 500°F(260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F(37°C) 450 PSIG (3105 KPa) at 500°F (260°C)	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F(37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F(37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F(37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	
PCTFE/(Kel-F®) Shields 0.063" (1.6 mm) thick	1 - 9	300 PSIG (2067 KPa) at -20°F (-29°C) to 100°F(37°C) 180 PSIG (1240 KPa) at 400°F (148°C)	

TABLE 2

NOTE:

Lower temperatures are possible with metallic material variation. (e.g., 316 Stainless construction, Grafoil® gaskets/cushions useable to -325°F [198°C])

The pressure and temperature ratings may deviate from the above tables if the gasketing materials of construction and/or bolting are other than those specified. Higher and/or lower temperature ratings are available with different materials of construction.

To determine the maximum allowable working pressure for a specific temperature within the design limits stated in the tables, the user should refer to Penberthy dimension sheets, or when provided, the specifically stated design limits on a Penberthy product proposal.

NOTE: under no circumstances should shields be used in reflex style gages. Installation of shields in reflex style gages will keep the liquid from coming in contact with the refractive prisms, thereby prohibiting visualization of the liquid level in the gage.



NEVER exceed these design ratings or application data. Exceeding design ratings or application data may result in mechanical failure of gage components resulting in death, serious personal injury and property damage.

4.0 Inspection

Upon receipt of a liquid level gage, check all components carefully for damage incurred in shipping. If damage is evident or suspected, do not attempt installation. Notify carrier immediately and request damage inspection.

Penberthy's standard 1 section TM gage consists of: (1) chamber, (2) gaskets, (2) borosilicate flat glass, (2) rubber bands, (2) cushions, (2) covers, (1) washer, (1) nameplate, and (6 - 14) bolting sets, depending on the size.

4.1 Glass Inspection

The self stick caution tape was applied at the factory to protect the glass during shipping, handling, and installation. Do not remove the tape from the glass until all installation procedures have been completed, except during receiving inspection to momentarily inspect glass for shipping damage. Glass that is not protected will be vulnerable to dust, grit, tools and any other objects which may scratch, chip, or break the glass.



WARNING



DO NOT use glass that is chipped or even slightly scratched. Glass surface defects weaken the glass which may result in glass breakage and fluid loss under pressure resulting in serious personal and property damage.

4.2 User Rating Inspection

The user should confirm that:

- 1) the Series M liquid level gage model and assembly number stamped on the nameplate conforms to the description on the user's purchase order,
- 2) the operating conditions described in the purchase order agree with the actual operating conditions at the installation site,
- 3) the actual operating conditions at the installation site are within the application data shown on the Penberthy Technical Data Bulletin or product proposal referred to above, and
- 4) the materials of construction of the liquid level gage are compatible with both the contained media and surrounding atmosphere in the specific application.

SAFETY INSTRUCTIONS

If the size, model, or performance data of the liquid level gage as received does not conform with any of the criteria above, do not proceed with installation. Contact an authorized Penberthy distributor for assistance. The incorrect gage can result in unacceptable performance and potential damage to the gage.

5.0 Installation

Installation should only be undertaken by qualified personnel who are familiar with equipment of this type. They should have read and understood all of the instructions in this manual. The user should refer to Penberthy dimension sheets or Penberthy product proposal to obtain dimensional information for the specific size and model liquid level gage.

Penberthy recommends that all liquid level gage installations be provided with gage valve sets equipped with ball check shut-off. Gage valve sets are designed to isolate the gages from the pressure vessel when it becomes necessary to drain or service the gages. The ball check shut-off is designed to retard leakage of the contained fluid in the event of gage glass breakage. Ball checks are available for both positive and negative vessel pressures.

The number of different types of gage and valve installations is too great to adequately detail in an installation manual. It is, therefore, the user's responsibility to assure that the knowledgeable installation personnel plan and carry out the installation in a safe manner. The following procedures are some of the installation guidelines that should be employed.

5.1 Piping Strain

The gage should be mounted and connected so that it does not support any piping weight. Piping not properly supported, independent of the gage, may subject the gage to stresses that can cause leaks or glass breakage. Support brackets are available as an accessory.

5.2 Differential Thermal Expansion

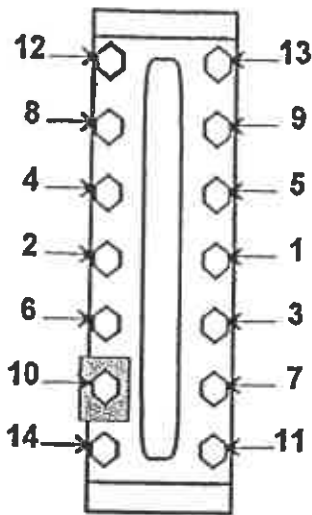
High mechanical loads may be imposed on a gage by expanding and contracting pipes due to hot or cold service. Such mechanical loads on the gage must be minimized by the use of expansion loops in the system. Failure to allow for expansion or contraction can result in leaks or glass breakage.

5.3 Mirror Viewing

For added safety, a system of indirect viewing by means of mirrors should be installed to protect personnel from the hazards of possible gage failure.

5.4 Nut Retorquing (not applicable for gages with Belleville washers) - see Section 5.5

Nut retorque is vital to the operation of a liquid level gage because gaskets take permanent set under initial bolt loading at assembly. Tightening of nuts before installation to values specified in Table 3 is necessary to insure pressure retaining capabilities of liquid level gage to specific design ratings. The user must refer to the liquid level gage model and assembly number and to the purchase order or tag to determine materials of construction.



**Nut Tightening Sequence
Figure 1**

BOLT TORQUE VALUES

GAGE MODELS and GASKET MATERIAL	ft-lb
RM, TM w/Grafoik® (standard)	25 to 30
RM, TM w/Non-asbestos (optional)	30 to 35
Top-Chem 2000®	25 to 30
25% glass filled PTFE	20
All Models w/Teflon®, Viton® or elastomeric (optional)	10
TM with PCTFE/(Kel-F®) Shields (optional) 0.063"	10

Table 3

Using a torque wrench, tighten nuts in five ft-lb increments following the "Z" pattern sequence in Figure 1, until the torque values shown in Table 3 above for the specific liquid level gage are reached. For multiple section gages, torque the center

section(s) and progressively work toward the ends of the gage.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued if necessary.

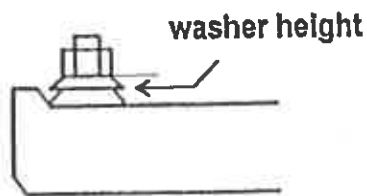
WARNING

Failure to comply with the proper torquing sequence or force/heght value can lead to leakage, gasket blow-out or glass breakage resulting in gage failure, serious injury and/or property damage.

NOTE: Depending on gage size there may be less bolting than shown in Figure 1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

5.5 Belleville Washers

Belleville washers are used to reduce or eliminate the need to retorque nuts. This is especially important for gages subject to pressure and/or thermal cycling and also in offshore applications where use of wrenches often cracks or chips the protective coat. The conical washers allow for material expansion and contraction while maintaining axial bolt loading and, therefore, compression on the gasket.



Belleville Washer Height
Figure 2

**CONICAL SPRING HEIGHT
FOR BELLEVILLE WASHERS**

GAGE MODELS	No. of Washers per nut	Spring Height (top of cover to bottom of nut) inch (mm)
RM	4	0.264 (6.7)
TM	2	0.136 (3.5)

Table 4

The effective range of a Belleville washer is measured in height (or compression distance) of the washer NOT TORQUE. Refer to Figure 2 and Table 4 for proper compression height. Do not tighten nuts until the washers are flat. Belleville washers cannot absorb expansion when flat.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and stack height, if necessary.

6.0 Operation

Before initializing liquid level gage operation, check that all installation procedures have been completed. Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. Check to determine that all connections are pressure tight. Assure that nuts have been retorqued to their proper values as specified in Table 5. Remove self stick caution tape from the glass and inspect to be sure that glass is clean and free of any damage such as cracks, scratches, pits, and chips.

6.1 Hydrostatic Test



Liquid level gage installations should be brought into service slowly to avoid excessive shock or stress on the glass. Rapid pressurization or sudden changes in temperature may cause glass breakage. To avoid excessive thermal shock or mechanical stress on glass, the connecting valves should be opened slightly, and the gage temperature and pressure allowed to slowly equalize. If the valves are equipped with ball checks, the valves must be opened all the way after the pressure and temperature have equalized to permit operation of the automatic ball checks in the event of failure. Failure to follow the recommended operating procedures can result in death, severe personal injury and/or property damage.

Take all precautions necessary to handle the possibility of leakage during the test. Hydrostatically pressure test all installations to at least 100 PSIG but less than design pressure and correct any leakage before proceeding.

7.0 Maintenance



WARNING



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. **DO NOT** proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

The rate at which components degrade is dependent upon a variety of conditions. Pressure, temperature and process media all influence the rate at which gage components deteriorate. Higher temperatures can accelerate the deterioration of gaskets, cushions, glass, and metals. Acids and similar chemicals can break down the integrity of almost any material. Concentration of chemicals can accelerate the corrosion rate. Penberthy cannot create a blanket maintenance schedule for every application.

The end user is the most familiar with the process media and conditions and must be responsible for creating a maintenance schedule. The user must create maintenance schedules, safety manuals, and inspection details for each liquid level gage. Realistic maintenance schedules can only be determined with full knowledge of the services and application situations involved. These will be based upon the user's own operating experience with their specific application.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued or repaired as necessary.

On all installations the following items should be regularly evaluated by the user for purposes of maintenance:

- 1) glass, for cleanliness and signs of damage or wear,
- 2) shields, if used, for signs of clouding, wear or deterioration,
- 3) gage, for signs of leakage around gaskets or at connections and
- 4) gage, for signs of internal or external corrosion.

7.1 Maintenance Procedures

GLASS should be given regular and careful attention. Keep glass clean using a commercial glass cleaner and a soft cloth. Inspect the surface of the glass for any clouding, etching or scratching or physical damage such as bruises, checks or corrosion. Glass that is damaged is weakened and may break under pressure. Shining a light at approximately a 45° angle will aid in detecting some of these conditions. Typical damaged areas will glisten more brightly than the surrounding glass because the light is reflected.

Detection of any damage, problem areas or surface wear is sufficient evidence to take the liquid level gage out of service. **DO NOT** proceed with operation of the liquid level gage until the glass has been replaced with a glass replacement kit following the assembly instructions in Section 8.

SHIELDS showing any signs of clouding, wear, or deterioration are an indication that the gage glass has been exposed, or could soon be exposed to the contained fluid. Immediately take liquid level gage out of service. DO NOT proceed with operation of the liquid level gage until shields and glass have been replaced by following the disassembly-reassembly instructions in Section 8.

GASKET LEAKS must be repaired immediately. DO NOT proceed with operation of a liquid level gage until gaskets have been replaced by following Section 8 assembly instructions.

CONNECTION LEAKS at a flanged or threaded connection should be corrected by tightening the bolting at the connection or by taking the liquid level gage out of service and wrapping the connection threads with Teflon® tape on all male pipe threads.

CORROSION may occur if the user has selected an improper material for the liquid level gage application. It is the responsibility of the user to choose a material of construction compatible with both the contained fluid and the surrounding environment. If internal or external corrosion is present, an investigation must immediately be performed by the user. It may be necessary to contact an authorized Penberthy distributor to better determine the origin of the corrosion.

7.2 Troubleshooting

Problem: glass becomes prematurely etched or clouded in service
Cause: fluid being handled is not compatible with the glass or shields
Solution: replace the glass and install shields which will not be affected by contained fluid

Problem: glass continually breaks in service despite careful attention to maintenance procedures
Cause: thermal shock, hydraulic shock, mechanical loads, exceeding design ratings or a combination of these
Solution: check entire system to determine possible sources of loads. Check application to determine actual operating conditions and contact an authorized Penberthy distributor on how to proceed.

8.0 Removal - Disassembly - Reassembly



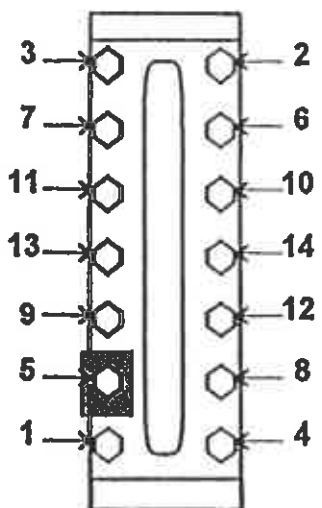
WARNING



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. DO NOT proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

8.1 Disassembly

Secure workbench longer than the liquid level gage, and sufficiently wide to lay out parts as they are removed.



Nut Loosening Sequence
Figure 3

- 1) Lay gage on bench so nut side of fastener is up.
- 2) Hold gage firmly, and loosen nuts starting at both ends of each section and then proceeding from both ends to the center of each section as shown in Figure 3.
- 3) Nut Loosening Sequence
 - remove nuts, washer, and nameplate
 - tap covers with rubber hammer as needed to loosen and remove
 - for belleville washer assemblies: to remove covers, studs may need to be removed by laying the assembly on its side and knocking the studs/U-bolts through the cover with a hammer and punch
 - remove cushions, glass, shields (if any), and gaskets
 - tap liquid chamber or remaining covers as necessary with rubber hammer to break loose, and remove remaining components
 - remove, destroy, and dispose of all glass, cushions, gaskets, and shields. Under no circumstances should these components be re-used or installed on a gage

NOTE: If size of gage is smaller than shown, follow spiraling sequence from the ends until all bolting is loosened.



WARNING



Once used cushions, gaskets, and shields are permanently deformed by compression and if re-used, may cause leaks and high stress points resulting in glass breakage. Glass may contain hidden damage and internal stresses caused by previous usage. If re-used, the glass may break under pressure causing personal and property damage.

8.2 Inspection of Glass Seating Surfaces

Clean the glass seating surfaces on the liquid chamber and cover with a soft metal scraper (preferably brass) to remove all burrs, rust, and remnants of the previous gaskets and cushions. Exercise extreme care to avoid gouging or scarring gasket and cushion seating surfaces.

Use a known flat piece of metal the same approximate length as the glass or a new piece of glass and a thickness gage to check flatness of each glass seating surface on liquid chamber and under cover. Surface must be flat within 0.002 inch. If any one surface is found to be beyond a tolerance of 0.002 inch, the entire gage must be disposed of and replaced. Gasket seating surface must have a final surface finish of 450 to 500 AARH.



WARNING



Flatness of glass seating surfaces outside 0.002 inch tolerance specified is an indication of the gage having been overstressed through repeated exposure to mechanical, thermal, or hydraulic shock during its previous service. Operation of a liquid level gage which has been overstressed will result in abnormal stresses on the glass which may cause glass to break. If surface finish is not in the 450 - 500 AARH range, gasket may extrude under pressure with resulting sudden release of pressure, leakage of contained fluid, serious personal injury, or property damage.

Glass seating surfaces should NOT be machined to achieve seating tolerance. The chamber and cover are designed for a critical thickness to achieve the pressure/temperature ratings. Machining glass seating surfaces may result in non-compliance to the necessary critical thickness due to material removal.

8.3 Reassembly

If all glass seating surfaces are found to be within the 0.002 inch (0.051mm) tolerance described in the previous section, proceed to obtain new glass, gaskets, cushions and shields (if used) and proceed to reassemble as follows (refer to exploded parts view in Section 11 if needed):

- 1) clean threads on bolt and nuts to remove all paint, rust, and scale. Apply a light coat of oil to the threads.
- 2) for transparent gages, insert bolts through half the cover and lay out covers along bench, side by side, with the liquid chambers. Use chambers to space covers and line them up with vision slots.
- 3) for reflex style and belleville reflex style gages, lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 4) for transparent belleville style gages, thread nuts on stud, place two belleville washers under nut with pointed end toward the nut (see Figure 2), insert stud through each cover and lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 5) install one cushion inside each cover.



WARNING



Separate installation instructions are supplied with replacement glass. All instructions supplied with the glass must be followed as there are precautions to be taken when handling gage glass. Among the precautions is avoidance of bumping or sliding glass against any surface and inspection of individual pieces. Failure to follow any of the replacement gage glass installation instructions could result in glass breakage with resulting sudden release of pressure, personal or property damage.

- 6) install rubber band around each piece of glass, then place glass centered inside each cover.

- 7) install shields, if used, and gasket on glass being careful to keep components centered.
- 8) place liquid chamber on the gaskets (shields - if used) making sure all components are aligned with vision slot.
- 9) for reflex gage, install U-bolts in place by tapping as needed with rubber hammer, being careful not to lose alignment with vision slot.
- 10) for reflex gage, quickly turn over assembly onto back side of U-bolts. Assemble nameplate, washer, and nuts to U-bolts. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.

NOTE: Depending on gage size there may be less bolting than shown in Figure 1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

- 11) for transparent gage, install gaskets in place, and shields if used.
- 12) install one cushion on each piece of glass
- 13) install rubber band around each piece of glass, then place glass centered inside each cover
- 14) install covers in place being careful to maintain components alignment inside.
- 15) install nameplate, washer, and nuts to studs. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.
- 15A) for transparent belleville style gages: install nameplate and two belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.

NOTE: the following procedure is to be done on only one side of the gage.

- 15B) for reflex belleville style gages: install nameplate and four belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.
- 16A) Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1. Once 20 ft-lb is reached, begin measuring stack height. Tighten nuts in five ft-lb increments until stack spring height is within 0.008" (0.2 mm) of proper height. Individually tighten each nut until stack height is achieved. (see Table 5) To estimate washer height, add the thickness of the nut to the compressed height requirement and use this value to compare to the measurement from the top of the nut to the face of the cover.

Refer to Section 5 for installation and Section 6 for operation of liquid level gage when returning to service.

9.0 Disposal at End of Useful Life

Penberthy gages are used in a variety of fluid applications. By following the appropriate governmental and industry regulations, the user must determine the extent of preparation and treatment the gage must incur before its disposal. A Material Safety Data Sheet (MSDS) may be required before disposal services accept certain components.

Metals, glass, and polymers should be recycled whenever possible. Refer to order and Penberthy's Material Specification sheets for materials of construction.

10.0 Telephone Assistance

If you are having difficulty with your liquid level gage, notify your local Penberthy distributor. You may also contact the factory direct at (815) 537-2311 and ask for an applications engineer. So that

we may assist you more effectively, please have as much of the following information as possible when you call:

- Model #
- Name of the company from whom you purchased your liquid level gage
- Invoice # and date
- Process fluid
- Operating pressures
- Operating temperatures
- A brief description of the problem
- Troubleshooting procedures that failed

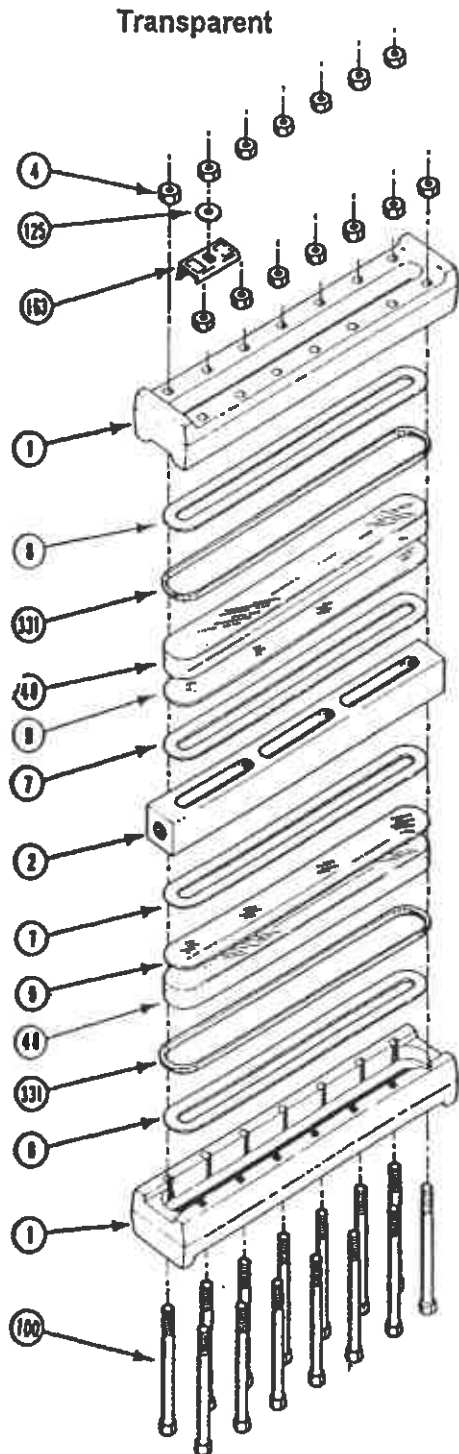
If attempts to solve your problem fail, you may be requested to return your liquid level gage to the factory for intensive testing. You must obtain a Return Authorization (R.A.) number from Penberthy prior to returning anything. Failure to do so will result in the unit being returned to you, without being tested, freight collect. To obtain a R.A. number, the following information (in addition to that above) is needed:

- Reason for return
- Person to contact at your company
- "Ship To" address

We recommend that you return the entire unit for testing. There is a minimum charge of \$75.00 for evaluation of non-warranty units. You will be contacted before any repairs are initiated should the cost exceed the minimum charge. If you return a unit that is covered by the warranty, but is not defective, the minimum charge will apply.

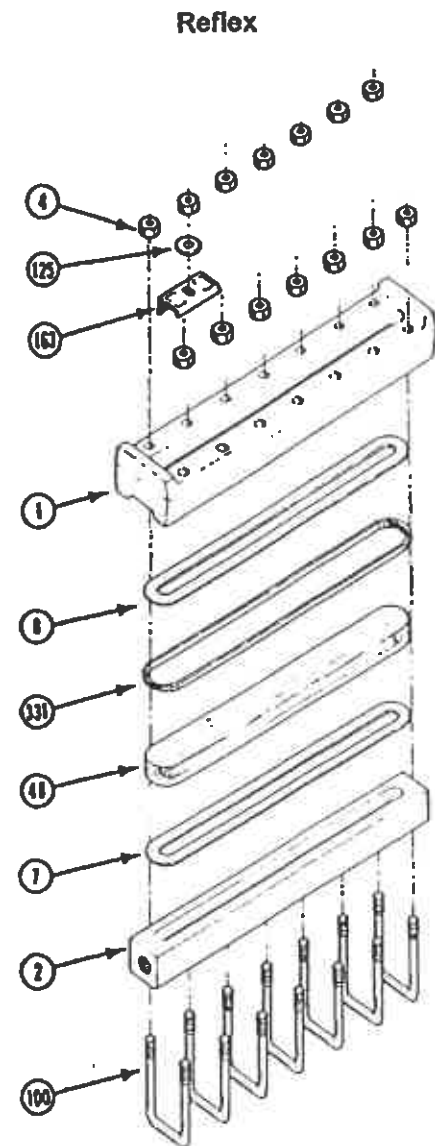
Grafo® is a registered trademark of Union Carbide Corporation
Neoprene®, Viton®, and Teflon® are registered trademarks of E.I. du Pont de Nemours and Company
Top Chem 2000® is a registered trademark of Klinger
Kel-F® is a registered trademark of 3M

11.0 Exploded Parts Drawing



Recommended Spare Parts		
REF #	ITEM	QTY
100	Bolt/U-bolt	2/1 per sect.
4	Nut	2 per sect.
48	Glass	1
7	Gasket	2
8	Cushion	2
9	Shield (if used)	2

- 1 - Cover
- 2 - Chamber
- 4 - Nut
- 48 - Glass
- 7 - Gasket
- 8 - Cushion
- 9 - Shield
- 100 - Bolt/U-bolt
- 125 - Washer
- 163 - Nameplate
- 331 - Band



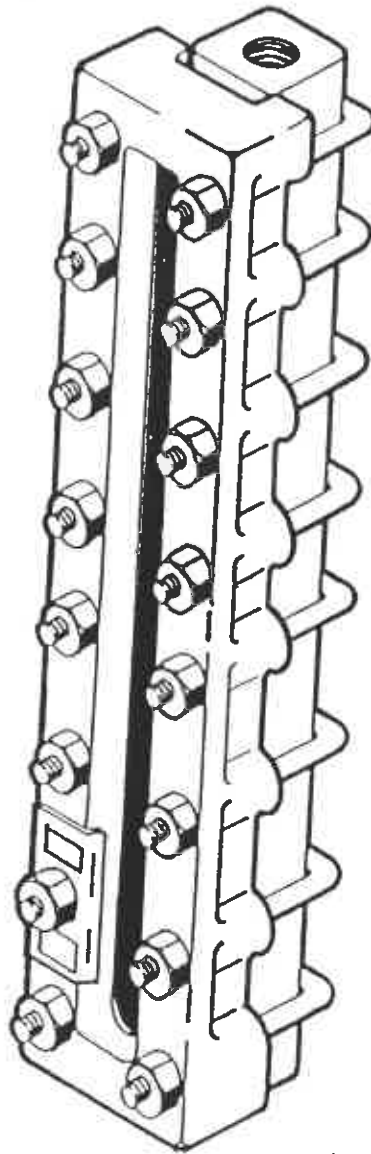
NOTE: size 9 shown - actual gage may be shorter and require fewer bolting components

PENBERTHY®

Flat Glass Gages

Series L

Section	2000
Instal. Instr.	2950L
Issued	9/96
Replaces	6/95



Installation/Operation/Maintenance Instructions

PENBERTHY

DECLARATION of CONFORMITY

In conformance with ISO/IEC Guide 22 - 96
LLG.DC r C

Manufacturer's Name: Penberthy, Incorporated
Manufacturer's Address: 320 Locust Street
Prophetstown, IL 61277-1147 U.S.A.

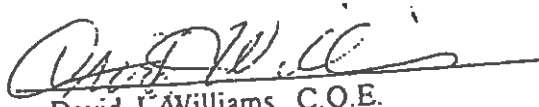
Product: Pressure Vessel - Liquid Level Gauge Glass
Type of Equipment: Industrial Instrumentation - Hazardous Area
Equipment Class: RL, TL, RM, TM, RH, TH, RMW, TMW, RLC, TLC
Model Designations:

The product described above is in conformity with:

92/59/EEC	General product safety	1992
87/404/EEC	Simple pressure vessel	1987
89/392/EEC	Machinery	1989
EN 10213-1:4	Technical delivery conditions for steel castings	1996
ISO 7-1	Pipe threads where pressure-tight joints are made	1996
BS 10	Flanges and bolting for pipes, valves and fittings	1962
BS 21	Pipe threads for tubes and fittings where pressure-tight	1985
BS 759	Valves, gauges and other safety fittings for application	1984
BS 970 Part 1	Wrought steels for mechanical and allied engineering	1996
BS 970 Part 3	Wrought steel for mechanical and allied engineering	1991
BS 1501 Part 3	Steels for pressure purposes	1990
BS 1502	Steels for fired and unfired pressure vessels	1982
BS 1506	Carbon, low alloy and stainless steel bars and billets	1990
BS 1560	Circular flanges for pipes, valves and fittings	1989
BS 1640 Part 1	Steel butt-welding pipe fittings	1962
BS 1640 Part 2	Steel butt-welding pipe fittings	1962
BS 1965	Butt-welding pipe fittings	1963
BS 3076	Nickel and nickel alloys: bar	1989
BS 3463	Observation and gauge glasses for pressure vessels	1975
BS 3602 Part 1	Steel pipes and tubes for pressure purposes	1987
BS 3605	Austenitic stainless steel pipes and tubes	1991
BS 3643	ISO metric screw threads	1981
BS 3799	Steel pipe fittings, screwed and socket-welding	1974
BS 4504	Circular flanges for pipes, valves and fittings	1989
ASME B&PV Code, Section VIII	Rules for construction of pressure vessels	1995
ANSI/ASME B1.1	Unified screw inch threads un and unr thread form	1982
ANSI/ASME B1.20.1	Pipe threads, general purpose (inch)	1983
ANSI/ASME B16.5	Pipe flanges and flanged fittings	1988
ANSI/ASME B18.2.1	Square and hex nuts and screw inch series	1981
ANSI/ASME B18.2.2	Square and hex nuts	1972
ANSI/ASME B31.3	Process piping	1996

Date: 30 December 1996
Prophetstown, IL U.S.A.

Signature:
Name:
Position:


David J. Williams, C.Q.E.
Quality Assurance Manager

Signature is contact person.

TABLE OF CONTENTS

Product Warranty	i
1.0 About the Manual	1
2.0 Introduction	1
2.1 System Description	1
3.0 Available Models	2
3.1 Design Ratings at Maximum and Minimum Operating Temperature	2
4.0 Inspection	3
4.1 Glass Inspection	4
4.2 User Rating Inspection	4
5.0 Installation	4
5.1 Piping Strain	5
5.2 Differential Thermal Expansion	5
5.3 Mirror Viewing	5
5.4 Nut Retorquing	5
5.5 Belleville Washers	6
6.0 Operation	6
6.1 Hydrostatic Test	7
7.0 Maintenance	7
7.1 Maintenance Procedures	8
7.2 Troubleshooting	8
8.0 Removal - Disassembly - Reassembly	9
8.1 Disassembly	9
8.2 Inspection of Glass Seating Surfaces	10
8.3 Reassembly	10
9.0 Disposal at End of Useful Life	12
10.0 Telephone Assistance	12
11.0 Exploded Parts Drawing	14

TABLES AND FIGURES

	page
Table 1 Design Ratings of RL Gage	2
Table 2 Design Ratings of TL Gage	3
Table 3 Bolt Torque Values	5
Table 4 Conical Spring Height for Belleville Washers	6
Figure 1 Nut Tightening Sequence	5
Figure 2 Belleville Washer Height	6
Figure 3 Nut Loosening Sequence	9

PRODUCT WARRANTY

Penberthy Inc., warrants its products as designed and manufactured by Penberthy to be free of defects in material and workmanship for a period of one year after the date of installation or eighteen months after the date of manufacture, whichever is earliest. Penberthy will, at its option, replace or repair any products which fail during the warranty period due to defective material or workmanship.

Prior to submitting any claim for warranty service, the owner must submit proof of purchase to Penberthy and obtain written authorization to return the product. Thereafter, the product shall be returned to Penberthy in Prophetstown, Illinois, with freight prepaid.

This warranty shall not apply if the product has been disassembled, tampered with, repaired or altered outside of the Penberthy factory, or if it has been subjected to misuse, neglect or accident.

Penberthy's responsibility hereunder is limited to repairing or replacing the product at its expense. Penberthy shall not be liable for loss, damage, or expenses directly or indirectly related to the installation or use of its products, or from any other cause or for consequential damages. It is expressly understood that Penberthy is not responsible for damage or injury caused to other products, building, property or persons, by reason of the installation or use of its products.

THIS IS PENBERTHY'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This document and the warranty contained herein may not be modified and no other warranty, expressed or implied, shall be made by or on behalf of Penberthy unless modified or made in writing and signed by the President or a Vice President of Penberthy.

1.0 About the Manual

This manual has been prepared as an aid and guide for personnel involved in installation or maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation, or maintenance. Failure to follow *any* instruction could possibly result in a malfunction of the gage or glass breakage with resulting sudden release of pressure, property damage or physical injury to personnel.

SAFETY INSTRUCTIONS

Penberthy does not have any control over the manner in which its liquid level gage is handled, installed or used. Penberthy cannot and will not guarantee that a liquid level gage is suitable or compatible for the user's specific application.



WARNING



Contained fluids may be pressurized and can unexpectedly exit vessel connections due to apparatus or material failure. Safety glasses should be worn when installing a liquid level gage. Failure to do so could result in serious physical injury to personnel.

2.0 Introduction

Penberthy liquid level gages are used to allow direct visualization of liquid level in vessels. By peering through the glass, it is possible to monitor color, clarity, and level of a gas/liquid interface. Gages are available in varying lengths and configurations (end connect, side connect, multiple sections, NPT or flange connections, etc.). Visual indication can be enhanced by using reflex glass or illuminators (accessory).

2.1 System Description

Penberthy gages are comprised of six basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the gage. Use the exploded parts view in Section 11 as additional reference material.

Chamber - provides a pressure retaining metallic channel for the liquid to enter and be viewed. Slot(s) are machined into the chamber to provide direct visualization of the process fluid.

Gaskets - seal the gap and prevent leakage between the chamber and the glass. Gaskets are available in a variety of materials for compatibility with the media in the gage.

Glass - glass allows for visual observation of the process fluid in the chamber

Cushion - acts as a protective buffer between the glass and the cover. For proper sealing cushions must be as hard as or harder than the gasket material.

Cover - protects the glass assembly from external hits and provides a flat, rigid surface that is used to evenly compress the gage assembly.

Bolting - compresses the components between the covers (transparent gages) or cover and chamber (reflex gages).

Shield (optional) - used to prevent the process media from contacting the glass.

3.0 Available Models

Penberthy (Series L) low pressure liquid level gages are designed for applications other than steam/water where the physical and mechanical properties of a ductile iron cover are sufficient to meet the pressure and temperature needs of the application.

3.1 Design Ratings at Maximum and Minimum Operating Temperatures

Gasket Material	Glass Size	Model RL Reflex	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoil® (standard) or Non-Asbestos	1 2 3 4 5 6 7 8 9	-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
		2400 PSIG (16550 KPa)	1780 PSIG (12275 KPa)
		2325 PSIG (16030 KPa)	1720 PSIG (11860 KPa)
		2250 PSIG (15515 KPa)	1670 PSIG (11515 KPa)
		2175 PSIG (15000 KPa)	1600 PSIG (11030 KPa)
		2100 PSIG (14495 KPa)	1550 PSIG (10685 KPa)
		2025 PSIG (13960 KPa)	1500 PSIG (10340 KPa)
		1950 PSIG (13445 KPa)	1440 PSIG (9930 KPa)
		1875 PSIG (12930 KPa)	1390 PSIG (9585 KPa)
		1800 PSIG (12410 KPa)	1340 PSIG (9240 KPa)
PTFE/ Top-Chem 2000®	1 - 9	2400 PSIG (6205 KPa) at -20°F (-29°C) to 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F (37°C) 450 PSIG (3105 KPa) at 500°F (260°C)	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	

TABLE 1

Gasket Material	Glass Size	Model TL Transparent	
		Wetted Parts Material Steel or Stainless Steel w/B7 Bolting	
Grafoik® (standard) or Non-Asbestos	1 2 3 4 5 6 7 8 9	-20°F (-29°C) to 100°F (37°C)	600°F (315°C)
		2000 PSIG (13783 KPa)	1480 PSIG (10200 KPa)
		1815 PSIG (12508 KPa)	1340 PSIG (9235 KPa)
		1630 PSIG (11233 KPa)	1210 PSIG (8339 KPa)
		1440 PSIG (9924 KPa)	1060 PSIG (7305 KPa)
		1250 PSIG (8614 KPa)	920 PSIG (6340 KPa)
		1065 PSIG (7339 KPa)	790 PSIG (5444 KPa)
		875 PSIG (6030 KPa)	645 PSIG (4445 KPa)
		690 PSIG (4755 KPa)	510 PSIG (3514 KPa)
		500 PSIG (3446 KPa)	370 PSIG (2550 KPa)
PTFE/ Top-Chem 2000®	1 - 9	2000 PSIG (6205 KPa) at -20°F (-29°C) to 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
25% glass filled PTFE	1 - 9	900 PSIG (6205 KPa) at -20°F (-29°C) to 100°F (37°C) 450 PSIG (3105 KPa) at 500°F (260°C) reference Application Report for gage pressure limitation at specific temperatures	
NBR/Buna N®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 225 PSIG (1550 KPa) at 250°F (121°C)	
FKM/Viton®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (204°C)	
PTFE/Teflon®	1 - 9	300 PSIG (2070 KPa) at -20°F (-29°C) to 100°F (37°C) 150 PSIG (2275 KPa) at 500°F (260°C)	
PCTFE/(Kel-F®) Shields 0.063" (1.6 mm) thick	1 - 9	300 PSIG (2067 KPa) at -20°F (-29°C) to 100°F (37°C) 180 PSIG (1240 KPa) at 400°F (148°C)	

TABLE 2

The pressure and temperature ratings may deviate from the previous tables if the gasketing materials of construction and/or bolting are other than those specified. Higher and/or lower temperature ratings are available with different materials of construction.

To determine the maximum allowable working pressure for a specific temperature within the design limits stated in the tables, the user should refer to Penberthy dimension sheets, or when provided, the specifically stated design limits on a Penberthy product proposal.

NOTE: under no circumstances should shields be used in reflex style gages. Installation of shields in reflex style gages will keep the liquid from coming in contact with the refractive prisms, thereby prohibiting visualization of the liquid level in the gage.



NEVER exceed these design ratings or application data. Exceeding design ratings or application data may result in mechanical failure of gage components resulting in death, serious personal injury and property damage.

4.0 Inspection

Upon receipt of a liquid level gage, check all components carefully for damage incurred in shipping. If damage is evident or suspected, do not attempt installation. Notify carrier immediately and request damage inspection.

Penberthy's standard 1 section TL gage consists of: (1) chamber, (2) gaskets, (2) borosilicate flat glass, (2) rubber bands, (2) cushions, (2) covers, (1) washer, (1) nameplate, and (6 - 14) bolting sets, depending on the size.

4.1 Glass Inspection

The self stick caution tape was applied at the factory to protect the glass during shipping, handling, and installation. Do not remove the tape from the glass until all installation procedures have been completed, except during receiving inspection to momentarily inspect glass for shipping damage. Glass that is not protected will be vulnerable to dust, grit, tools and any other objects which may scratch, chip, or break the glass.



WARNING



DO NOT use glass that is chipped or even slightly scratched. Glass surface defects weaken the glass which may result in glass breakage and fluid loss under pressure resulting in serious personal and property damage.

4.2 User Rating Inspection

The user should confirm that:

- 1) the Series L liquid level gage model and assembly number stamped on the nameplate conforms to the description on the user's purchase order,
- 2) the operating conditions described in the purchase order agree with the actual operating conditions at the installation site,
- 3) the actual operating conditions at the installation site are within the application data shown on the Penberthy Technical Data Bulletin or product proposal referred to above, and
- 4) the materials of construction of the liquid level gage are compatible with both the contained media and surrounding atmosphere in the specific application.

SAFETY INSTRUCTIONS

If the size, model, or performance data of the liquid level gage as received does not conform with any of the criteria above, do not proceed with installation. Contact an authorized Penberthy distributor for assistance. The incorrect gage can result in unacceptable performance and potential damage to the gage.

5.0 Installation

Installation should only be undertaken by qualified personnel who are familiar with equipment of this type. They should have read and understood all of the instructions in this manual. The user should refer to Penberthy dimension sheets or Penberthy product proposal to obtain dimensional information for the specific size and model liquid level gage.

Penberthy recommends that all liquid level gage installations be provided with gage valve sets equipped with ball check shut-off. Gage valve sets are designed to isolate the gages from the pressure vessel when it becomes necessary to drain or service the gages. The ball check shut-off is designed to retard leakage of the contained fluid in the event of gage glass breakage. Ball checks are available for both positive and negative vessel pressures.

The number of different types of gage and valve installations is too great to adequately detail in an installation manual. It is, therefore, the user's responsibility to assure that the knowledgeable installation personnel plan and carry out the installation in a safe manner. The following procedures are some of the installation guidelines that should be employed.

5.1 Piping Strain

The gage should be mounted and connected so that it does not support any piping weight. Piping not properly supported, independent of the gage, may subject the gage to stresses that can cause leaks or glass breakage. Support brackets are available as an accessory.

5.2 Differential Thermal Expansion

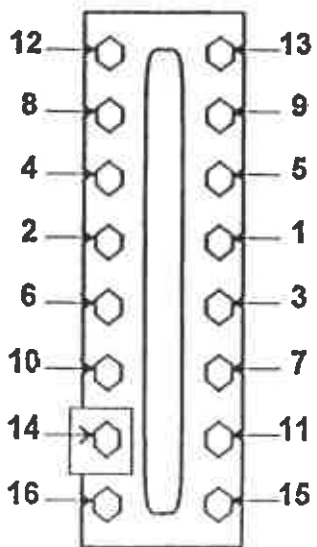
High mechanical loads may be imposed on a gage by expanding and contracting pipes due to hot or cold service. Such mechanical loads on the gage must be minimized by the use of expansion loops in the system. Failure to allow for expansion or contraction can result in leaks or glass breakage.

5.3 Mirror Viewing

For added safety, a system of indirect viewing by means of mirrors should be installed to protect personnel from the hazards of possible gage failure.

5.4 Nut Retorquing (not applicable for gages with Belleville washers) - see Section 5.5

Nut retorquing is vital to the operation of a liquid level gage because gaskets take permanent set under initial bolt loading at assembly. Tightening of nuts before installation to values specified in Table 3 is necessary to insure pressure retaining capabilities of liquid level gage to specific design ratings. The user must refer to the liquid level gage model and assembly number and to the purchase order or tag to determine materials of construction.



Nut Tightening Sequence
Figure 1

BOLT TORQUE VALUES

GAGE MODELS and GASKET MATERIAL	ft-lb
RL, TL w/Grafoil® (standard)	25 to 30
RL, TL w/Non-asbestos (optional)	30 to 35
Top-Chem 2000®	25 to 30
25% glass filled PTFE	20
All Models w/Teflon®, Viton® or elastomeric (optional)	10
TL with PCTFE/(Kel-F®) Shields (optional) 0.063"	10

Table 3

Using a torque wrench, tighten nuts in five ft-lb increments following the "Z" pattern sequence in Figure 1, until the torque values shown in Table 3 above for the specific liquid level gage are reached. For multiple section gages, torque the center section(s) and progressively work toward the ends of the gage.

If bolting, gasketing or glass on any or repaired section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued as necessary.

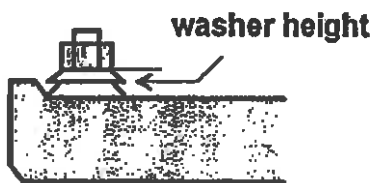
WARNING

Failure to comply with the proper torquing sequence or force/height value can lead to leakage, gasket blow-out or glass breakage resulting in gage failure, serious injury and/or property damage.

NOTE: Depending on gage size there may be less bolting than shown in Figure-1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

5.5 Belleville Washers

Belleville washers are used to reduce or eliminate the need to retorque nuts. This is especially important for gages subject to pressure and/or thermal cycling and also in offshore applications where use of wrenches often cracks or chips the protective coat. The conical washers allow for material expansion and contraction while maintaining axial bolt loading and, therefore, compression on the gasket.



Belleville Washer Height
Figure 2

CONICAL SPRING HEIGHT FOR BELLEVILLE WASHERS

GAGE MODELS	No. of Washers per nut	Spring Height (top of cover to bottom of nut) inch (mm)
RL	3	0.200 (5.1)
TL	2	0.136 (3.5)

Table 4

The effective range of a Belleville washer is measured in height (or compression distance) of the washer **NOT TORQUE**. Refer to Figure 2 and Table 4 for proper compression height. Do not tighten nuts until the washers are flat. Belleville washers cannot absorb expansion when flat.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and stack height, if necessary.

6.0 Operation

Before initializing liquid level gage operation, check that all installation procedures have been completed. Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. Check to determine that all connections are pressure tight. Assure that nuts have been retorqued to their

proper values as specified in Table 3. Remove self stick caution tape from the glass and inspect to be sure that glass is clean and free of any damage such as cracks, scratches, pits, and chips.

6.1 Hydrostatic Test



DANGER



Liquid level gage installations should be brought into service slowly to avoid excessive shock or stress on the glass. Rapid pressurization or sudden changes in temperature may cause glass breakage. To avoid excessive thermal shock or mechanical stress on glass, the connecting valves should be opened slightly, and the gage temperature and pressure allowed to slowly equalize. If the valves are equipped with ball checks, the valves must be opened all the way after the pressure and temperature have equalized to permit operation of the automatic ball checks in the event of failure. Failure to follow the recommended operating procedures can result in death, severe personal injury and/or property damage.

Take all precautions necessary to handle the possibility of leakage during the test. Hydrostatically pressure test all installations to at least 100 PSIG but less than design pressure and correct any leakage before proceeding.

7.0 Maintenance



WARNING



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. DO NOT proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

The rate at which components degrade is dependent upon a variety of conditions. Pressure, temperature and process media all influence the rate at which gage components deteriorate. Higher temperatures can accelerate the deterioration of gaskets, cushions, glass, and metals. Acids and similar chemicals can break down the integrity of almost any material. Concentration of chemicals can accelerate the corrosion rate. Penberthy cannot create a blanket maintenance schedule for every application.

The end user is the most familiar with the process media and conditions and must be responsible for creating a maintenance schedule. The user must create maintenance schedules, safety manuals, and inspection details for each liquid level gage. Realistic maintenance schedules can only be determined with full knowledge of the services and application situations involved. These will be based upon the user's own operating experience with their specific application.

On all installations the following items should be regularly evaluated by the user for purposes of maintenance:

- 1) glass, for cleanliness and signs of damage or wear,
- 2) shields, if used, for signs of clouding, wear or deterioration,
- 3) gage, for signs of leakage around gaskets or at connections and
- 4) gage, for signs of internal or external corrosion.

If bolting, gasketing or glass on any section of a multi-section gage is disturbed, all sections must be checked for integrity and retorqued or repaired as necessary.

7.1 Maintenance Procedures

GLASS should be given regular and careful attention. Keep glass clean using a commercial glass cleaner and a soft cloth. Inspect the surface of the glass for any clouding, etching or scratching or physical damage such as bruises, checks or corrosion. Glass that is damaged is weakened and may break under pressure. Shining a light at approximately a 45° angle will aid in detecting some of these conditions. Typical damaged areas will glisten more brightly than the surrounding glass because the light is reflected.

Detection of any damage, problem areas or surface wear is sufficient evidence to take the liquid level gage out of service. **DO NOT** proceed with operation of the liquid level gage until the glass has been replaced with a glass replacement kit following the disassembly - reassembly instructions in Section 8.

SHIELDS showing any signs of clouding, wear, or deterioration are an indication that the gage glass has been exposed, or could soon be exposed to the contained fluid. Immediately take liquid level gage out of service. **DO NOT** proceed with operation of the liquid level gage until shields and glass have been replaced by following the disassembly-reassembly instructions in Section 8.

GASKET LEAKS must be repaired immediately. **DO NOT** proceed with operation of a liquid level gage until gaskets have been replaced by following Section 8 disassembly-reassembly instructions.

CONNECTION LEAKS at a flanged or threaded connection should be corrected by tightening the bolting at the connection or by taking the liquid level gage out of service and wrapping the connection threads with Teflon® tape on all male pipe threads.

CORROSION may occur if the user has selected an improper material for the liquid level gage application. It is the responsibility of the user to choose a material of construction compatible with both the contained fluid and the surrounding environment. If internal or external corrosion is present, an investigation must immediately be performed by the user. It may be necessary to contact an authorized Penberthy distributor to better determine the origin of the corrosion.

7.2 Troubleshooting

Problem:	glass becomes prematurely etched or clouded in service
Cause:	fluid being handled is not compatible with the glass or shields

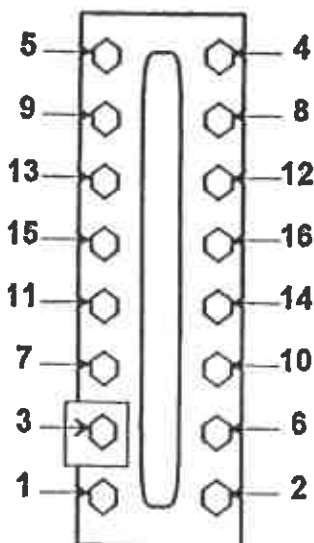
- Solution:** replace the glass and install shields which will not be affected by contained fluid
- Problem:** glass continually breaks in service despite careful attention to maintenance procedures
- Cause:** thermal shock, hydraulic shock, mechanical loads, exceeding design ratings or a combination of these
- Solution:** check entire system to determine possible sources of loads. Check application to determine actual operating conditions and contact an authorized Penberthy distributor on how to proceed.

8.0 Removal - Disassembly - Reassembly



Use only qualified, experienced personnel who are familiar with liquid level gage equipment and thoroughly understand the implications of the tables and all the instructions. **DO NOT** proceed with any maintenance unless the liquid level gage has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

8.1 Disassembly



Nut Loosening Sequence
Figure 3

Secure workbench longer than the liquid level gage, and sufficiently wide to lay out parts as they are removed.

- 1) Lay gage on bench so nut side of fastener is up.
- 2) Hold gage firmly, and loosen nuts starting at both ends of each section and then proceeding from both ends to the center of each section as shown in Figure 3.
- 3) Nut Loosening Sequence
 - remove nuts, washer, belleville washers (if any) and nameplate
 - tap covers with rubber hammer as needed to loosen and remove
 - for belleville washer assemblies: to remove covers, studs may need to be removed by laying the assembly on its side and knocking the stud/U-bolts through the cover with a hammer and punch
 - remove cushions, glass, shields (if any), and gaskets
 - tap liquid chamber or remaining covers as necessary with rubber hammer to break loose, and remove remaining components
 - remove, destroy, and dispose of all glass, cushions, gaskets, and shields. Under no circumstances should

these components be re-used or installed on a gage

NOTE: If size of gage is smaller than shown, follow "Z" sequence from the ends until all bolting is loosened.



WARNING



After assembly and proper torquing, cushions, gaskets and shields are permanently deformed by compression and if re-used, may cause leaks and high stress points resulting in glass breakage. Glass may contain hidden damage and internal stresses caused by previous usage. If re-used, the glass may break under pressure causing personal and property damage.

8.2 Inspection of Glass Seating Surfaces

Clean the glass seating surfaces on the liquid chamber and cover with a soft metal scraper (preferably brass) to remove all burrs, rust, and remnants of the previous gaskets and cushions. Exercise extreme care to avoid gouging or scarring gasket and cushion seating surfaces.

Use a known flat piece of metal the same approximate length as the glass or a new piece of glass and a thickness gage to check flatness of each glass seating surface on liquid chamber and under cover. Surface must be flat within 0.002 inch (0.051 mm). If any one surface is found to be beyond a tolerance of 0.002 inch (0.051 mm), the entire gage must be disposed of and replaced. Gasket seating surface must have a final surface finish of 450 to 500 AARH.



WARNING



Flatness of glass seating surfaces outside 0.002 inch tolerance specified is an indication of the gage having been overstressed through repeated exposure to mechanical, thermal, or hydraulic shock during its previous service. Operation of a liquid level gage which has been overstressed will result in abnormal stresses on the glass which may cause glass to break. If surface finish is not in the 450-500 AARH range, gasket may extrude under pressure with resulting sudden release of pressure, leakage of contained fluid, serious personal injury, or property damage.

Glass seating surfaces should NOT be machined to achieve seating tolerance. The chamber and cover are designed for a critical thickness to achieve the pressure/temperature ratings. Machining glass seating surfaces may result in non-compliance to the necessary critical thickness due to material removal.

8.3 Reassembly

If all glass seating surfaces are found to be within the 0.002 inch (0.051mm) tolerance described in the previous section, proceed to obtain new glass, gaskets, cushions and shields (if used) and proceed to reassemble as follows (refer to exploded parts view in Section 11 if needed):

- 1) clean threads on bolt and nuts to remove all paint, rust, and scale. Apply a light coat of oil to the threads.

- 2) for transparent gages, insert bolts through half the cover and lay out covers along bench, side by side, with the liquid chambers. Use chambers to space covers and line them up with vision slots.
- 3) for reflex style and belleville reflex style gages, lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 4) for transparent belleville style gages, thread nuts on stud, place two belleville washers under nut with pointed end toward the nut (see Figure 2), insert stud through each cover and lay out covers along bench, side by side, with liquid chambers. Use chambers to space covers and line them up with vision slots.
- 5) install one cushion inside each cover.



WARNING



Separate installation instructions are supplied with replacement glass. All instructions supplied with the glass must be followed as there are precautions to be taken when handling gage glass. Among the precautions is avoidance of bumping or sliding glass against any surface and inspection of individual pieces. Failure to follow any of the replacement gage glass installation instructions could result in glass breakage with resulting sudden release of pressure, personal or property damage.

- 6) install rubber band around each piece of glass, then place glass centered inside each cover.
- 7) install shields, if used, and gasket on glass being careful to keep components centered.
- 8) place liquid chamber on the gaskets making sure all components are aligned with vision slot.
- 9) for reflex gage, install U-bolts in place by tapping as needed with rubber hammer, being careful not to lose alignment with vision slot.
- 10) for reflex gage, quickly turn over assembly onto back side of U-bolts. Assemble nameplate, washer, and nuts to U-bolts. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.

NOTE: Depending on gage size there may be less bolting than shown in Figure 1. Start at the center and follow "Z" pattern outward to the limit of bolting on a specific gage.

- 11) for transparent gage, install gaskets in place, and shields if used.
- 12) install rubber band around each piece of glass, then place glass centered inside each cover. **NOTE WARNING ABOVE**
- 13) install one cushion on each piece of glass
- 14) install covers in place being careful to maintain components alignment inside.
- 15) install nameplate, washer, and nuts to studs. Tighten nuts with fingers. Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1 until the torque values shown in Table 3 are reached.
- 15A) for transparent belleville style gages: install nameplate and two belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.

NOTE: the following procedure is to be done on only one side of the gage.

15B) for reflex belleville style gages: install nameplate and three belleville washers under each nut with pointed end toward the nut (see Figure 2). Finger tighten nuts.

16A) Using a torque wrench, tighten nuts in five ft-lb increments, following the sequence in Figure 1. Once 20 ft-lb is reached, begin measuring stack height. Tighten nuts in five ft-lb increments until stack spring height is within 0.008" (0.2 mm) of proper height. Individually tighten each nut until stack height is achieved. (see Table 5) To estimate washer height, add the thickness of the nut to the compressed height requirement and use this value to compare to the measurement from the top of the nut to the face of the cover.

Refer to Section 5 for installation and Section 6 for operation of liquid level gage when returning to service.

9.0 Disposal at End of Useful Life

Penberthy gages are used in a variety of fluid applications. By following the appropriate governmental and industry regulations, the user must determine the extent of preparation and treatment the gage must incur before its disposal. A Material Safety Data Sheet (MSDS) may be required before disposal services accept certain components.

Metals, glass, and polymers should be recycled whenever possible. Refer to order and Penberthy's Material Specification sheets for materials of construction.

10.0 Telephone Assistance

If you are having difficulty with your liquid level gage, notify your local Penberthy distributor. You may also contact the factory direct at (815) 537-2311 and ask for an applications engineer. So that we may assist you more effectively, please have as much of the following information as possible when you call:

- Model #
- Name of the company from whom you purchased your liquid level gage
- Invoice # and date
- Process fluid
- Operating pressures
- Operating temperatures
- A brief description of the problem
- Troubleshooting procedures that failed

If attempts to solve your problem fail, you may be requested to return your liquid level gage to the factory for intensive testing. You must obtain a Return Authorization (R.A.) number from Penberthy prior to returning anything. Failure to do so will result in the unit being returned to you, without being tested, freight collect. To obtain a R.A. number, the following information (in addition to that above) is needed:

- Reason for return
- Person to contact at your company
- "Ship To" address

We recommend that you return the entire unit for testing. There is a minimum charge of \$75.00 for evaluation of non-warranty units. You will be contacted before any repairs are initiated should the

PENBERTHY

≈ DECLARATION of CONFORMITY ≈

In conformance with ISO/IEC Guide 22 - 96
LLG.DC r C

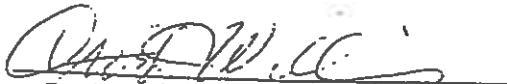
Manufacturer's Name: Penberthy, Incorporated
Manufacturer's Address: 320 Locust Street
Prophetstown, IL 61277-1147 U.S.A.
Product:
Type of Equipment: Pressure Vessel - Liquid Level Gauge Glass
Equipment Class: Industrial Instrumentation - Hazardous Area
Model Designations: RL, TL, RM, TM, RH, TH, RMW, TMW, RLC, TLC

The product described above is in conformity with:

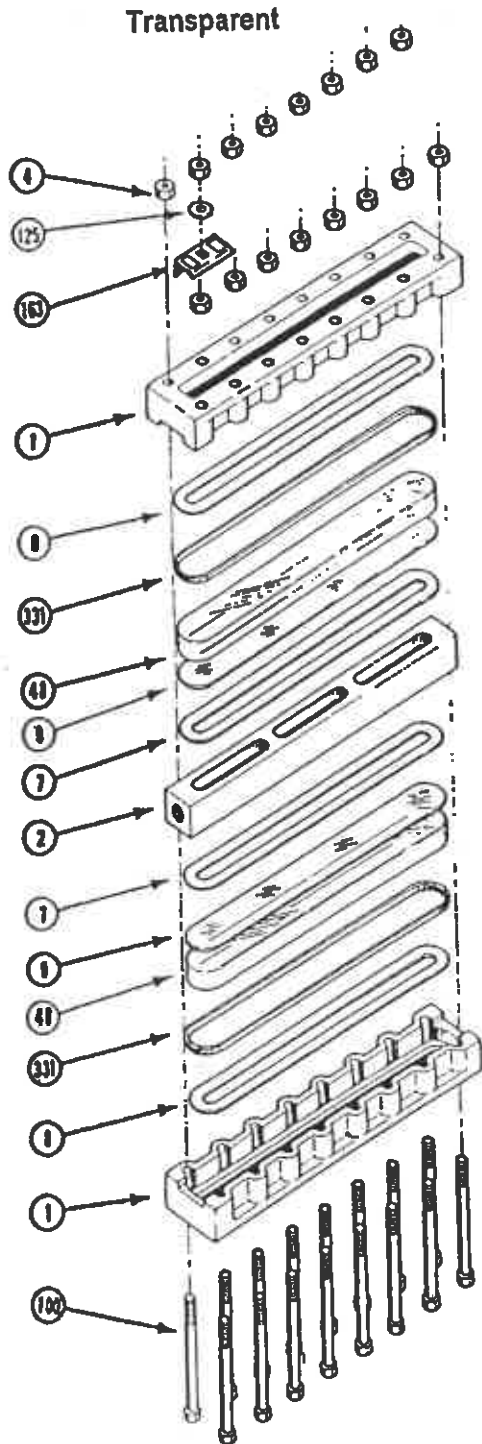
92/59/EEC	General product safety	1992
87/404/EEC	Simple pressure vessel	1987
89/392/EEC	Machinery	1989
EN 10213-1:4	Technical delivery conditions for steel castings	1996
ISO 7-1	Pipe threads where pressure-tight joints are made	1996
BS 10	Flanges and bolting for pipes, valves and fittings	1962
BS 21	Pipe threads for tubes and fittings where pressure-tight	1985
BS 759	Valves, gauges and other safety fittings for application	1984
BS 970 Part 1	Wrought steels for mechanical and allied engineering	1996
BS 970 Part 3	Wrought steel for mechanical and allied engineering	1991
BS 1501 Part 3	Steels for pressure purposes	1990
BS 1502	Steels for fired and unfired pressure vessels	1982
BS 1506	Carbon, low alloy and stainless steel bars and billets	1990
BS 1560	Circular flanges for pipes, valves and fittings	1989
BS 1640 Part 1	Steel butt-welding pipe fittings	1962
BS 1640 Part 2	Steel butt-welding pipe fittings	1962
BS 1965	Butt-welding pipe fittings	1963
BS 3076	Nickel and nickel alloys: bar	1989
BS 3463	Observation and gauge glasses for pressure vessels	1975
BS 3602 Part 1	Steel pipes and tubes for pressure purposes	1987
BS 3605	Austenitic stainless steel pipes and tubes	1991
BS 3643	ISO metric screw threads	1981
BS 3799	Steel pipe fittings, screwed and socket-welding	1974
BS 4504	Circular flanges for pipes, valves and fittings	1989
ASME B&PV Code, Section VIII	Rules for construction of pressure vessels	1995
ANSI/ASME B1.1	Unified screw inch threads un and unr thread form	1982
ANSI/ASME B1.20.1	Pipe threads, general purpose (inch)	1983
ANSI/ASME B16.5	Pipe flanges and flanged fittings	1988
ANSI/ASME B18.2.1	Square and hex nuts and screw inch series	1981
ANSI/ASME B18.2.2	Square and hex: nuts	1972
ANSI/ASME B31.3	Process piping	1996

Date: 30 December 1996
Prophetstown, IL U.S.A.

Signature:
Name:
Position:


David J. Williams, C.Q.E.
Quality Assurance

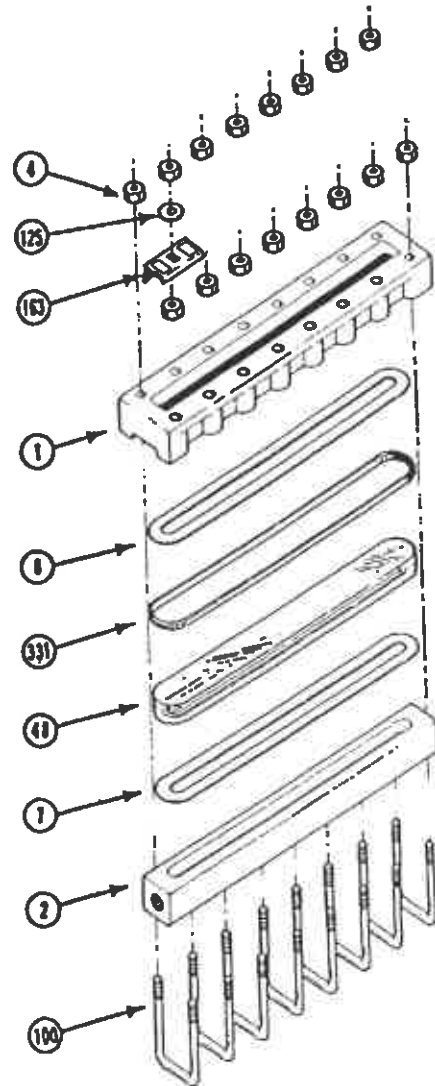
11.0 Exploded Parts Drawing



Recommended Spare Parts		
REF #	ITEM	QTY
100	Bolt/U-bolt	2/1 per sect.
4	Nut	2 per sect.
48	Glass	1
7	Gasket	2
8	Cushion	2
9	Shield (If used)	2

Reflex

- 1 - Cover
- 2 - Chamber
- 4 - Nut
- 48 - Glass
- 7 - Gasket
- 8 - Cushion
- 9 - Shield
- 100 - Bolt/U-bolt
- 125 - Washer
- 163 - Nameplate
- 331 - Band



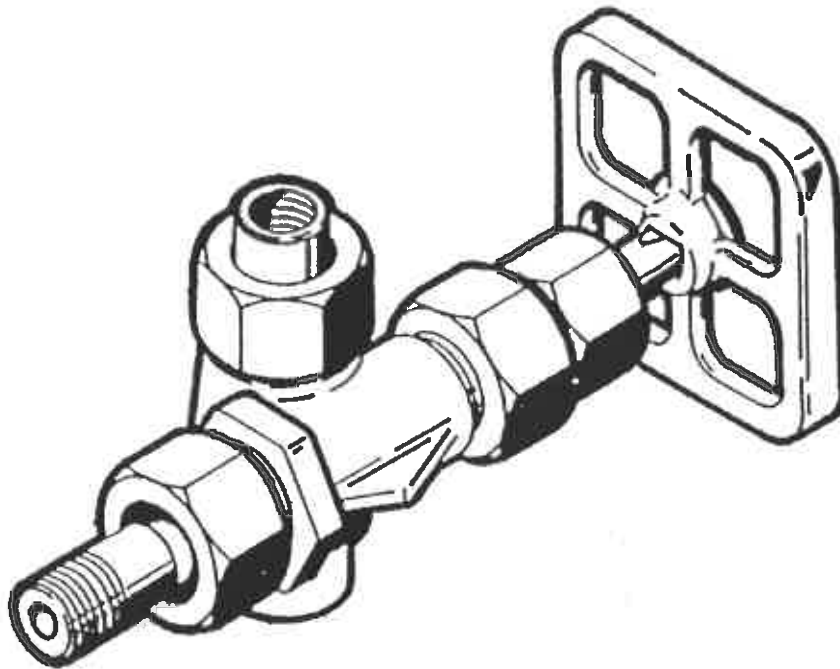
NOTE: size 9 shown - actual gage may be shorter and require fewer bolting components

PENBERTHY®

Section 2000
Instal. Instr. 2960
Issued 8/96
Replaces 2/94

Gage Valves

Series 100, 200, 300 and 400



Installation/Operation/Maintenance Instructions

TABLE OF CONTENTS

Product Warranty	i
1.0 About the Manual	1
2.0 Introduction	1
2.1 System Description	1
3.0 Available Models	2
3.1 Design Ratings at Maximum and Minimum Operating Temperature	2
3.2 Steam Application	3
4.0 Inspection	3
4.1 User Rating Inspection	3
5.0 Installation	4
5.1 Piping Strain	4
5.2 Differential Thermal Expansion	4
5.3 Mounting	4
6.0 Operation	5
6.1 Hydrostatic Test	5
7.0 Maintenance	5
7.1 Preventative Maintenance	6
7.2 Ball Check Shutoff	6
7.3 Troubleshooting	7
8.0 Removal – Disassembly – Reassembly	7
8.1 Disassembly	8
8.2 Reassembly	8
9.0 Disposal at End of Useful Life	8
10.0 Telephone Assistance	9
11.0 Exploding Parts Drawing	10
TABLES AND FIGURE	
Table 1 Design Ratings for Threaded or Welded Connections	3
Figure 1 Teflon® Tape Wrapping	5

PRODUCT WARRANTY

Penberthy Inc., warrants its products as designed and manufactured by Penberthy to be free of defects in material and workmanship for a period of one year after the date of installation or eighteen months after the date of manufacture, whichever is earliest. Penberthy will, at its option, replace or repair any products which fail during the warranty period due to defective material or workmanship.

Prior to submitting any claim for warranty service, the owner must submit proof of purchase to Penberthy and obtain written authorization to return the product. Thereafter, the product shall be returned to Penberthy in Prophetstown, Illinois, with freight prepaid.

This warranty shall not apply if the product has been disassembled, tampered with, repaired or altered outside of the Penberthy factory, or if it has been subjected to misuse, neglect or accident.

Penberthy's responsibility hereunder is limited to repairing or replacing the product at its expense. Penberthy shall not be liable for loss, damage, or expenses directly or indirectly related to the installation or use of its products, or from any other cause or for consequential damages. It is expressly understood that Penberthy is not responsible for damage or injury caused to other products, building, property or persons, by reason of the installation or use of its product.

THIS IS PENBERTHY'S SOLE WARRANTY AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED WHICH ARE HEREBY EXCLUDED, INCLUDING IN PARTICULAR ALL WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This document and the warranty contained herein may not be modified and no other warranty, expressed or implied, shall be made by on behalf of Penberthy unless modified or made in writing and signed by the President or a Vice President of Penberthy.

1.0 About the Manual

This manual has been prepared as an aid and guide for personnel involved in installation or maintenance. All instructions must be read and understood thoroughly before attempting any installation, operation, or maintenance. Failure to follow any instruction could possibly result in a malfunction of the valve with resulting sudden release of pressure, property damage or physical injury to personnel.

SAFETY INSTRUCTION

Penberthy does not have any control over the manner in which its gage valves are handled, installed, or used. Penberthy cannot and will not guarantee that a gage valve is suitable or compatible for the user's specific application.



CAUTION



Vessel fluids may be pressurized and can unexpectedly exit vessel connections due to apparatus or material failure. Safety glasses should be worn when installing a gage valve. Failure to do so could result in serious physical injury to personnel or property damage.

2.0 Introduction

Penberthy armored gage valves are used to isolate gage glass, magnetic gages or other apparatus from the holding or pressure vessel when it becomes necessary to drain and service the gage. Penberthy Series 100, 200, 300, and 400 gage valve are supplied in pairs (upper and lower) and are available with socketweld, flanged and NPT connections.

These valves are equipped, as a standard feature, with a floating shank union vessel connection, which permits up to 3/8" [9.5mm] variation in center to center distance and with ball check shut-offs to prevent leakage of contained fluid in case of accidental gage glass breakage.

Series 100, 200, 300, and 400 valves for process use should include ball check shut-off feature. Valves without the ball check shut-off feature will not automatically stop leakage of contained fluid in the event of accidental gage glass breakage.

2.1 System Description

Penberthy armored valves are comprised of six basic components. Each component may vary slightly, depending on the desired physical and mechanical properties for the valve. Use the exploded parts view in Section 11.0 as additional reference material.

Body – a pressure retaining structure through which liquid passes to enter a gage glass or other apparatus. Provides a rigid, union, or spherical union connection to the vessel and seating surfaces for most valve components. Series 100 and 200 are straight pattern bodies; Series 300 and 400 are offset pattern bodies.

Ball Checks – sphere installed loosely within the body of the valve that seats to prevent significant leakage when a differential pressure surge occurs (e.g., mechanical failure). Ball checks for ASME steam service incorporate a vertically rising lower and leaky horizontal upper or omit ball checks completely. “Reverse acting” ball checks are available for vacuum service.

Trim – wetted parts that mechanically control the liquid path from the vessel to the gage glass or other apparatus. The ball and stem act to seal and release the liquid. In the event of mechanical failure, the ball will seat to prevent large quantities of the contained fluid from exiting the vessel. Liquid is allowed to exit the vessel into the gage glass or other apparatus when the stem is screwed away from its seated position. The liquid is sealed when the stem is screwed into its seated position.

The stem packing retainer provides a compression surface between the process liquid and the stem packing. A stem packing gland is used to compress the packing against the retainer and around the stem to prevent leakage.

Stem Packing – under compression the stem packing is forced to mold around the stem and prevent leakage of media during operation.

Gage Connection – provides connection between the valve and the gage glass or other apparatus. A union, spherical union or rigid connection may be used. A union connection can move in a plane parallel to the vessel connection.

Handwheel/Lever – rotated to engage threads and provide screw action of stem.

3.0 Available Models

Armored valves standard feature are listed in chart below.

Features	Model No.							
	120	130	220	230	320	330	420	430
Straight Pattern	X	X	X	X				
Offset Pattern					X	X	X	X
Integral Bonnet	X	X			X	X		
Union Bonnet			X	X			X	X
Union Gage Connection	X		X		X		X	
Rigid Gage Connection		X		X		X		X
Screwed in Seat			X	X			X	X

3.1 Design Ratings at Maximum and Minimum Operating Temperatures

To determine the maximum allowable working pressure for a specific temperature within the design limits stated below, the user must refer to Penberthy Dimension Sheets, or when provided, the specifically stated design limits on a Penberthy product proposal.

DESIGN RATINGS FOR THREADED OR WELDED CONNECTIONS

Valve Series	Material of Construction	Maximum Allowable Working Pressure	
		Teflon® packing	Grafoil® packing
100 200 300 400	Carbon Steel	4000 psig [27579 kPa] @ -20°F to +100°F [-29°C to +38°C] 3525 psig [24304 kPa] @ 500°F [260°C]	4000 psig [27579 kPa] @ -20°F to +100°F [-29°C to +38°C] 2620 psig [18064 kPa] @ 750°F [399°C]
	316 STS Construction	4000 psig [27579 kPa] @ -300°F to +100°F [-184°C to +38°C] 3525 psig [24304 kPa] @ 500°F [260°C]	4000 psig [27579 kPa] @ -300°F to +100°F [-184°C to +38°C] 2755 psig [18995 kPa] @ 750°F [399°C]
For other materials or connections consult factory			

TABLE 1



NEVER exceed these design ratings or application data. Exceeding design ratings or application data may result in mechanical failure of valve components resulting in serious personal injury and/or property damage.

3.2 Steam Application

Penberthy series 100, 200, 300 and 400 valves are designed for process conditions. In low pressure steam/water applications (≤ 350 psig [2413 kPa] @ 431°F [221°C]), Penberthy allows the use of 300 and 400 series valves because the potential mechanical stress imposed on the valve assembly by the thermodynamic steam environment is relatively small. Request Penberthy Application Reports for more detailed information.

4.0 Inspection

Upon receipt of a gage valve set, check all components carefully for damage incurred in shipping. If damage is evident or suspected, do not attempt installation. Notify carrier immediately and request damage inspection. Refer to exploded view drawing in Section 11.0 to inventory parts.

4.1 User Rating Inspection

The user should confirm that:

- 1) The gage valve set model number and pressure/temperature rating stamped on nameplate (163) conforms to the description on the user's purchase order
- 2) The operating conditions described in the purchase order agree with the actual operating conditions at the installation site
- 3) The actual operating conditions at the installation site are within the applications data shown on the Penberthy Technical Data Bulletin or product proposal referred to previously.

- 4) The materials of construction of the gage valve set are compatible with both the contained fluid and the surrounding atmosphere in the specific application.

SAFETY INSTRUCTIONS

If the size, model or performance data of the gage valve set as received does not conform with any of the criteria above, do not proceed with installation. Contact an authorized Penberthy distributor for assistance. The incorrect valve can result in unacceptable performance and potential damage to the gage.

5.0 Installation

Installation should only be undertaken by qualified personnel who are familiar with this equipment. They should have read and understood all of the instructions in this manual. The user should refer to Penberthy dimension sheets or Penberthy product proposal to obtain dimensional information for specific size and model gage valve.

Penberthy recommendations on gage valve installations are not necessarily related to the installation of flat glass liquid level gages. The number of different types of gage and valve installations is too great to adequately explain in an installation manual. Therefore, it is the user's responsibility to assure that knowledgeable installation personnel plan and carry out the installation in a safe manner. The following procedures are some of the guidelines that should be employed.

5.1 Piping Strain

The gage valve should be mounted and connected so that it can support the gage without binding. Torsional stresses can make it difficult or impossible to seal tailpipes. Although union connections will allow marginal errors in piping alignment, misalignment can still create unusual strain on connectors. Gages not properly supported by brackets may subject the gage valve to stresses that can cause leaks or mechanical failure.

5.2 Differential Thermal Expansion

High mechanical loading may be imposed on a gage valve by expanding and contracting gages due to hot or cold service. Such mechanical loads on the valve must be minimized by controlling process conditions in the system.

5.3 Mounting

- 1) Prior to installation, turn the handwheel of each valve clockwise until the stem closes against the seat
- 2) Remove union vessel connections from valves, where applicable, and apply heavy grease (where allowable) to tailpipe seat. (the grease minimizes galling of the seat surfaces when tightening the coupling nuts.)

- 3) Wrench tighten tailpipes of upper and lower valves to the vessel using Teflon® tape, or equivalent, on all male tapered pipe thread connections as shown in Figure 1. If the valve is flanged or weld mount, use proper industry standard procedures.

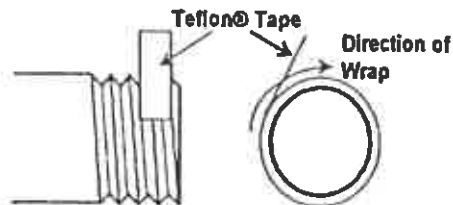


FIGURE 1

- 4) If installing with a flat glass gage, follow all installation instructions for the specific liquid level gage as there are many points to consider on gage installation; among them, piping strain, differential thermal expansion, weight and bolt torque.
- 5) Install gage tailpipes to union gage connections, where applicable, making sure that coupling nuts are in place.

6.0 Operation

Before initializing gage valve operation, check that all installation procedures have been completed. Use only qualified, experienced personnel who are familiar with valve equipment and thoroughly understand the implications of the tables and all the instructions. Check to determine that all connections are pressure tight.



DANGER



Valve installations should be brought into service slowly. Valves should be opened slightly, and the valve assembly temperature and pressure allowed to slowly equalize. If the valves are equipped with ball checks, the valves must be opened all the way after the pressure and temperature have equalized to permit operation of the automatic ball check in the event of failure. Failure to follow the recommended operating procedures can result in severe personal injury and property damage.

6.1 Hydrostatic Test

Take all precautions necessary to handle the possibility of leakage during the test. Hydrostatic pressure test all installations to 100 psig [689 kPa] and correct any leakage before proceeding.

7.0 Maintenance



WARNING



Use only qualified, experienced personnel who are familiar with valve equipment and thoroughly understand the implications of the tables and all the instructions. **DO NOT** proceed with any maintenance unless the valve assembly has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

The user must create maintenance schedules, safety manuals, and inspection details for each gage valve. These will be based upon the users own operating experience with their specific application. Realistic maintenance schedules can only be determined with full knowledge of the services and application situations involved.

During system shutdown, the valves should be left open to permit the gage to lose pressure and cool with the rest of the system. Failure to leave the valve open during system shutdown may trap high pressure fluid in the gage.

7.1 Preventive Maintenance

On all installations the following items should be regularly evaluated by the user for purposes of maintenance:

- 1) Leakage around stem area
- 2) Internal stem leak
- 3) Leakage around union connections
- 4) Internal or external corrosion

The user must determine upon evaluation of his or her own operating experience an appropriate maintenance schedule necessary for his or her own specific application. Realistic maintenance schedules can only be determined with full knowledge of the services and application situation involved.

7.2 Ball Check Shut-Off

SAFETY INSTRUCTION

Ball checks, when installed, may fail to seat due to corrosion of the ball or seat, foreign material in ball chamber or viscous material in the ball chamber. A routine operational test of the ball check can prevent significant seepage of liquid in the event of glass breakage.

An operational check can be performed on the valve ball checks by closing both the upper and lower valve stems completely. Drain contents from and relieve pressure on liquid gage to an appropriate safe container/area. NOTE: some loss of process fluid to the drain line is expected with this test procedure.



WARNING



Use only qualified, experienced personnel who are familiar with valve equipment and thoroughly understand the implications of the tables and all the instructions. DO NOT proceed with any maintenance unless the valve assembly has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

With drain line still in place, open **BOTTOM** valve as rapidly as possible. Listen for "click" sound which will indicate that the ball has seated. If possible, observe the quantity of flow from the drain line. Flow should either stop completely or be no greater than single drips (no solid stream). Close lower valve. Repeat above procedure for **UPPER** valve. There must be a pressure differential of at least 5 psi [34.5 kPa] for the above procedure to work properly.

If the above procedure is not successful, the only alternative is to isolate the gage and valve assembly from the vessel or to shut the process down completely. Disassemble the valve as outlined in Section 8.1 using the exploded parts drawing in Section 11.0 as reference. Visibly inspect ball check and ball seats in the valve body. Remove any foreign matter and/or replace with new ball checks if inspection indicates this is required. If the ball seat is damaged, consider replacing the valve or the seat (if it is removable). Reassemble valves as outlined in Section 8.2

7.3 Troubleshooting

STEM PACKING LEAKAGE can often be stopped by tightening the stem packing nut. If leak persists, the stem packing should be replaced by following steps 1) through 5) of the Disassembly and 1) through 6) of the Reassembly instructions

INTERNAL SEAT LEAKAGE is an indication of a worn or damaged stem or seat. To replace the stem follow steps 1) through 5) of the Disassembly and 1) through 7) of the Reassembly instructions. To renew the seat surface, follow steps 1) and 2) of the Disassembly instructions. Renew the seats by using a fine lapping compound and a mandrel the same size, shape and seat angle as the stem. Flush the valve body clean and reassemble by following steps 4) and 5) of the Reassembly instructions.

Renewable Threaded Seats (Series 200 and 400). Remove the seat by inserting a 1/4" [6.4mm] square driver in the seat and turning it counterclockwise. Replace the new seat by turning it clockwise using the square driver, making sure that the ball check, if used, is replaced in the body. Tighten the seat in place. Follow steps 4) and 5) of the Reassembly instructions.

LEAKAGE AROUND UNION connections can often be stopped by tightening union coupling nut or remake connection using Teflon® tape, or equivalent, on all male pipe threads as shown in Figure 1

INTERNAL OR EXTERNAL CORROSION could be an indication of a misapplication. An investigation should immediately be carried out to determine the cause of the problem. It is the user's responsibility to choose a material of construction compatible with both the contained fluid and the surrounding atmosphere.

8.0 Removal – Disassembly – Reassembly



WARNING



Use only qualified, experienced personnel who are familiar with valve equipment and thoroughly understand the implications of the tables and all the instructions.

DO NOT proceed with any maintenance unless the valve assembly has been relieved of all pressure or vacuum, has been allowed to reach ambient temperature, and has been drained or purged of all fluids. Failure to do so can cause serious personal injury and property damage.

8.1 Disassembly

Refer to the exploded parts drawing in Section 11.0 for additional reference during disassembly and reassembly of the valves.

- 1) Remove handwheel nut (30), nameplate (163) and handwheel (28) or lever from stem.
- 2) Loosen and remove stem packing nut (26).
- 3) Remove stem by turning counterclockwise, along with stem packing gland, stem packing, and stem packing retainer.
- 4) Slip the stem packing gland, stem packing and stem packing retainer off stem.
- 5) On Series 200 and 400 valves, remove bonnet nut and bonnet.
- 6) To replace seat on Series 200 and 400 valves, follow instructions as described in maintenance procedures.

8.2 Reassembly

Refer to the exploded parts drawing in Section 11.0 for additional reference during disassembly and reassembly of the valves.

- 1) Prepare for installation of new packing by cleaning all packing chambers and glands of upper and lower valves.
- 2) On Series 200 and 400 valves, replace bonnet (20), and bonnet nut (21) and tighten securely in place.
- 3) Slip packing retainer (18) on stem (17)
- 4) Install new stem packing (25) and stem packing gland (19)
- 5) Thread stem assembly into valve by turning clockwise until stem seats and then back off one turn (1/8 turn with quick close stem).
- 6) Assemble stem packing nut (26) and tighten in place.
- 7) Assemble handwheel (28) or lever (261), nameplate (163) and handwheel nut (30) on stem and tighten securely in place.
- 8) Close both valves by turning handwheel or lever clockwise until stem seats.

Refer to Section 6.0 for operation of the gage valve when returned to service.

9.0 Disposal at End of Useful Life

Penberthy valves are used in a variety of fluid applications. By following the appropriate governmental and industry regulations, the user must determine the extent of preparation and treatment the valve must incur before its disposal. A Material Safety Data Sheet (MSDS) may be required before disposal services accept certain components.

Metals and polymers should be recycled whenever possible. Refer to order and Penberthy's Material Specification sheets for materials of construction.

10.0 Telephone Assistance

If you are having difficulty with your armored gage valve, notify your local Penberthy distributor. You may also contact the factory direct at (815) 537-2311 and ask for an applications engineer. So that we may assist you more effectively, please have as much of the following information as possible when you call:

- Model #
- Name of the company from whom you purchased your valve
- Invoice # and date
- Process fluid
- Operating pressures
- Operating temperature
- A brief description of the problem
- Troubleshooting procedures that failed

If attempts to solve your problem fail, you may be requested to return your valve to the factory for intensive testing. You must obtain a Return Authorization (RA) number from Penberthy prior to returning anything. Failure to do so will result in the unit being returned to you, without being tested, freight collect. To obtain a R.A. number, the following information (in addition to that above) is needed:

- Reason for return
- Person to contact at your company
- "Ship To" address
- MSDS sheet if in harmful service

We recommend that you return the entire valve set for testing. There is a minimum charge of \$50.00 for evaluation of non-warranty units. You will be contacted before any repairs are initiated should the cost exceed the minimum charge. If you return a unit that is covered by the warranty, but is not defective, the minimum charge will apply.

Grafoil® is a registered trademark of Union Carbide Corporation
Teflon® is a registered trademark of E.I. duPont de Nemours and Company

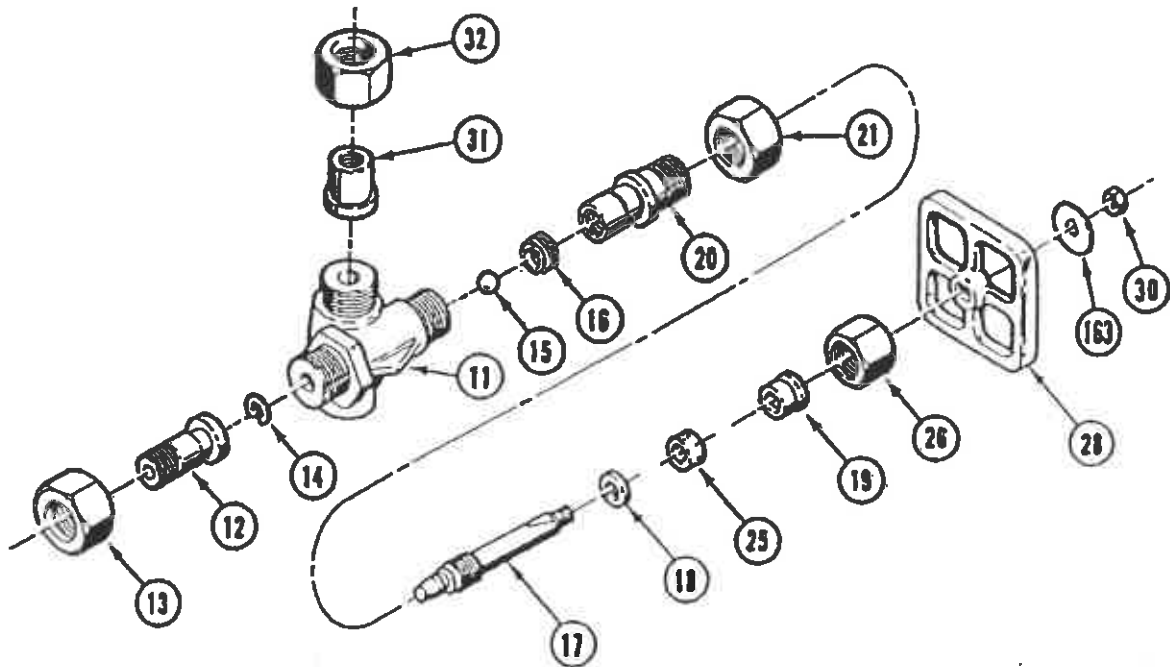
11.0 Exploded Parts Drawing

- 11 Body
- 12 Tailpipe, Vessel
- 13 Nut, Vessel Coupling
- 15 Ball
- 16 Seat
- 17 Stem
- 18 Retainer, Stem Packing
- 19 Gland, Stem Packing
- 20 Bonnet
- 21 Nut, Bonnet
- 25 Packing, Stem
- 26 Nut, Stem Packing
- 30 Nut, Handwheel
- 31 Tailpipe, Gage
- 32 Nut, Gage Coupling
- 163 Nameplate
- 261 Lever

SPARE PARTS

Ref. No.	Item	Min. Qty.
18	Retainer, Stem Packing	1
19	Gland, Stem Packing	1
25	Packing, Stem	1
30	Nut, Handwheel	1

RECOMMENDED MAXIMUM QUANTITIES SHOULD PROVIDE SPARE PARTS FOR 10% OF THE VALVES IN SERVICE



Note: Seat (16), Bonnet (20) and Nut (21) to be used on Series 200 and 400 valves only.

PENBERTHY

DECLARATION of CONFORMITY

In conformance with ISO/IEC Guide 22 - 96
VLV.DC r C


Manufacturer's Name: Penberthy, Incorporated
Manufacturer's Address: 320 Locust Street
Prophetstown, IL 61277-1147 U.S.A

Product:
Type of Equipment: Pressure Vessel - Armored and Tubular Gauge Glass Valves
Equipment Class: Industrial Instrumentation - Hazardous Area
Model Designations: 100, 200, 300, 400, 500, 600, 700 series N2, K2, K3, N6, N7, A5

The product described above is in conformity with:

92/59/EEC	General product safety	1992
87/404/EEC	Simple pressure vessels	1987
89/392/EEC	Machinery	1989
EN 10213-1:4	Technical delivery conditions for steel castings	1996
ISO 7 - 1	Pipe threads where pressure-tight joints are made	1994
BS 10	Flanges and bolting for pipes, valves and fittings	1962
BS 21	Pipe threads for tubes and fittings where pressure tight	1985
BS759	Valves, gauges and other safety fittings for application	1984
BS 970 Part 1	Wrought steels for mechanical and allied engineering	1996
BS 970 Part 3	Wrought steel for mechanical and allied engineering	1991
BS 970 Part 4	Wrought steels in the form of blooms, billets, bars	1970
BS 1502	Steels for fired and unfired pressure vessel	1982
BS 1506	Carbon, low alloy and stainless steel bars and billets	1990
BS 1560	Circular flanges for pipes, valves and fittings	1989
BS 1640 Part 1	Steel butt-welding pipe fittings	1962
BS 1640 Part 2	Steel butt-welding pipe fittings	1962
BS 1965	Butt-welding pipe fittings	1963
BS 3076	Nickel and nickel alloys: bar	1989
BS 3463	Observation and gauge glasses for pressure vessels	1975
BS Part 1	Steel pipes and tubes for pressure purposes	1987
BS 3605	Austenitic stainless steel pipes and tubes	1991
BS 3643	ISO metric screw threads	1981
BS 3799	Steel pipe fittings, screwed and socket-welding	1974
BS 4504	Circular flanges for pipes, valves and fittings	1989
ASME B&PV Code, Section VIII	Rules for construction of pressure vessels	1995
ANSI/ASME B1.1	Unified screw inch threads un and unr thread form	1982
ANSI/ASME B1.20.1	Pipe threads, general purpose (inch)	1983
ANSI/ASME B16.5	Pipe flanges and flanged fittings	1988
ANSI/ASME B18.2.1	Square and hex bolts and screw inch series	1981
ANSI/ASME B18.2.2	Square and hex nuts	1972
ANSI/ASME B18.3	Socket cap shoulder and set screws inch series	1982
ANSI/ASME B31.3	Process piping	1996

Date: 30 December 1996
Prophetstown, IL U.S.A.

Signature: 
Name: David J. Williams, C.Q.E.
Position: Quality Assurance Manager

Technical Construction File is available at stated address. Signatory is contact person.



Model # EW52NBL

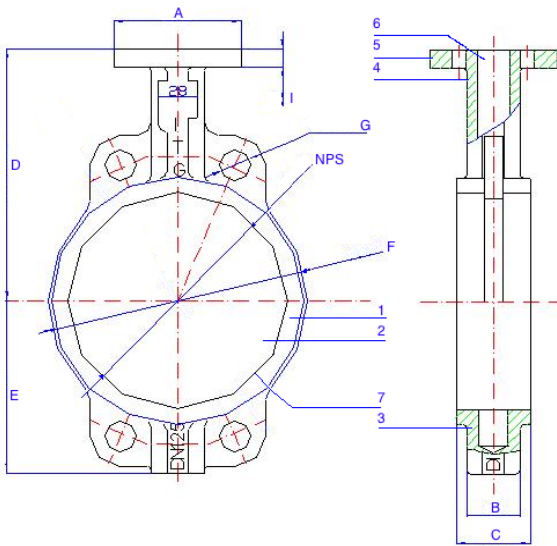
Cast Iron Butterfly Valve

ANSI Class 125, 200 WOG



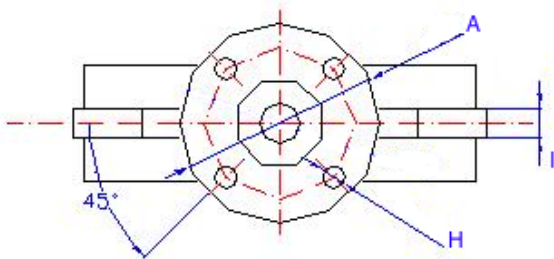
Material Specifications

No.	Description	Material
1	Body	Cast Iron
2	Disc	Ductile Iron
3	Seat	Buna-N
4	Stem	420 SS
5	Position Plate	Steel-Chrome Plate
6	Bushing	PTFE
7	Seal	Buna-N O-Ring
8	Handle	Malleable Iron



Dimensions

Size, NPS	A, mm	B, mm	C, mm	D, mm	E, mm	F, mm	G, mm	H, mm	I, mm
2"	77	33	43 0.13	124 0.79	80	96	19.1	7	10
3"	77	33	46 0.13	152 0.79	95.25	127	19.1	7	10
4"	92	38	52 0.13	171 0.79	114.3	157.5	19.1	10	10
5"	92	38	56 0.13	185 0.79	127	187	22.4	10	13
6"	92	44	56 0.13	197	139.7	213.5	22.4	10	13
8"	125	48	60	231 0.79	174	266	22.4	12	19
10"	125	51	68 0.31	262 0.79	203	326	25.4	12	19
12"	140	58	78 0.31	303 0.79	234	400	25.4	12	19

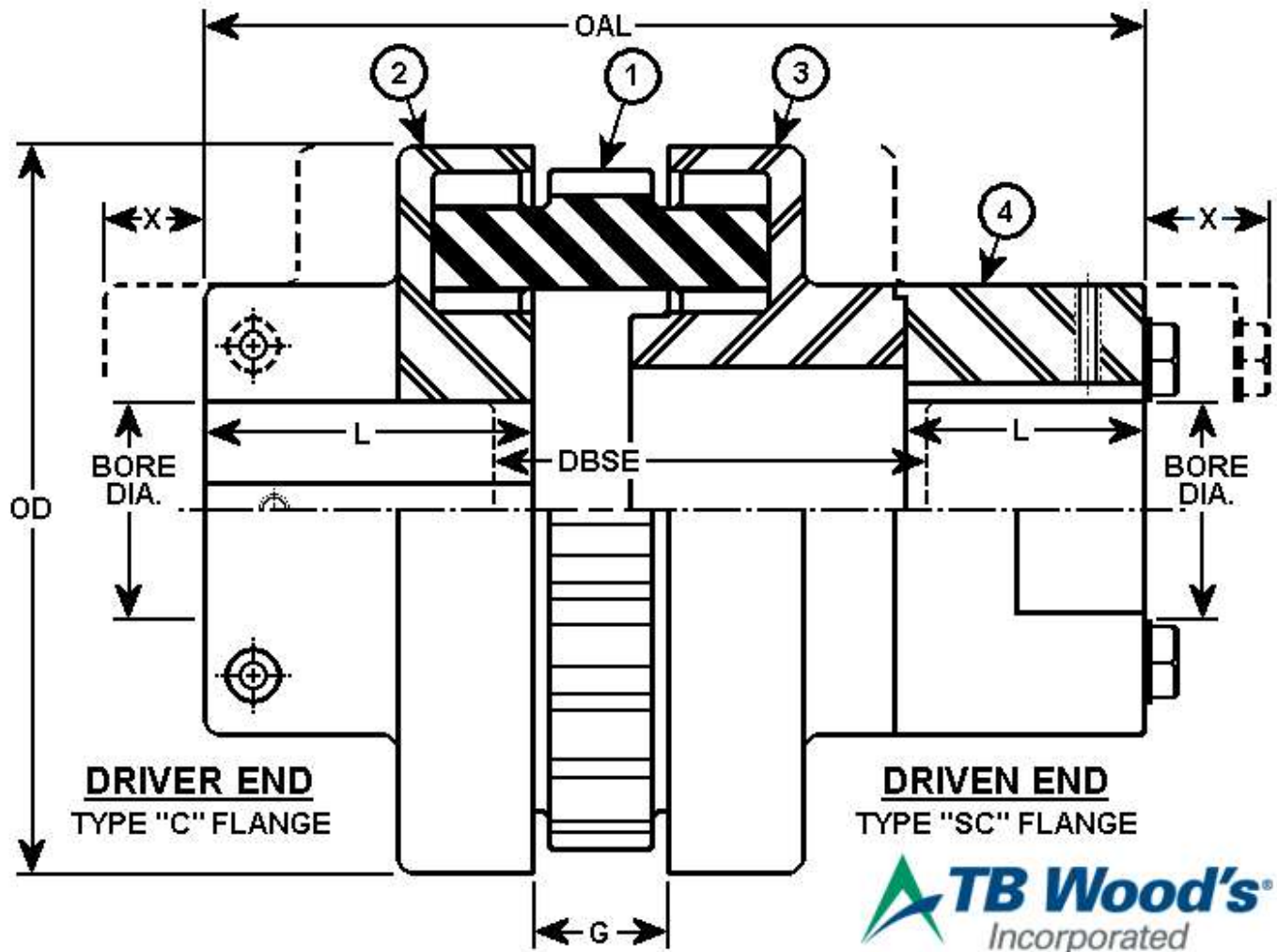


Customer Name:

Sure-Flex® Plus Coupling Size 11

June 24, 2021, 1:08 pm

Quote Number:



OD in (mm)	OAL in (mm)	G in (mm)	DBSE in (mm)			Nominal Bore Dia. in (mm)		Bore Length(L) in (mm)		To Remove Sleeve(X) in (mm)	
			Minimum	Maximum	Actual	Driver	Driven	Driver	Driven	Driver	Driven
8.63 (219.1)	10.09 (256.4)	1.875 (47.63)	4.438 (112.71)	5.525 (140.33)	5.000 (127.00)	3.375 (85.73)	2.000 (50.80)	4.000 (101.60)	2.688 (68.26)	2.12 (53.8)	1.19 (30.2)

ITEM	DESCRIPTION	PART NUMBER	WEIGHT lbs (Kg)
-	COUPLING ASSEMBLY		49.97 (22.67)
1	11HS HYTREL SLEEVE (Split)	11HS	4.50 (2.04)
2	TYPE C FLANGE (Rebore)	ALTERED 11CMPB x 3.375	19.89 (9.02)
3	TYPE SC FLANGE	11SC48	12.53 (5.68)
4	SC HUB (Rebore)	11SCHMPB	13.06 (5.92)

* - Rebore charges are added to the final discount price for one piece. Discounts will apply to higher quantities.

Operating Torque in-lbs (Nm)	Rated Torque in-lbs (Nm)	Design Service Factor	Actual Service Factor	Power HP (Kw)	Operating Speed rpm	Rated Speed rpm	Static Torsional Stiffness in-lb/rad	Maximum Misalignment	
								Ang. Gap in (mm)	Par. Offset in (mm)
7,003 (791)	18,000 (2,034)	2.00	2.57	200.0 (149.1)	1,800	3,600	125,000	.037 (.94)	.022 (.56)



SUR-FLO
METERS & CONTROLS LTD.

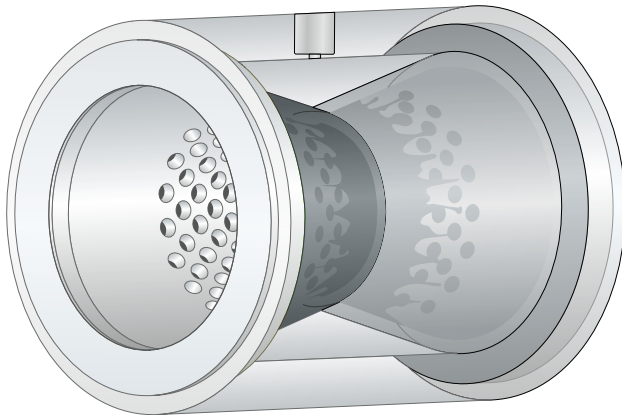
SF10V CONTROL VALVE

Sur-Flo Meters & Controls Ltd.
4520 - 50 Avenue SE
Calgary, Alberta T2B 3R4

Toll Free 1-877-527-8977
Office 403 207-9715
Fax 403 207-9440

Canadian Inquiries: sales@sur-flo.net
US Inquiries: salesUSA@sur-flo.net

www.sur-flo.net



ADVANTAGES

- Uses process gas
- Green technology – no venting – no emissions
- No spring and diaphragm
- Small footprint
- Four main components interchangeable between applications
- Ease of repair reduces downtime and maintenance costs

SPECIFICATIONS

Standard Valve Sizes	1" to 10" (for larger sizes, contact Sur-Flo)
Pressure Rating	Up to 2500 ANSI
Valve Temperature Range	-45°C – 205°C, -50°F – 400°F
Process Connections	Raised Faced Flanged, Wafer Style
Housing Material	Carbon Steel, Stainless Steel
Sleeve Material	HSN, Viton, EPDM
Cone Material	Stainless Steel, Tool Steel

SLEEVE MATERIAL

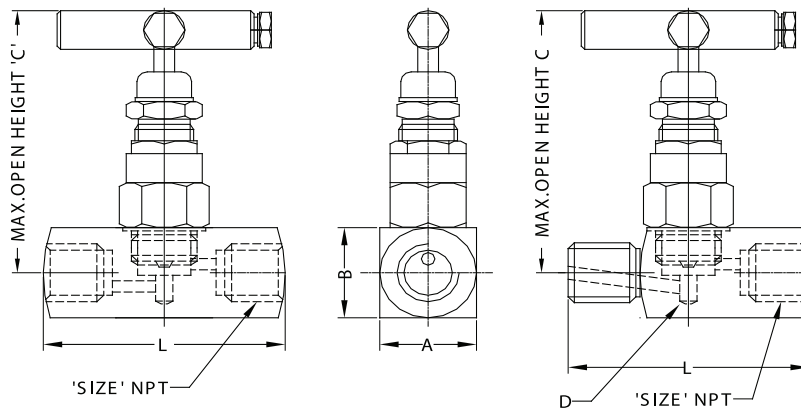
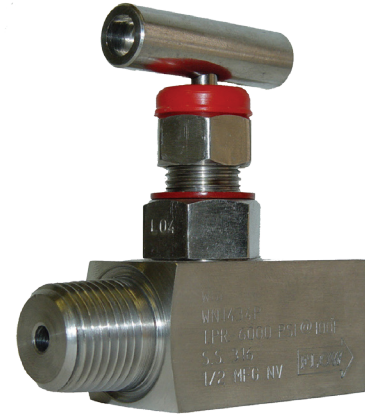
Cone Assembly	SLEEVE MATERIAL			Continuous Pressure Drop	
	SF55 HSN	SF75 Viton or HSN	SF75H Viton H or HSN		
S43	X			430 kpa	62 psi
S43		X		860 kpa	124 psi
S43			X	1375 kpa	199 psi
S63	X			1215 kpa	176 psi
S63		X		2430 kpa	352 psi
S63			X	3890 kpa	564 psi
S83	X			2415 kpa	350 psi
S83		X		4830 kpa	700 psi
S83			X	7730 kpa	1121 psi
S93			X	8400 kpa	1218 psi
S10			X	13790 kpa	2000 psi

WGI Packager Needle Valves – Instrumentation Valve – Carbon Steel

WGI packager series needle valve offers a compact valve at a very competitive price. The carbon steel valve comes with standard NACE MR0175 approval and carry a traceable heat number stamped on each valve.

Specifications

Sizes	1/4" — 1"
Maximum Operating Pressure	6,000 PSI tested at 10,000 PSI
Body & Bonnet Material	ASME-A175SN
Stem Material	ASME-SA-479
Stem Packing	ASTM SA479
Stem	Non-rotating tip – 1/2" NPT and larger
Temperature Limits	-40°F — 500°F (-40°C — 260°C)



Dimensions

Part Number	Size	Pattern	Ends	Material	Cv	A	B	C	L	D
WN1612PN	1/4"	G	F x F	CS NACE	0.25	22.0	22.0	74	54.0	3.2
WN1613PN	3/8"	G	F x F	CS NACE	0.25	28.5	28.5	85	68.0	3.2
WN1614PN	1/2"	G	F x F	CS NACE	0.25	28.5	28.5	85	76.2	3.2
WN1616PN	3/4"	G	F x F	CS NACE	0.70	35.0	35.0	89	68.0	6.0
WN1618PN	1"	G	F x F	CS NACE	0.70	45.0	45.0	91	76.2	6.0
WN1631PN	1/2" x 3/8"	G	M x F	CS NACE	0.25	22.0	22.0	62	54.0	3.2
WN1632PN	1/4"	G	M x F	CS NACE	0.25	22.0	22.0	62	54.0	3.2
WN1633PN	3/8"	G	M x F	CS NACE	0.25	28.5	28.5	85	76.2	3.2
WN1634PN	1/2"	G	M x F	CS NACE	0.25	28.5	28.5	85	76.2	3.2
WN1635PN	1/2" x 1/4"	G	M x F	CS NACE	0.25	28.5	28.5	85	76.2	3.2
WN1636PN	3/4"	G	M x F	CS NACE	0.70	35.0	35.0	89	76.2	6.0
WN1637PN	3/4" x 1/2"	G	M x F	CS NACE	0.40	30.0	30.0	78	76.2	4.2
WN1638PN	1"	G	M x F	CS NACE	0.70	45.0	45.0	112	90.0	6.0
WN1639PN	1" x 1/2"	G	M x F	CS NACE	-	45.0	45.0	112	90.0	9.0

*D = Orifice diameter | Dimensions: mm

Bourdon Tube Pressure Gauges Stainless Steel Series Type 232.53 - Dry Case Type 233.53 - Liquid-filled Case

WIKA Datasheet 23X.53

Applications

- With liquid filled case for applications with high dynamic pressure pulsations or vibration
- Suitable for corrosive environments and gaseous or liquid media that will not obstruct the pressure system
- Process industry: chemical/petrochemical, power stations, mining, on and offshore, environmental technology, mechanical engineering and plant construction

Product features

- Excellent load-cycle stability and shock resistance
- All stainless steel construction
- Positive pressure ranges to 15,000 psi (1,000 bar)
- FlexWindow™ option with integrated pressure compensation and 100% case fill*

Specifications

Design

ASME B40.100 & EN 837-1

Sizes

2", 2½" & 4" (50, 63 and 100 mm)

Accuracy class

2" & 2½": ± 2/1/2% of span (ASME B40.100 Grade A)
4": ± 1.0% of span (ASME B40.100 Grade 1A)

Ranges

Vacuum / compound to 200 psi (16 bar)
Pressure from 15 psi (1 bar) to 15,000 psi (1,000 bar) or other equivalent units of pressure or vacuum

Working pressure

2" & 2½":	Steady:	3/4 scale value
	Fluctuating:	2/3 full scale value
	Short time:	full scale value
4":	Steady:	full scale value
	Fluctuating:	0.9 x full scale value
	Short time:	1.3 x full scale value

Operating temperature

Ambient: -40°F to +140°F (-40°C to +60°C) - dry
-4°F to +140°F (-20°C to +60°C) - glycerine filled
-40°F to +140°F (-40°C to +60°C) - silicone filled
Medium: +212°F (+100°C) maximum



Bourdon Tube Pressure Gauge Model 232.53 – 2-1/2" » with FlexWindow™ option

Temperature error

Additional error when temperature changes from reference temperature of 68°F (20°C) ±0.4% of span for every 18°F (10°K) rising or falling.

Ingress protection

IP 65 per EN 60529 / IEC 60259
IP66 (NEMA 4) with FlexWindow™ option (2-1/2" only)

Pressure connection

Material: 316 stainless steel
Lower mount (LM) or center back mount (CBM)
Lower back mount (LBM) for 4" size
1/8" NPT, 1/4" NPT or 1/2" NPT limited to wrench flat area

Bourdon tube

Material: 316 stainless steel
≤ 1,500 psi (100 bar): C-shape,
> 1,500 psi (100 bar): Helical type

Movement

Stainless steel

Dial

White aluminum with black lettering, 2" and 2½" with stop pin

Pointer

Black aluminum

(* EN837-1 does not apply to FlexWindow™.

Case

304 stainless steel with vent plug for ranges ≤ 300 psi
(FlexWindow™ option without vent plug) and stainless steel
crimp ring.

Window

Polycarbonate (standard)
Laminated Safety Glass
FlexWindow™ (Clear liquid silicone rubber)

Case fill

Model 233.53 – Glycerin, Glycerin/Water
100% Case fill with integrated pressure compensation with
FlexWindow™ option (only available in 2-1/2")

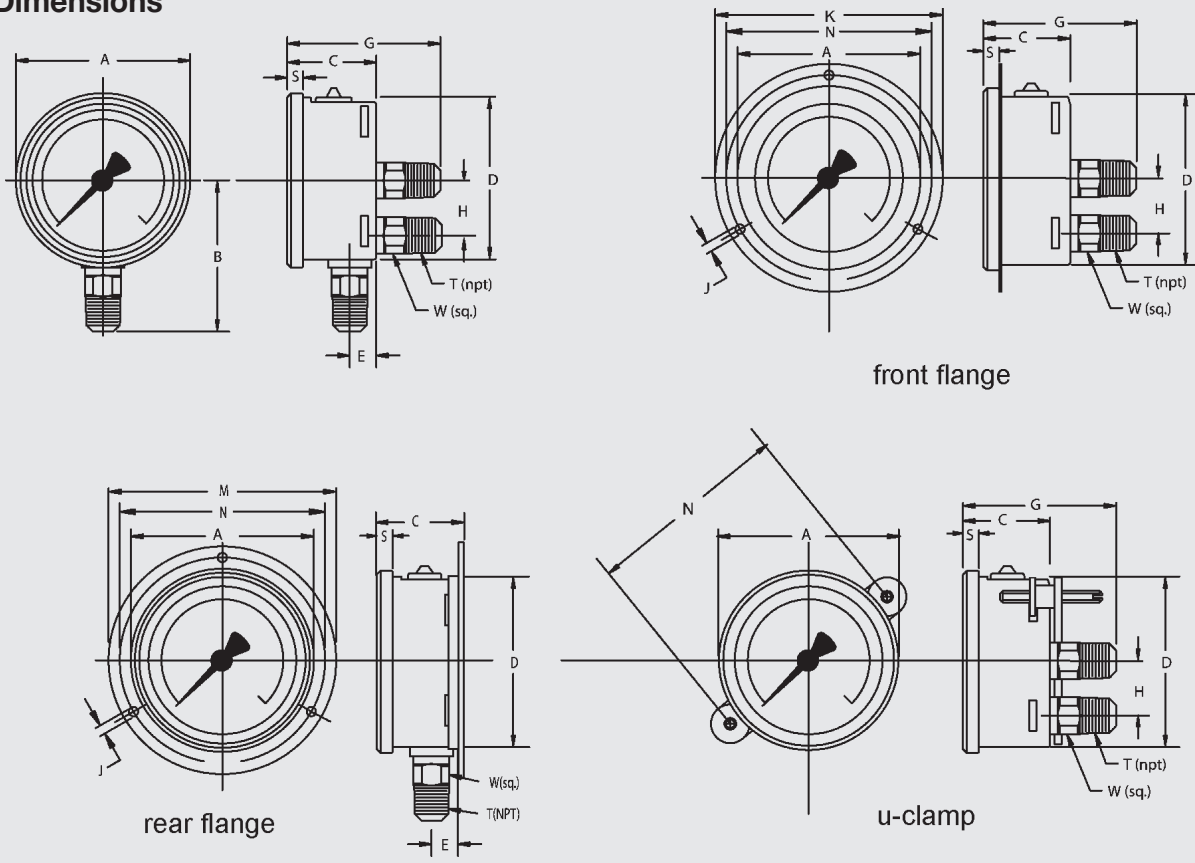
Approvals

NGV 3.1 Approval (not available with FlexWindow™)

Optional extras

- SS restrictor
- SS front flange
- SS rear flange (2½" and 4" only)
- Zinc-plated steel or SS u-clamp bracket
(field installable - see note)
- Cleaned for oxygen service
(not available with FlexWindow™)
- Red drag pointer or mark pointer (2½" and 4" only)
(not available with FlexWindow™)
- External zero adjustment (4" size only)
- Other pressure connections
- Silicone or Halocarbon Oil case filling
(not available with FlexWindow™)
- Other pressure scales available:

Dimensions



Size		A	B	C	D	E	G	H	J	K	M	N	S	T	W	Weight
2"	mm	55	48	30	50	12	53	-	3.6	71	71	60	5.5		14	0.27 lb. dry
	in	2.17	1.89	1.18	1.97	0.47	2.09	-	0.14	2.80	2.80	2.36	0.22	1/4"	0.55	0.33 lb. filled
2.5"	mm	69	54	32	62	13	54	-	3.6	85	88.1	75	6.5		14	0.36 lb. dry
	in	2.69	2.13	1.26	2.45	0.51	2.13	-	0.14	3.35	3.47	2.95	0.26	1/4"	0.55	0.44 lb. filled
4"	mm	107	87	48	100	15.5	79.5	30	4.8	132	132	116	8		22	1.10 lb. dry
	in	4.21	3.43	1.89	3.91	0.61	3.13	1.18	0.19	5.20	5.20	4.57	0.31	1/2"	0.87	1.76 lb. filled

Recommended panel cutout is dimension **D + 3 mm**

Standard Order Code - 23X.53 2½”

		Measuring System				2nd Scale / Special Scale	
1	<input type="checkbox"/>	3	Stainless Steel			Z	without
		Case filling				B	2nd scale bar
		2	without			P	2nd scale psi
2	<input type="checkbox"/>	3	with			L	2nd scale kPa
		Case				E	2nd scale MPa
3	<input type="checkbox"/>	53	Non-removable crimp ring	7	<input type="checkbox"/>	K	2nd scale kg/cm2
		Unit of outer Scale				Process Connection	
		P	psi / -inHg			NB	1/4 NPT
		B	bar			GA	G 1/8 B
		L	kPa			GB	G 1/4 B
		E	MPa	8	<input type="checkbox"/>	NH	1/8 NPT
4	<input type="checkbox"/>	K	kg/cm2			Connector location	
		Measuring range				U	lower mount
		G	gauge pressure range			B	center back mount
5	<input type="checkbox"/>	V	vacuum- or compound-range			E	3 o'clock
		Scale range				G	9 o'clock
		310	0/15 psi (-30"Hg/0)	9	<input type="checkbox"/>	D	12 o'clock
		321	0/30 psi (-30"Hg/15 psi)			Mounting Flange/Bracket	
		341	0/60 psi			Z	Without (Standard)
		369	0/100 psi			F	front flange, polished SS
		411	0/160 psi	10	<input type="checkbox"/>	C	Rear Flange, Stainless Steel
		414	0/200 psi			K	Panel mount with Stainless steel U-clamp
		421	0/300 psi			Restrictor	
		428	0/400 psi			Z	Without (Standard)
		441	0/600 psi			Q	stainless steel, D 0.6
		455	0/800 psi	11	<input type="checkbox"/>	R	Stainless Steel, Orifice 0.3mm(0.012 inches)
		469	0/1000 psi			Special design features	
		510	0/1500 psi			Z	without (Standard)
		514	0/2000 psi			G	for Oxygen, Cleanliness ASME B40.1 Level IV
		521	0/3000 psi			D	Cleanliness ASME B40.1 Level IV
		528	0/4000 psi	12	<input type="checkbox"/>	N	NACE Sour Gas Service
		534	0/5000 psi			Certificates	
		541	0/6000 psi			Z	without (Standard)
		552	0/7500 psi	13	<input type="checkbox"/>	1	quality certificates
		569	0/10000 psi			Approvals	
		610	0/15000 psi	14	<input type="checkbox"/>	Z	without (Standard)
		331	-30 inHg/30 psi			Additional ordering information	
		352	-30 inHg/60 psi			Z	Without (Standard)
		379	-30 inHg/100 psi	15	<input type="checkbox"/>	T	Additional text
		412	-30 inHg/160 psi				
		415	-30 inHg/200 psi				
6	<input type="checkbox"/>	422	-30 inHg/300 psi				

Modelcode: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
2 3 . 53 .063 - - - - - Z

Additional Text:

Additional scale ranges and options are available. Please contact the factory or access the product configurator for model 23X.53 on the WIKA US website.

Quick Order Guide/Standard Items - 23X.53 4''

Specifications according to data sheet
Nominal size





23X.53 and 23X.54
100 mm




Standard features

Measuring System
2nd Scale / Special Scale
Accuracy Class
Material pressure element

Stainless Steel
without
+/- 1% (ASME B40.100 Grade 1A)
Measuring System 316L

Ordering information

Case		Non-removable crimp ring					
Case filling		without			with		
Connector location							
Unit of outer Scale		psi / -inHg		psi / -inHg	psi / -inHg		psi / -inHg
Scale range	Process Connection	1/2 NPT	1/4 NPT	1/2 NPT	1/2 NPT	1/4 NPT	1/2 NPT
0/15 psi		9768513	9767428	9737120	9833387	9833026	9831571
0/30 psi		9768521	9767436	9737138	9833395	9833035	9831589
0/60 psi		9768530	9767444	9737146	9833409	9833043	9831597
0/100 psi		9768548	9767452	9737154	9833417	9833051	9831601
0/160 psi		9768556	9767460	9737162	9833425	9833069	9831619
0/200 psi		9768564	9767479	9737170	9833434	9833077	9831627
0/300 psi		9768572	9767487	9737189	9833442	9833085	9831635
0/400 psi		9768580	9767495	9737197	9833450	9833094	9831644
0/600 psi		9768963	9767509	9737200	9833727	9833107	9831652
0/1000 psi		9768858	9767517	9737227	9833697	9833115	9831678
0/1500 psi		9768866	4382613	9737235	9833701	50417754	9831686
0/2000 psi		9768807	50025708	9737243	9833655	50570838	9831695
0/3000 psi		9768874	50576151	9737251	9833719	50563181	9831708
0/5000 psi		9768823	4232724	9737260	9833663	4267927	9831716
0/10000 psi		9768831	52806638	9737278	9833671	4267935	9831725
0/15000 psi		9768840	52873915	9737286	9833689	52142809	9831733
-30 inHg/0 psi		9768459	9767576	9737057	9833328	9833124	9831504
-30 inHg/15 psi		9768467	9737910	9737065	9833336	9831775	9831512
-30 inHg/30 psi		9768475	9767398	9737073	9833345	9832993	9831520
-30 inHg/60 psi		9768483	9767401	52912433	9833353	9833000	9831538
-30 inHg/100 psi		9737880	9737898	9737090	9831741	9831759	9831546
-30 inHg/160 psi		9768491	9767410	9737103	9833361	9833018	9831555
-30 inHg/200 psi		9768505	9737901	9737111	9833379	9831767	9831563

	available on stock
	available after production
	not available

Standard Order Code - 23X.53 4"

		Measuring System				2nd Scale / Special Scale	
1	<input type="checkbox"/>	3	Stainless Steel			B	2nd scale bar
		Case filling				P	2nd scale psi
		2	without			L	2nd scale kPa
2	<input type="checkbox"/>	3	with			E	2nd scale MPa
		Case		7	<input type="checkbox"/>	K	2nd scale kg/cm2
3	<input type="checkbox"/>	53	Non-removable crimp ring			Process Connection	
		Unit of outer Scale				ND	1/2 NPT
		P	psi/ -inHg			NB	1/4 NPT
		B	bar			GD	G 1/2 B
		L	kPa	8	<input type="checkbox"/>	GB	G 1/4 B
		E	MPa			Connector location	
4	<input type="checkbox"/>	K	kg/cm2			U	lower mount
		Measuring range				3	lower back mount
		G	gauge pressure range			E	3 o'clock
5	<input type="checkbox"/>	V	vacuum- or compound-range			G	9 o'clock
		Scale range		9	<input type="checkbox"/>	D	12 o'clock
		310	0/15 psi (-30"Hg/0)			Mounting Flange/Bracket	
		321	0/30 psi (-30"Hg/15 psi)			Z	Without (Standard)
		341	0/60 psi			F	front flange, polished SS
		369	0/100 psi			C	Rear Flange, Stainless Steel
		411	0/160 psi	10	<input type="checkbox"/>	K	Panel mount with Stainless steel U-clamp
		414	0/200 psi			Restrictor	
		421	0/300 psi			Z	Without (Standard)
		428	0/400 psi			Q	stainless steel, D 0.6
		441	0/600 psi	11	<input type="checkbox"/>	R	Stainless Steel, Orifice 0.3mm(0.012 inches)
		455	0/800 psi			Special design features	
		469	0/1000 psi			Z	without (Standard)
		510	0/1500 psi			G	for Oxygen, Cleanliness ASME B40.1 Level IV
		514	0/2000 psi			D	Cleanliness ASME B40.1 Level IV
		521	0/3000 psi	12	<input type="checkbox"/>	N	NACE Sour Gas Service
		528	0/4000 psi			Certificates	
		534	0/5000 psi			Z	without (Standard)
		541	0/6000 psi	13	<input type="checkbox"/>	1	quality certificates
		552	0/7500 psi			Approvals	
		569	0/10000 psi			Z	without (Standard)
		610	0/15000 psi	14	<input type="checkbox"/>	Additional ordering information	
		331	-30 inHg/30 psi			Z	Without (Standard)
		352	-30 inHg/60 psi			Additional ordering information	
		379	-30 inHg/100 psi	15	<input type="checkbox"/>	T	Additional text
		412	-30 inHg/160 psi			Additional ordering information	
		415	-30 inHg/200 psi			Additional ordering information	
6	<input type="checkbox"/>	422	-30 inHg/300 psi			Additional ordering information	

Modelcode: 2 3 . 53 .100 - - - - - Z

Additional Text:

Additional scale ranges and options are available. Please contact the factory or access the product configurator for model 23X.53 on the WIKA US website.



Doc. No.	NDP 173M-08
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MAINTENANCE MANUAL

YAMADA AIR-OPERATED DOUBLE DIAPHRAGM PUMP

DP-15 series

WARNING



- For your own safety, be sure to read procedures carefully before performing maintenance on this product. After reading this document, be sure to keep it handy for future reference.

This maintenance manual covers what you should know about maintenance of the Yamada DP-15 series Diaphragm Pumps.

This edition is based on the standards for the December 2018 production run. Remember, the specifications are always subject to change; therefore, some of the information in this edition may not apply to new specifications.

•Warnings and Cautions

For safe use of this product, be sure to note the following: In this document, warnings and cautions are indicated by symbols. These symbols are for those who will operate this product and for those who will be nearby, for safe operation and for prevention of personal injury and property damage. The following warning and caution symbols have the meanings described below. Be sure to remember their meanings.



WARNING : If you ignore the warning described and operate the product in an improper manner, there is danger of serious bodily injury or death.



CAUTION : If you ignore the caution described and operate the product in an improper manner, there is danger of personal injury or property damage.

Furthermore, to indicate the type of danger and damage, the following symbols are also used along with those mentioned above:



This symbol indicates a DON'T, and will be accompanied by an explanation on something you must not do.



This symbol indicates a DO, and will be accompanied by instructions on something you must do in a certain situation.

WARNING



- Before starting maintenance work, cut off the feed air and clean the pump. If air pressure or residue remain in the pump, there is danger of explosion, or possible poisoning resulting in serious injury or death if chemicals adhere to the skin or are accidentally swallowed. (For details on cleaning the pump, refer to Chapter 6 of the Operation Manual.)



- When replacing parts, be sure to use the recommended genuine parts or Equivalents. Use of other parts may cause a malfunction of the product. (Refer to Exploded View and Reminder to order correct item on the separate sheets.)

CAUTION



- When it is instructed that special tools must be used, be sure to use the specified tools. Otherwise, the pump may be damaged.



- Refer to 10.1 "Specifications" in the Operation Manual. Also, remember that the pump is heavy, and extreme care must be taken when lifting it.

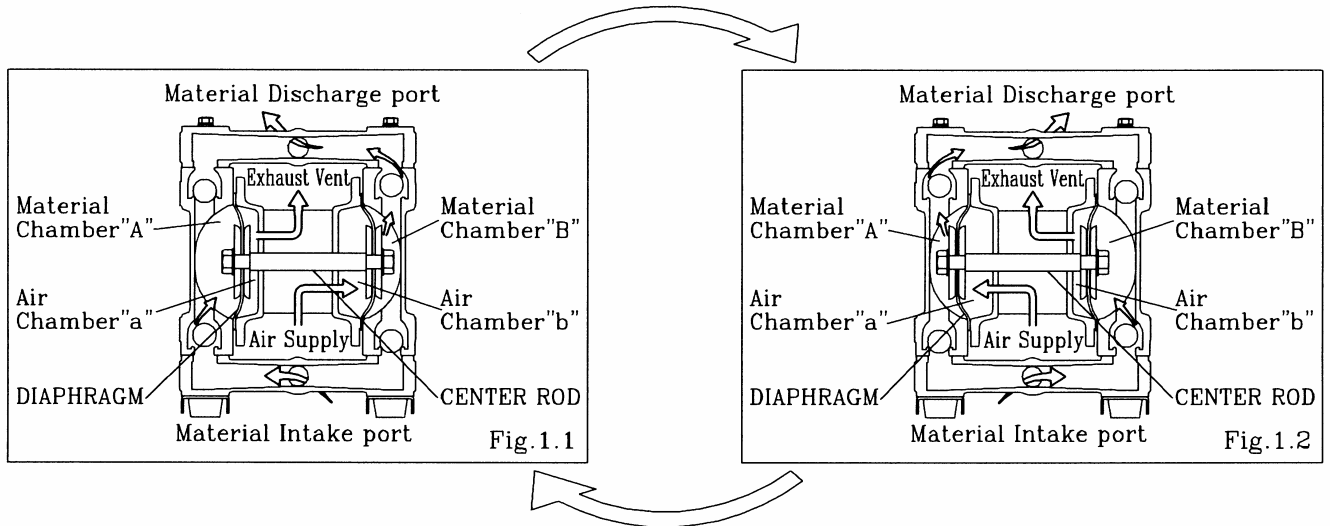
Table of Contents

·Warnings and Cautions	
·Table of Contents	
1. Principles of operation	1
2. Tools, etc.	
2.1 General tools	1
2.2 Misc.	1
3. Ordering Replacement parts	1
4. Balls and Valve seats	
4.1 Removal	2
4.2 Inspection	3
4.3 Installation	3
5. Diaphragm	
5.1 Removal	4
5.2 Inspection	4
5.3 Installation	
■_PH, _PS types	5
■_PN, _PT types	5
6. Center rod, Body and Guide bush	
6.1 Removal	6
6.2 Inspection	6
6.3 Installation	6
7. Spool valve case and Spool Assembly	
7.1 Removal	7
7.2 Inspection	7
7.3 Installation	7
8. Retightening of tie rods	8

1. Principles of operation

There are two diaphragms fixed to the center rod, one at each end. When compressed air is supplied to air chamber b (right side, see Fig.1.1), the center rod moves to the right, the material in material chamber B is pushed out, and at the same time material is sucked into material chamber A.

When the center rod is moved full-stroke to the right, the air switch valve is switched, compressed air is sent to air chamber a (left side, see Fig.1.2), and the center rod moves to the left. The material in material chamber A is pushed out, and at the same time material is sucked into material chamber B. Through repetition of this operation, material is repeatedly taken in and discharged out.



2. Tools, etc.

2.1 General tools

- Socket wrenches 13mm
- Hexagonal box wrenches 5mm
- Open-end wrenches 21mm
- Snap ring pliers

2.2 Misc.

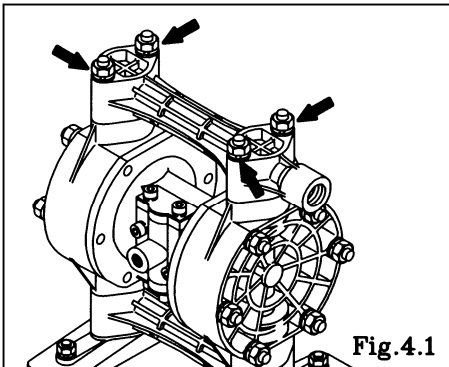
- Assembly oil Turbine oil none addition class 1 (equivalent to ISO VG32 grade)
- Grease Urea grease grade (NLGI) No.2

3. Ordering Replacement parts

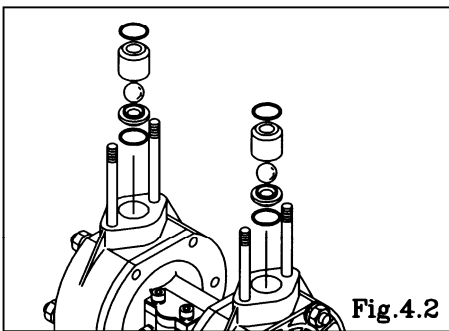
For accurate and speedy shipment of parts, be sure to order the right parts for your model to distributor. Indicate the part numbers, descriptions, and quantities.

4. Balls and Valve seats

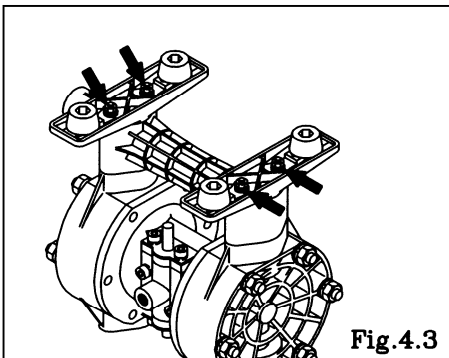
4.1 Removal



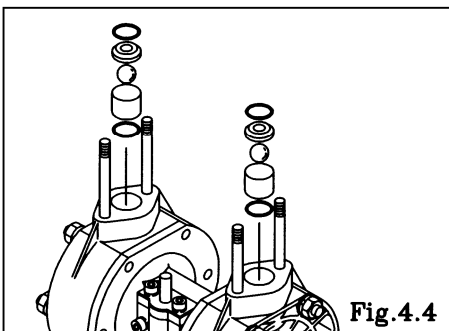
- Remove the 4 retainer nuts from the out manifold, and remove the out manifold. [Fig.4.1]



- Remove the O ring, valve stopper, ball (flat valve) and valve seat. [Fig.4.2]



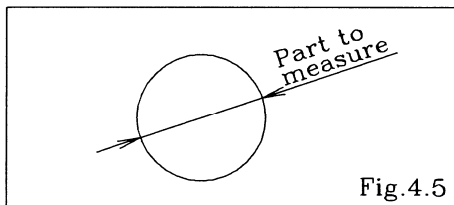
- Turn over the main body assembly. [Fig.4.3]
Remove the 4 retainer nuts from the in manifold, and remove the base and in manifold. [Fig.4.3]



- Remove the O ring, valve seat, ball (flat valve) and valve stopper. [Fig.4.4]

4.2 Inspection

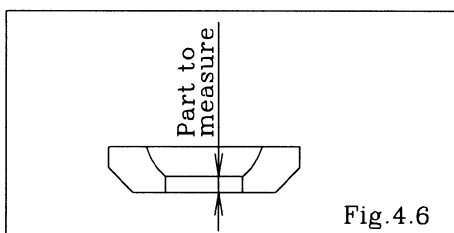
■ Ball valve type



- Ball [Fig.4.5]
Measure the outside diameter, and if it is outside the usable range, replace the ball.

Usable range of ball

$S\phi 0.787 \sim S\phi 0.898$ in { $S\phi 20.0 \sim S\phi 22.8$ mm}

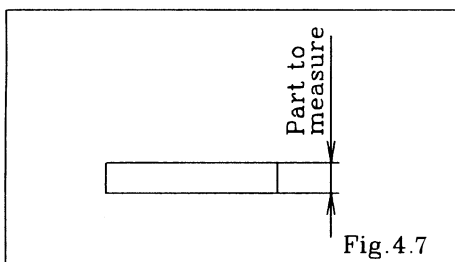


- Valve seat [Fig.4.6]
Measure the dimension shown at left, and if it is outside the usable range, replace the seat.

Usable range of valve seat

0.102 ~ 0.225 in {2.6 ~ 5.7 mm}

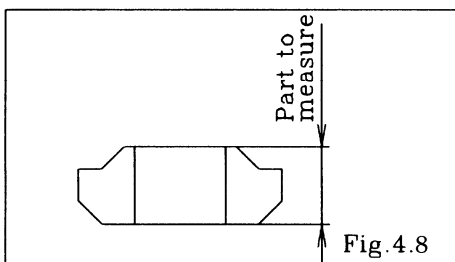
■ Flat valve type



- Flat valve [Fig.4.7]
Measure the dimension shown at left, and if it is outside the usable range, replace the seat. If the seal ring is worn out or cracked, replace it.

Usable range of Flat valve

0.169 ~ 0.197 in {4.3 ~ 5.0 mm}



- Valve seat [Fig.4.8]
Measure the dimension shown at left, and if it is outside the usable range, replace the seat.

Usable range of Valve seat

0.323 ~ 0.394 in {8.2 ~ 10.0 mm}

- O ring (other than PTFE)
If O ring is worn out or cracked, replace it.

4.3 Installation

For installation, see [Exploded View] on the separate sheet and install in the reverse order of disassembly.

Tightening torque for manifold retainer bolts

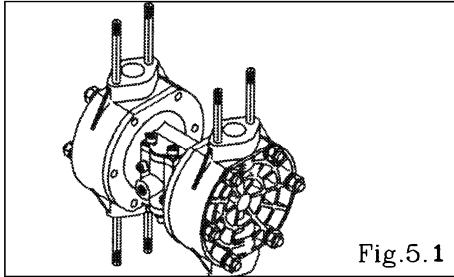
105 in-lbf {12 N-m}

<NOTE>

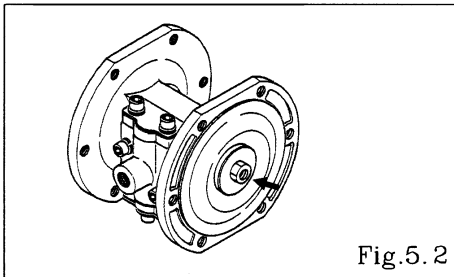
- Make sure there is no dust on the seal surface and the seal is not damaged.
- Replace the PTFE O ring regardless of its condition.

5. Diaphragm

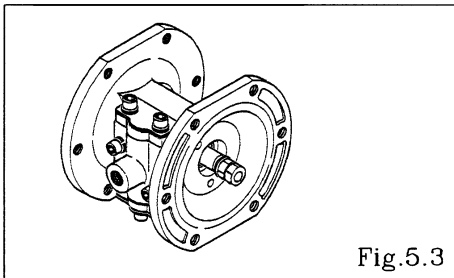
5.1 Removal



- Remove the ball (flat valve), valve stopper and valve seat etc. (see [4.1 Removal])
- Remove the 12 retainer bolts from the out chamber, and remove the out chamber. [Fig.5.1]



- Remove the center disk from one side. [Fig.5.2]
- After the center disk (on one side) have been removed, remove the diaphragm and the center disk (inside).



- Remove the center disk and diaphragm from the opposite side using the double nut. [Fig.5.3]
Be careful not to scratch or score the center rod.

5.2 Inspection

- Diaphragm
If the diaphragm is worn out or damaged, replace it.
Never replace just one diaphragm.

Guideline of diaphragm life

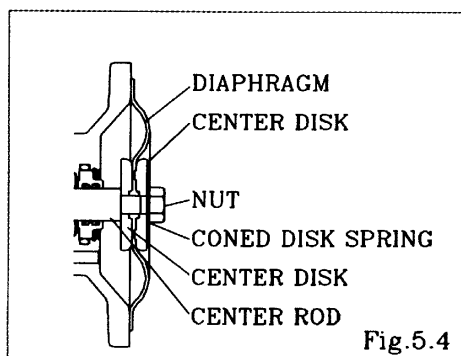
NBR, PTFE	10,000,000 cycle
TPEE, TPO	15,000,000 cycle

(When used with clean water at room temperature)

5.3 Installation

■ _PH, _PS types

For installation, see [Exploded View] on the separate sheet and install in the reverse order of disassembly.



- Apply assembly oil to the center rod, and insert it into the main body.
- Keep the convex side to the outside (cf. Fig.5.4).
- Tighten the center disk using the open-end wrenches. (No coned disk springs and nuts are needed.)
- Tighten the out chamber temporarily at first.
- After installation of the out chambers on both sides, place the pump on a flat surface and stand the pump upright for further assembly.

Tightening torque for center rod and out chamber

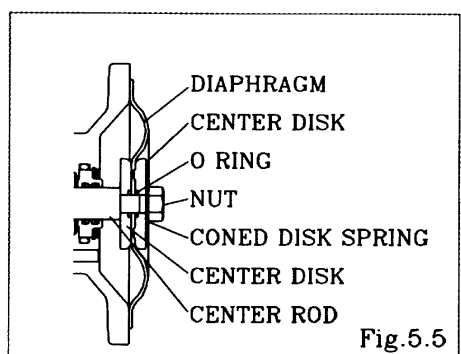
Center rod	Out chamber
122 in-lbf {14 N-m}	105 in-lbf {12 N-m}

<NOTE>

- Make sure there is no dust on the seal surface in order to prevent seal damaged
- Tighten the bolts that balance should be equal from both side on diagonal line with even torque.

■ _PN, _PT types

For installation, see [Exploded View] on the separate sheet and install in the reverse order of disassembly.



- Apply assembly grease to the center rod, and insert it into the main body.
- Keep the marking "LIQUID" to liquid end for NBR diaphragms. Keep the convex side to the outside for PTFE diaphragm.
- Install the O ring (cf. Fig.5.5).
- Tighten the center disk using the open-end wrenches. (No coned disk springs and nuts are needed.)
- After installation of the out chambers on both sides, place the pump on a flat surface and stand the pump upright for further assembly.

Tightening torque for center rod and out chamber.

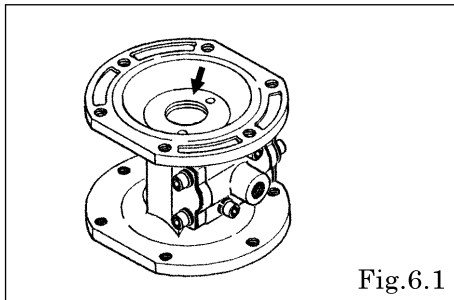
Center rod	Out chamber
122 in-lbf {14 N-m}	105 in-lbf {12 N-m}

<NOTE>

- Make sure there is no dust on the seal surface in order to prevent seal damaged.
- Replace the PTFE O ring by new one.
- Tighten the bolts that balance should be equal from both side on diagonal line with even torque.

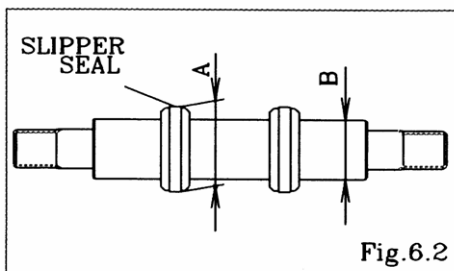
6. Center rod, Body and Guide bushing

6.1 Removal



- Remove the diaphragm etc. (see [5.1 Removal])
- Remove the snap ring using the snap ring pliers, and remove the guide bushing, spacer and center rod assembly. [Fig.6.1]

6.2 Inspection



- Center rod assembly [Fig.6.2]
Measure the outside diameter (A), and if it is outside the usable range, replace the slipper seal.

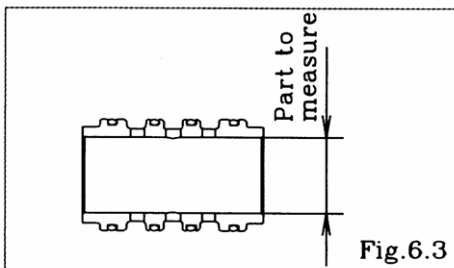
Usable range of Slipper seal (A)

$\phi 0.783 \sim \phi 0.787$ in $\{\phi 19.9 \sim \phi 20.0 \text{ mm}\}$

- Measure the outside diameter (B), and if it is outside the usable range, replace the center rod Slipper seal.

Usable range of Center rod (B)

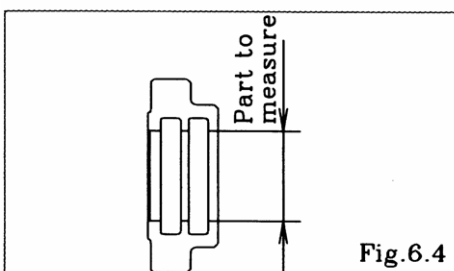
$\phi 0.547 \sim \phi 0.551$ in $\{\phi 13.9 \sim \phi 14.0 \text{ mm}\}$



- Sleeve [Fig.6.3]
Measure the inside diameter, and if it is outside the usable range, replace the Sleeve.
Remove the Sleeve from the Spacer side.

Usable range of Body

$\phi 0.7874 \sim \phi 0.7906$ in $\{\phi 20.00 \sim \phi 20.08 \text{ mm}\}$



- Guide bushing [Fig.6.4]
Measure the inside diameter, and if it is outside the usable range, replace the guide bushing.

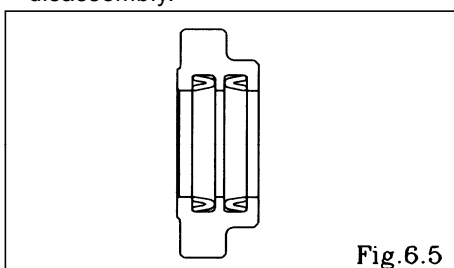
Usable range of Guide bushing

$\phi 0.5520 \sim \phi 0.5551$ in $\{\phi 14.02 \sim \phi 14.10 \text{ mm}\}$

- O ring
If the O ring is worn out or cracked, replace it.

6.3 Installation

For installation, see [Exploded View] on the separate sheet and install in the reverse order of disassembly.

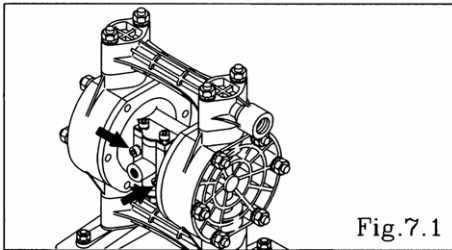


<NOTE>

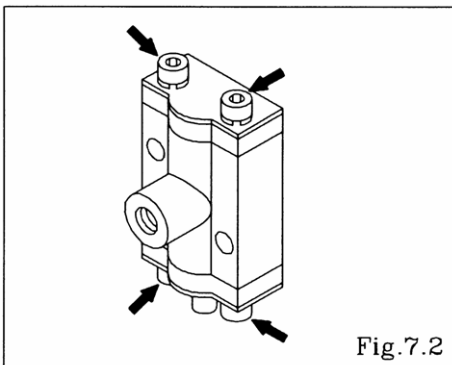
- Make sure there is no dust on the seal surface and it is not damaged.
- Apply grease to packing.

7. Spool valve case and Spool Assembly

7.1 Removal

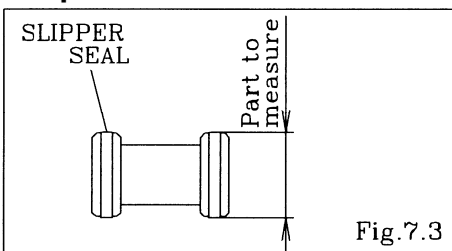


- Remove the 2 retainers from the spool valve case, and remove the spool valve case. [Fig.7.1]



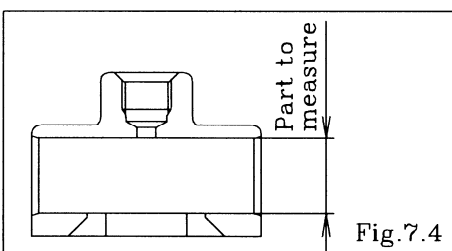
- Remove the 2 retainer bolts from the cap, and remove the reinforcement plate A, cap and reset button. [Fig.7.2]
- Remove the 2 retainer bolts from the cap, and remove the reinforcement plate B, and cap. [Fig.7.2]
- Remove the spool valve assembly from the spool valve case.

7.2 Inspection



- Spool valve assembly [Fig.7.3]
Measure the outside diameter, and if it is outside the usable range, replace the slipper seal.

Usable range of spool valve assembly
 $\phi 0.783 \sim \phi 0.787$ in { $\phi 19.9 \sim \phi 20.0$ mm}

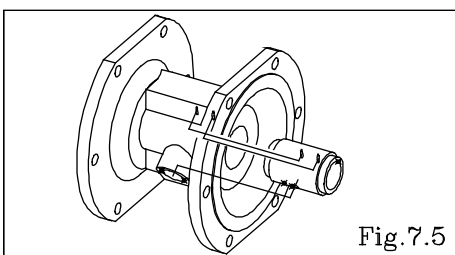


- Spool valve case [Fig.7.4]
Measure the inside diameter, and if it is outside the usable range, replace the Spool valve case.

Usable range of spool valve case
 $\phi 0.7874 \sim \phi 0.7906$ in { $\phi 20.00 \sim \phi 20.08$ mm}

7.3 Installation

For installation, see [Exploded View] on the separate sheet and install in the reverse order of disassembly.



Tightening torque for installation Cap

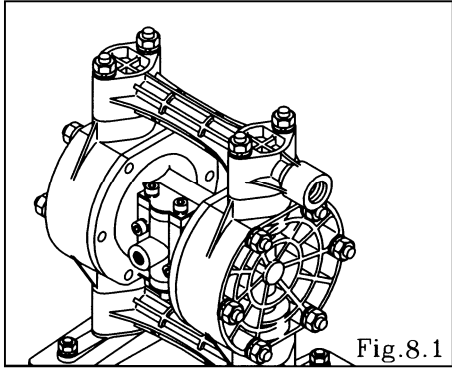
55 in-lbf { 6 N-m}

Tightening torque for installation Spool valve case

55 in-lbf { 6 N-m}

- Sleeve [Fig.7.5]
When inserting the sleeve into the body, please make sure the position of the 3 holes in the sleeve match the corresponding holes in the body.
- <NOTE>
- Make sure there is no dust on the seal surface and it is not damaged.

8. Retightening of Tie rods



- The torque should be applied on the occasion of
 - (1) Right before the pump to use
 - (2) There are any leaks of material on daily inspecting a pump.

Retightening of tie rods and torque

Horizontal tie rods	Vertical tie rods
105 in-lbf {12 N-m}	105 in-lbf {12 N-m}

<NOTE>

- Fasten the nut (tie rods) on a diagonal line alternately with even force.
- Retighten the horizontal tie rods and then the vertical tie rods. [Fig. 8.1]

YAMADA AMERICA, INC

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www.yamadapump.com

Manufactured by:

YAMADA CORPORATION

International Department
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PHONE : +81-(0)3-3777-0241 FAX : +81-(0)3-3777-0584

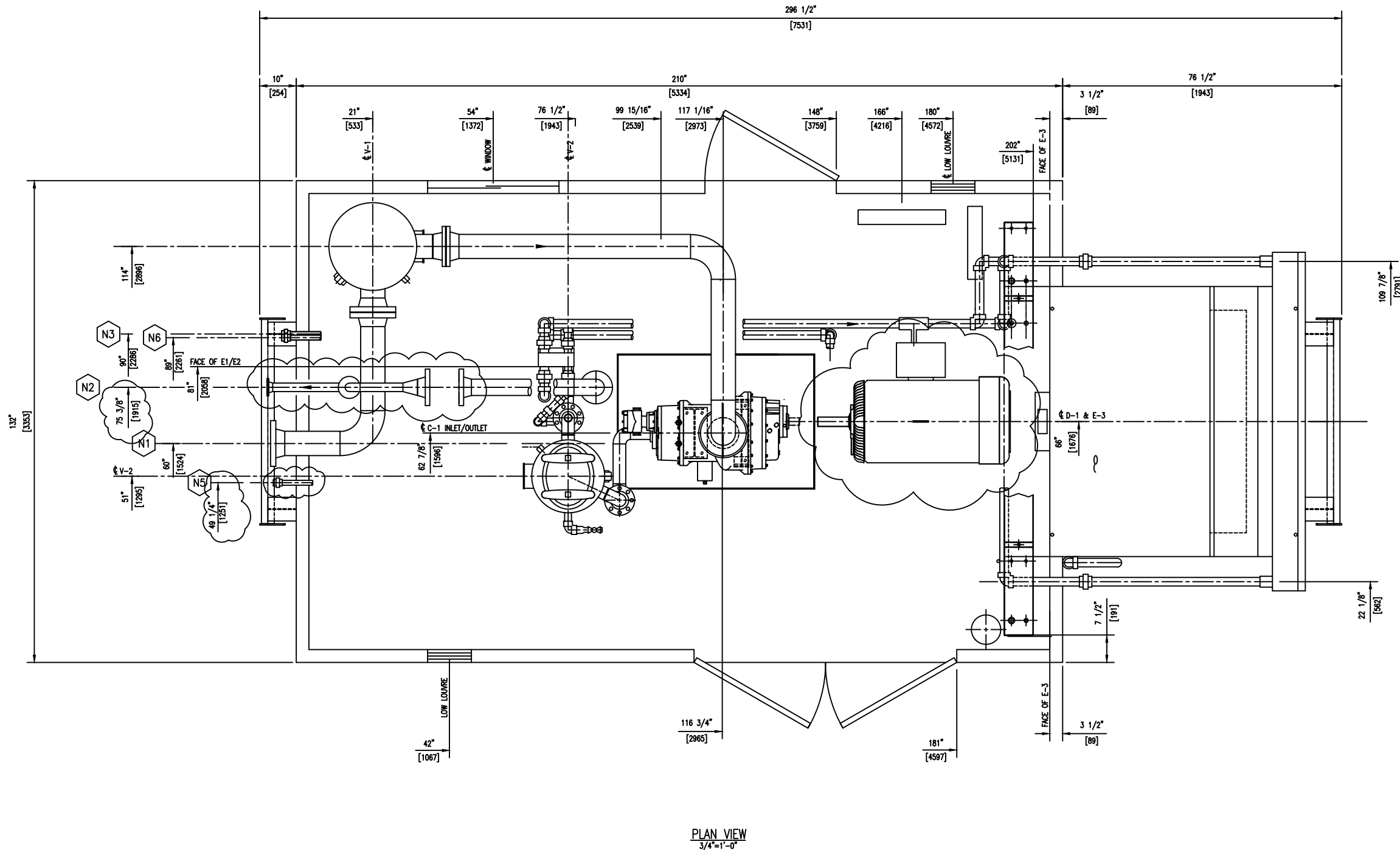
201812 NDP173M



5. Drawings

THIS DRAWING IS THE EXCLUSIVE PROPERTY OF CONCEPT COMPRESSION CORP. AND CANNOT BE REPRODUCED WITHOUT THE PERMISSION OF CONCEPT COMPRESSION CORP.

SKID EDGE CONNECTIONS				
MARK	SERVICE	SIZE	RATING	TYPE
N1	GAS INLET	6"	150#	RFWN
N2	GAS OUTLET	4"	300#	RFWN
N3	DRAIN	1"	3000#	NPT UNION
N5	INSTRUMENT AIR SUPPLY	1"	3000#	NPT UNION
N6	PURGE & FUEL GAS SUPPLY	1"	3000#	NPT UNION



PLAN VIEW
3/4"=1'-0"

- GENERAL NOTES**
- ALL DIMENSIONS OUTSIDE OF BRACKETS ARE IN INCHES. ALL DIMENSIONS WITHIN [] ARE IN MM.
 - ALL TAIL DIMENSIONS ARE FROM DATUM.
 - ALL WELDED PIPING TO BE HYDROTESTED TO B31.3
 - ALL PROCESS PIPING TO BE LEAK TESTED TO B31.3
 - ALL PIPING TO BE SUBJECT TO 10% RADIOGRAPHY.
 - WELDING PROCEDURES TO BE PERFORMED TO MEET A 22 HRC HARDNESS TEST.
 - SEE CHART FOR PIPING/FITTING FOR MATERIAL/RATING REQ.
 - TUBING TO BE SS. FITTINGS TO BE CADMIUM PLATED w/ SS PRIMARY FERRULE & CS SECONDARY FERRULE.
 - ALL PIPING & TUBING TO BE SUPPORTED AS REQ'D.
 - ALL PIPING TO COMPLY WITH ANSI B31.3 & THE SPECS PER C.C.C.
 - NG-NON CODE
 - AA-150 CLASS SWEET
 - BA-300 CLASS SWEET
 - AS-150 CLASS SOUR
 - BS-300 CLASS SOUR

- NOTES**
- SURFACE PREP: -
PRIMER: SELF PRIMING PAINT, SEE BELOW
PAINT: 1 s/c GENERAL PAINT 16010, SELF PRIMING PAINT, GLOSS URETHANE ENAMEL, CONCEPT TAN
 - SHIPPING WEIGHT IS APPROX.
 - ROOF VENTS REMOVED FOR SHIPPING

REV.	DESCRIPTION	DATE	BY	APPR.
4	SOLD AS-BUILT	JUL 06/21	R.R.	
3	AS-BUILT	SEP 21/05	T.K.	
2	ADD PURGE SYSTEM	SEP 06/05	J.H.	
1	LONGER SKID	MAY 9/05	E.P.	
0	ISSUED FOR CONSTRUCTION	-	E.P.	

STAMPS

DESIGNED BY	E. PETERS	DATE	
CHECKED BY		DATE	
APPROVED BY		DATE	
SCALE	100421	P.A. NO.	

GENERAL ARRANGEMENT
PLAN VIEW
CC180 PDR UNIT
E&D JOB# 15630

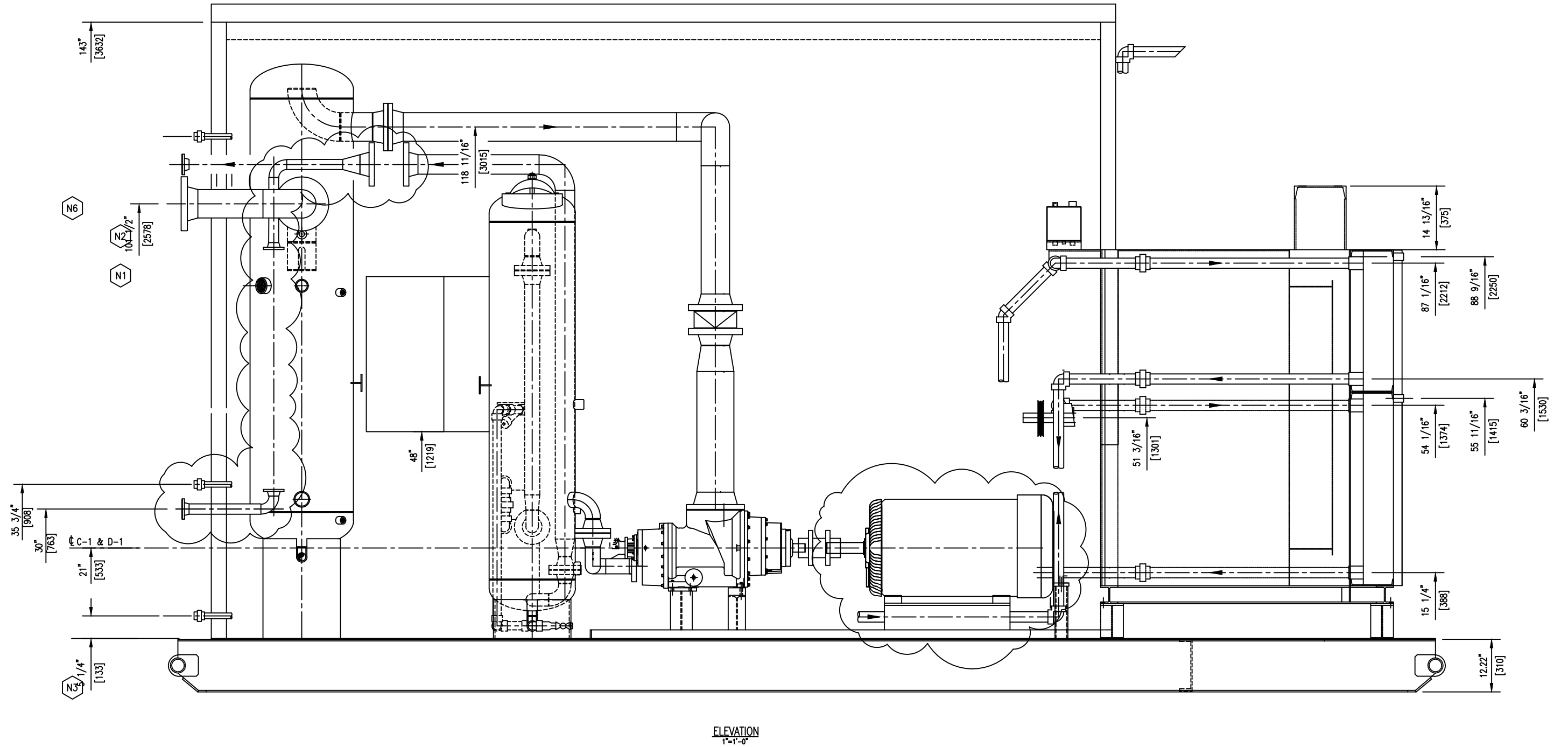
CONCEPT COMPRESSION CORP.

FOR
KELT EXPLORATION
FUELLED INC
STOCK RETROFIT

100421-201

REV. 4

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GENERAL NOTES

1. ALL DIMENSIONS OUTSIDE OF BRACKETS ARE IN INCHES. ALL DIMENSIONS WITHIN [] ARE IN mm.
2. ALL TAIL DIMENSIONS ARE FROM DATUM.
3. ALL WELDED PIPING TO BE HYDROTESTED TO B31.3
4. ALL PROCESS PIPING TO BE LEAK TESTED TO B31.3
5. ALL PIPING TO BE SUBJECT TO 10% RADIOGRAPHY.
6. WELDING PROCEDURES TO BE PERFORMED TO MEET A 22 HRC HARDNESS TEST.
7. SEE CHART FOR PIPING/FITTING FOR MATERIAL/RATING REQ.
8. TUBING TO BE SS. FITTINGS TO BE CADMIUM PLATED w/ SS PRIMARY FERRULE & CS SECONDARY FERRULE.
9. ALL PIPING & TUBING TO BE SUPPORTED AS REQ'D.
10. ALL PIPING TO COMPLY WITH ANSI B31.3 & THE SPECS PER C.C.C.
 - NG-NON CODE
 - AA-150 CLASS SWEET
 - BA-300 CLASS SWEET
 - AS-150 CLASS SOUR
 - BS-300 CLASS SOUR

NOTES

11. SURFACE PREP: -
PRIMER: SELF PRIMING PAINT, SEE BELOW
PAINT: 1 s/c GENERAL PAINT 16010, SELF PRIMING PAINT, GLOSS URETHANE ENAMEL, CONCEPT TAN
12. SHIPPING WEIGHT IS APPROX.
13. ROOF VENTS REMOVED FOR SHIPPING

REV.	DESCRIPTION	DATE	BY	APPR.
3	SOLD AS-BUILT	JUL 08/21	R.R.	
2	AS-BUILT	SEP 21/05	T.K.	
1	ADD PURGE SYSTEM	SEP 06/05	J.H.	
0	ISSUED FOR CONSTRUCTION	-	E.P.	

STAMPS

DESIGNED BY	E. PETERS	DATE	
CHECKED BY		DATE	
APPROVED BY		DATE	
SCALE	100421	P.D.	

GENERAL ARRANGEMENT
ELEVATION
CC180 PDR UNIT
E&D JOB# 15630

CONCEPT
COMPRESSION CORP.

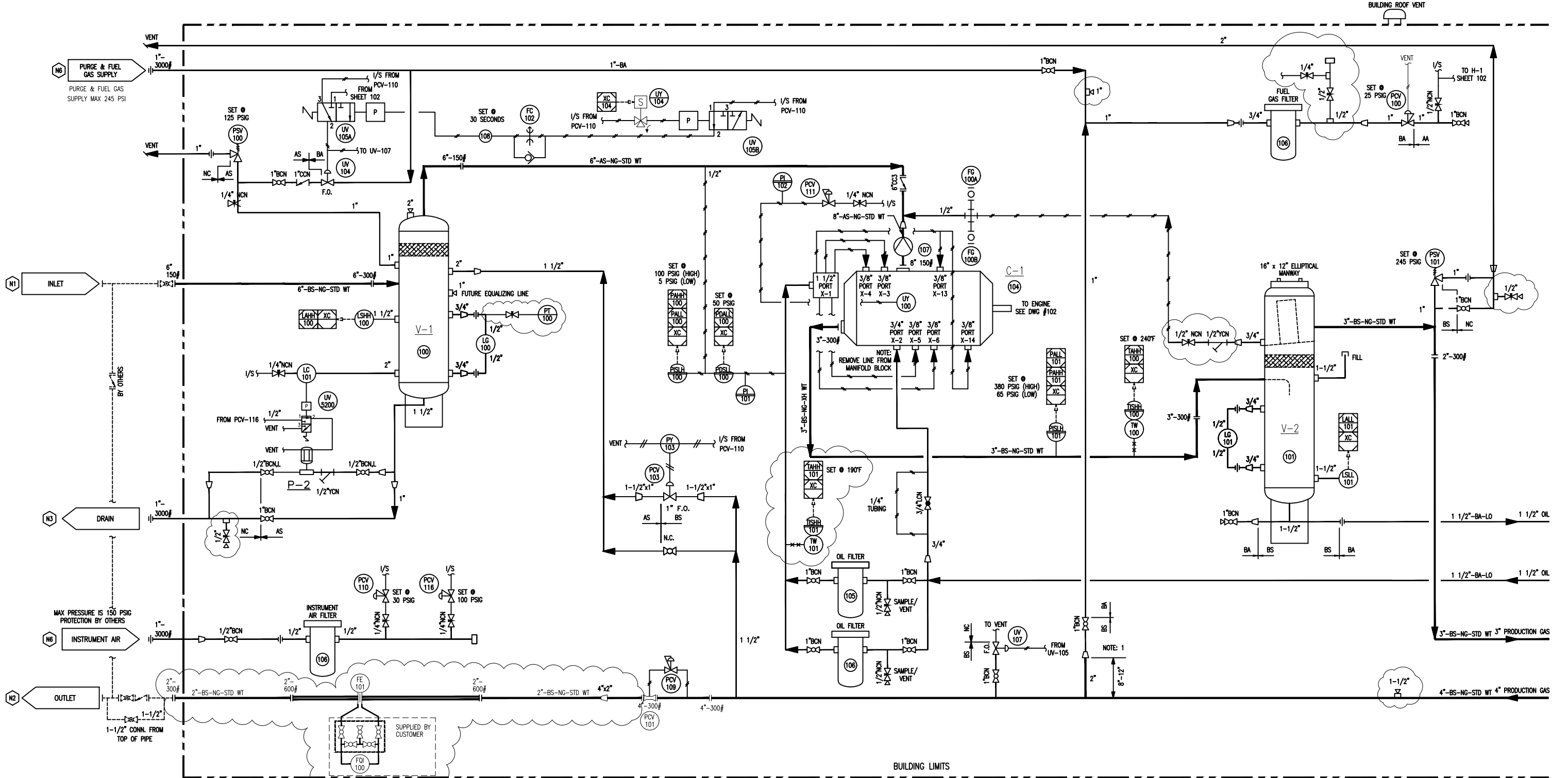
FOR
KELT EXPLORATION
FUELLED INC
STOCK RETROFIT

100421-202

V-1
INLET SEPARATOR
 SIZE: 24"O.D. x 96" S/S
 M.A.W.P.: 245 PSIG @ 250°F
 M.D.M.T.: -20/250°F
 C.A.: 0.125"
 WEIGHT: 1340 LBS

C-1
GAS COMPRESSOR
 MANUFACTURER: SULLAIR
 MODEL: PDR20
 INPUT SPEED: 1800 RPM
 MAX. PS: SEE CURVES
 MAX. PD: 175 PSIG
 WEIGHT: 1250 LBS

V-2
OIL SEPARATOR
 SIZE: 20"O.D. x 83" S/S
 M.A.W.P.: 450 PSI @ 250°F
 M.D.M.T.: -20/250°F
 C.A.: 0.125"
 WEIGHT: 1200 LBS



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NPT/SW PIPE WT CHART		PIPE SPECIFICATION						
SIZE		NC	AA	BA	CA	AS	BS	CS
1/2"	80	AA	BA	CA	XXH	XXH	XXH	
3/4"	80	AA	BA	CA	XXH	XXH	XXH	
1"	80	AA	BA	CA	XXH	XXH	XXH	
1 1/4"	80	AA	BA	CA	XXH	XXH	XXH	
1 1/2"	80	AA	BA	CA	XXH	XXH	XXH	
2"	80/STD	80/STD	80/STD	160/80	160/XXH	160/XXH	160/XXH	160/XXH

GENERAL NOTES

- ELECTRICAL CLASSIFICATION: CLASS 1, DIV. 2, GROUP D
- COMPRESSOR OIL TYPE: CCGN1
- ENGINE OIL TYPE: ESSO GMA-40 OR EQUAL
- COOLANT TYPE: 50/50 EG
- LUBE OIL CAPACITIES: ENGINE: 7.5 GALLONS; COMPRESSOR: 22 GALLONS
- COOLANT CAPACITY: SYSTEM TOTAL: 45 US GALLONS
- TUBING TO BE SS. FITTINGS TO BE CADMIUM PLATED w/ SS
- PRIMARY FERRULE & CS SECONDARY FERRULE.
- INTRINSICALLY SAFE WIRING TO BE TWO CONDUCTOR, 18 AWG, PVC COVERING AND PVC SHEATH, TINNED COPPER WITH STAINLESS STEEL BRAID.
- ALL PROCESS PIPING TO COMPLY WITH ANSI B31.3

NOTES

1. TAKE FROM TOP OF PIPE

REV.	DESCRIPTION	DATE	BY	APPR.
5	AS-BUILT	JUL 08/21	R.R.	H.S.
4	CHANGE ORDER 1.1.	JUN 21/21	R.R.	J.H.
3	RETROFIT SCOPE ADDED	JUN 08/21	R.R.	J.H.
2	AS-BUILT	SEP 21/05	T.K.	
1	ADD BYPASS, CHANGE TO SOUR	SEP 02/05	J.H.	
0	ISSUED FOR CONSTRUCTION	APR 06/05	J.S.	

P&ID NEXT S200E NGC JOB# 15630		DATE SEP 02/05		FOR	
DESIGNED BY J.SILVER	DATE	REVISED BY	DATE	PROJECT NO. 100421	
				KELT EXPLORATION BOOSTER LSD: TBA	
SCALE	100421	REV. NO.	100421-101	REL. NO.	5

H-1A/B
BUILDING HEATER
 CATALYTIC ROOM HEATER
 MODEL: WK24-24-000-1 12VDC
 RATED INPUT: 16000 BTU/HR
 MAKE: CIS-CAN
 WEIGHT: 38 LBS

E-1
OIL COOLER
 MODEL: FP 10x20x36
 M.A.W.P.: 450 PSIG
 SURFACE AREA: 44.6 SQ FT
 WEIGHT: 50 LBS (DRY)

E-2
GAS COOLER
 MODEL: FPA 10x20L-60
 M.A.W.P.: 450 PSIG
 SURFACE AREA: 76.1SQ FT
 WEIGHT: 84.6 LBS (DRY)

CP-1
MURPHYMATIC CONTROL PANEL
 MODEL: TTD-IGN-T
 SELECTRONIC TATTLETALE
 WEIGHT: 30 LBS

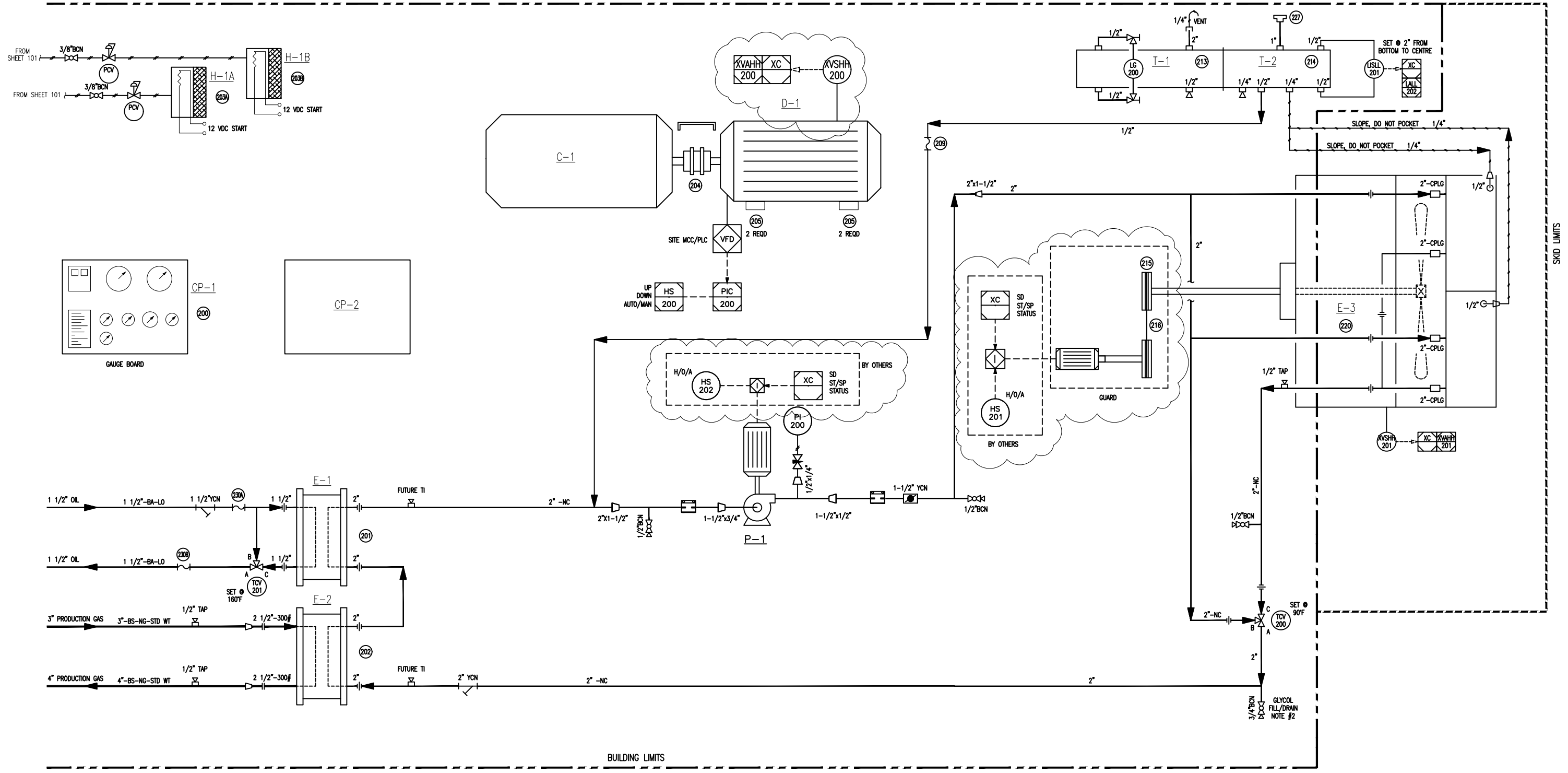
CP-2
ALLEN BRADLEY CONTROL PANEL
 MODEL: MICRO 820

D-1
DRIVER
 MAKE: TECO WESTINGHOUSE
 FRAME SIZE: 44T
 POWER: 200 BHP @ 1800 RPM
 460/3/60
 WEIGHT: 2004 LBS

T-1
DAY TANK
 SERVICE: ENGINE OIL
 VOLUME: 18 GALLONS
 8"x8"x6"
 WEIGHT: 125 LBS

T-2
SURGE TANK
 SERVICE: GLYCOL
 VOLUME: 6.7 GALLONS
 8"x8"x24"

E-3
AIR COOLER
 MAKE: AIR-X-HEMPHILL
 MODEL: 60 VI
 SERVICE: E-GLYCOL
 FAN: MOORE 27-ED/VT
 FAN SPEED: 600 RPM
 FAN POWER: 7.2
 WEIGHT: 3900 LBS (DRY)



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NPT/SW PIPE WT CHART		PIPE SPECIFICATION						
SIZE		NC	AA	BA	CA	AS	BS	CS
1/2"	80	80	80	160	XXH	XXH	XXH	
3/4"	80	80	80	160	160	160	XXH	
1"	80	80	80	160	160	160	XXH	
1 1/4"	80	80	80	160	160	160	XXH	
1 1/2"	80	80	80	160	160	160	XXH	
2"	80/STD	80/STD	80/STD	160/80	160/80	160/80	XXH/160	

GENERAL NOTES

- SLOPE, DO NOT TRAP. MAX. PRESSURE OF CRANKCASE +/- 0.5" W.C.
- LOWEST POINT ON SYSTEM
- RAIN CAP SUPPLIED WITH ENGINE
- MOUNT AS CLOSE TO CARBURATOR AS OPERATIONALLY POSSIBLE

8. TAKE OFF FOR STARTER TO BE AS CLOSE TO STARTER AS POSSIBLE

NOTES

- SLOPE, DO NOT TRAP. MAX. PRESSURE OF CRANKCASE +/- 0.5" W.C.
- LOWEST POINT ON SYSTEM
- RAIN CAP SUPPLIED WITH ENGINE
- MOUNT AS CLOSE TO CARBURATOR AS OPERATIONALLY POSSIBLE

8. TAKE OFF FOR STARTER TO BE AS CLOSE TO STARTER AS POSSIBLE

REV.	DESCRIPTION	DATE	BY	APPR.
5	AS-BUILT	JUN 08/21	R.R.	H.S.
4	CHANGE ORDER 1.1.	JUN 21/21	R.R.	J.H.
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2	AS-BUILT	SEP 21/05	T.K.	
1	ADD BYPASS, CHANGE TO SOUR	SEP 02/05	J.H.	
0	ISSUED FOR CONSTRUCTION	APRIL 06/05	J.S.	

P&ID NEXT S200E NGC JOB# 15630		STAMPS	
DRN. BY J. SILVER	DATE SEP 02/05	FOR	KELT EXPLORATION BOOSTER LSD: TBA
CHK. BY	DATE		
APP. BY	DATE		
DWG. NO. 100421	P.D. NO.	DWG. NO. 100421-102	REV. NO. 5



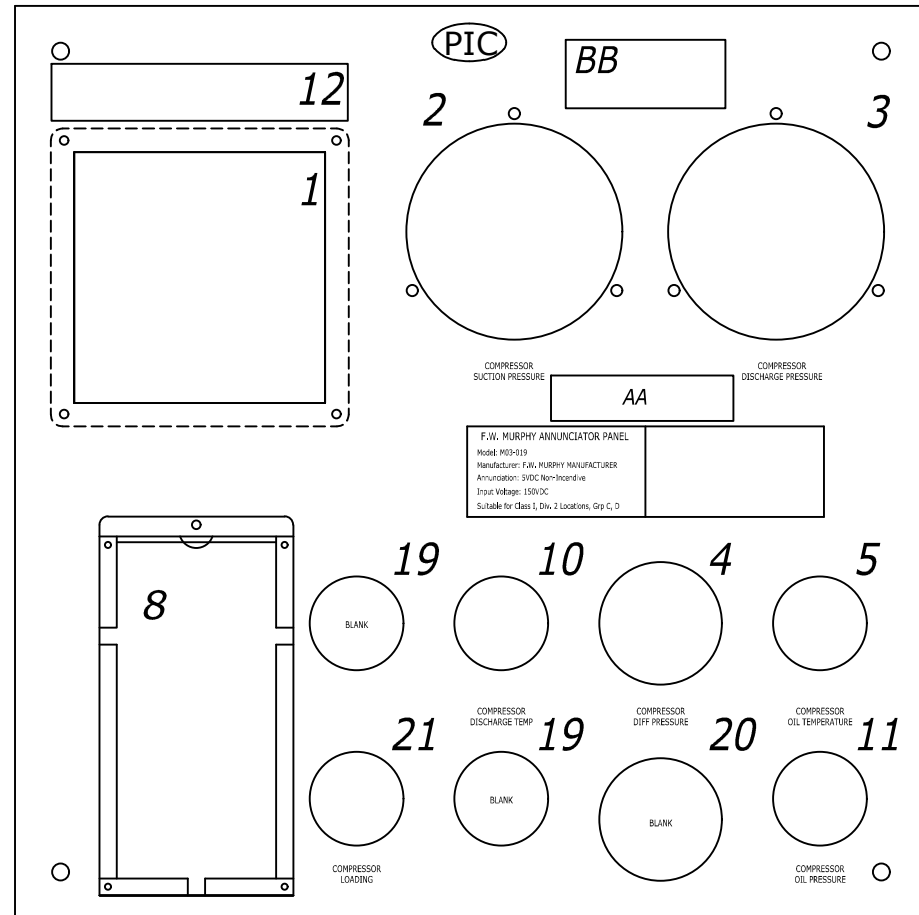
20" X 20" GAUGE BOARD

9

TAG BB - (TAPED)

PANEL NOT SUITABLE
FOR USE IN H₂S
(SOUR) ENVIRONMENTS

(LAMACOID SIZE: 1.5x3.5, COLOR: YELLOW)



LAMACOID TAG 'AA'
(LAMACOID SIZE: 1x4, COLOR: BLACK)

SERIAL # M02-152-040

EQUIPMENT RECORD # 10933927

July 08 2021 3:53PM

PERMIT / ENG. SEAL

REV.	DESCRIPTION	DATE	DRAWN	CHK	DESIGN	APP
0	FIELD AS BUILT (CHANGE FROM ENGINE TO MOTOR)	30 JUN 2021	RDW	MLA	MLA	MLA

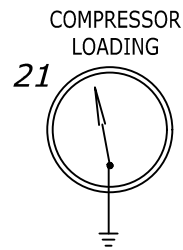
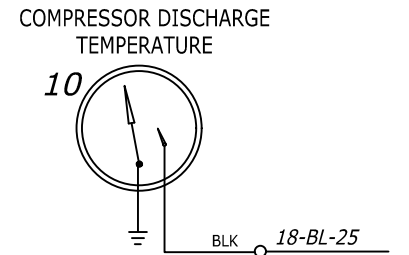
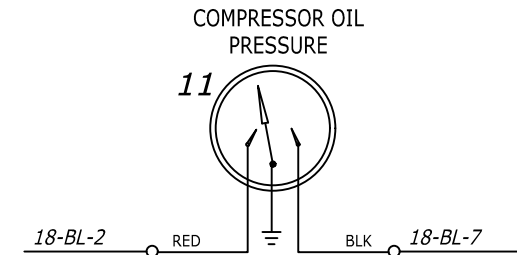
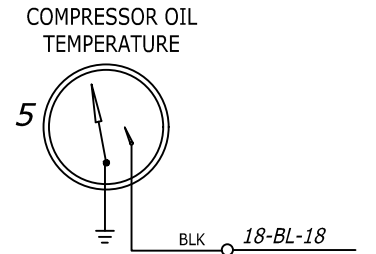
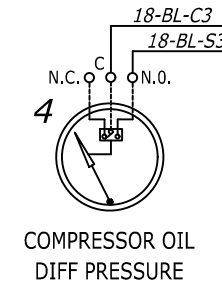
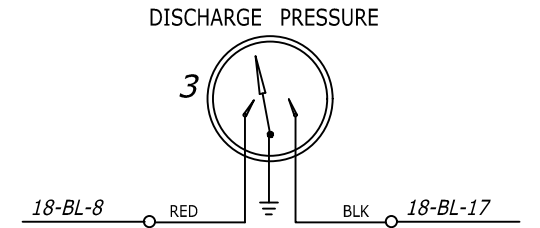
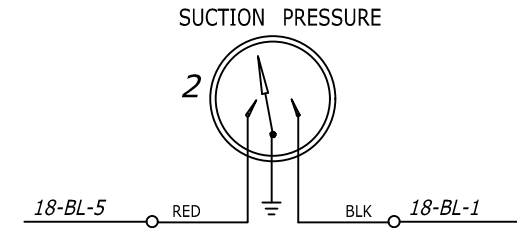


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PROJECT No. CAD1049		SCALE: NTS	DRAWING No. CAD-1420-AA-100-00	P.O.#
LSD:		NEXT COMPRESSION - - COMPRESSOR CONTROL SYSTEM CABINET LAYOUT REF. #		REV. 0

PANEL LEGEND

ITEM	QTY.	MFR.	MODEL No.	DESCRIPTION
1.	1	MURPHY	TTD-H	DIGITAL FAULT ANNUNCIATOR HEAD
2.	1	MURPHY	OPLFC-S-200	SUCTION PRESSURE "SWICHGAGE" - FIELD ADJUSTABLE
3.	1	MURPHY	OPLFC-S-300	DISCHARGE PRESSURE "SWICHGAGE" - FIELD ADJUSTABLE
4.	1	MURPHY	25CDPEF-100	COMPRESSOR OIL DIFFERENTIAL PRESSURE "SWICHGAGE" - SET FALLING 50PSID
5.	1	MURPHY	20T-250-16-1/2	COMPRESSOR OIL TEMPERATURE "SWICHGAGE" - FIELD ADJUSTABLE
6.	-	-	-	-
7.	-	-	-	-
8.	1	MURPHY	50225495	VERTICAL LEGEND c/w 50225541
9.	1	PIC	M03-019 BOARD	20"x20" ALUMINUM GAUGEBOARD
10.	1	MURPHY	20T-250-16-1/2	COMPRESSOR DISCHARGE TEMPERATURE "SWICHGAGE" - FIELD ADJUSTABLE
11.	1	MURPHY	20P-HL-150	HI/LO COMPRESSOR OIL PRESSURE "SWICHGAGE" - FIELD ADJUSTABLE
12.	1	PIC	60PANEL TAG	"SOLD & SERVICED" TAG
13.	1	HOFFMAN	ASE886	8"x8"x6" ENCLOSURE TO COVER TTD
14.	1	-	2535	ELECTRICAL FITTING 3/4"
15.	1	-	CI-1706	3/4" LOCK NUT
16.	-	-	-	-
17.	-	-	-	-
18.	1	MURPHY	PSU-2-T	DIV 2 POWER SUPPLY/C/W TACH TTD G-LEAD CHOKE (FERRITE ASSMBLY)
19.	1	MURPHY	05706163	2" HOLE COVER
20.	1	MURPHY	05706178	2.5" HOLE COVER
21.	1	MURPHY	208PG-50	COMPRESSOR LOADING GAUGE



NOTES:

- FACTORY WIRING: _____
CUSTOMER WIRING: _____
END USER WIRING: _____
TUBING: _____
- TUBING: N/A
FITTINGS: N/A
- "18-BL-25" REPRESENTS "AWG-WIRE COLOR-WIRE NUMBER"
- ROUTE SENSOR LEADS SEPARATE FROM ALL OTHER WIRING.
- MAXIMUM LENGTH OF SENSOR LEADS IS 200 FEET.
- CAUTION: DISCONNECT ALL SENSOR LEADS BEFORE WELDING.
- THIS PANEL IS SUITABLE FOR USE IN CLASS I, DIV. 2, GROUP C&D HAZARDOUS LOCATIONS.
- GROUND SYMBOLS WILL BE SHOWN PER THE FOLLOWING:
EARTH/NON-INCENDIVE CHASSIS/NON-INCENDIVE DC COM/CLOSE LOOP
- UNLESS OTHERWISE NOTED ALL DEVICES ARE SHOWN IN THE SHELF POSITION.
- ALL WIRING TO BE 18 GA. UNLESS OTHERWISE NOTED.
- EACH OF THE FIRST 16 INPUTS CAN BE CONFIGURED FOR CLASS A, B1, B2, OR C AND FOR SHUTDOWN OR ALARM. SPARE SHUTDOWNS WILL BE DEFAULTED TO CLASS "A".
- INPUT #29 IS SELECTABLE CLASS "A" OR FOR EMERGENCY STOP (OVERRIDES TEST TIMER)
INPUT #30 IS SELECTABLE REMOTE RESET OR CLASS "A"
INPUT #31 IS REMOTE LOCKOUT OR CLASS "A"
(INHIBITS CLASS "B1" & "B2" LOCKOUT TIMERS)
INPUT #32 TYPICALLY USED FOR EMERGENCY STOP (OVERRIDES TEST TIMER)
DISPLAY #50 IS OVERSPEED (INTERNAL, ON "T" MODEL ONLY)
DISPLAY #51 IS UNDERSPEED/LOSS OF IGNITION (ON "T" MODEL ONLY)
DISPLAY #52 IS MANUAL STOP (INTERNAL)
- SENSOR INPUTS ARE PASSIVE SWITCHES. REMOVE FACTORY INSTALLED JUMPER FOR NORMALLY CLOSED SWITCHES.
- NORMALLY OPEN SENSORS ARE RETURNED TO GROUND TO ACTIVATE ANNUNCIATOR.
- FOR ADDITIONAL INFORMATION REFER TO INSTALLATION BULLETIN.

June 30 2021 6:38PM
PERMIT / ENG. SEAL

REV.	DESCRIPTION	DATE	DRAWN	CHK	DESIGN	APP
0	FIELD AS BUILT (CHANGE FROM ENGINE TO MOTOR)	30 JUN 2021	RDW	MLA	MLA	MLA



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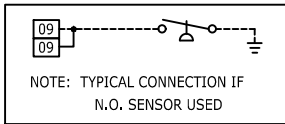
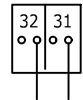
PROJECT No. CAD1049		SCALE: NTS	DRAWING No. CAD-1420-AA-200-00		P.O.# 0
LSD:		NEXT COMPRESSION		COMPRESSION CONTROL SYSTEM	
		REF. #		BILL OF MATERIALS	

INDICATOR READOUTS

CLASS	DISPLAY	DESCRIPTION	TERMINAL	WIRING
B1	01	HIGH SUCTION PRESSURE	01	18-BL-1
B1	02	LOW COMPRESSOR OIL PRESSURE	02	18-BL-6
B1	03	LOW COMPRESSOR DIFFERENTIAL PRESSURE	03	18-BL-C2, 18-BL-S2
.	04	.	04	
B1	05	LOW SUCTION PRESSURE	05	18-BL-5
.	06	.	06	
B1	07	HIGH COMPRESSOR OIL PRESSURE	07	18-BL-7
B1	08	LOW DISCHARGE PRESSURE	08	18-BL-8
.	09	.	09	
.	10	.	10	
.	11	.	11	
.	12	.	12	
.	13	.	13	
.	14	.	14	
.	15	.	15	
.	16	.	16	
A	17	HIGH DISCHARGE PRESSURE	17	18-BL-17
A	18	HIGH COMPRESSOR OIL TEMPERATURE	18	18-BL-18
A	19	HIGH SUCTION SCRUBBER LEVEL	19	
A	20	LOW OIL SEPARATOR LEVEL	20	
.	21	.	21	
.	22	.	22	
A	23	HIGH COMPRESSOR VIBRATION	23	
.	24	.	24	
A	25	HIGH COMPRESSOR DISCHARGE TEMPERATURE	25	18-BL-25
.	26	LOW AUXILIARY COOLANT LEVEL	26	
.	27	HIGH COOLER VIBRATION	27	
.	28	.	28	
.	29	.	29	
.	30	.	30	
.	31	.	31	
.	32	.	32	
.	33	.	33	
.	34	.	34	
.	35	.	35	
.	36	.	36	
.	37	.	37	
.	38	.	38	
.	39	.	39	
.	40	.	40	
.	41	.	41	
.	42	.	42	
.	43	.	43	
.	44	.	44	
.	45	.	45	
ESD	46	REMOTE SHUTDOWN (OPTIONAL)	46	
ESD	47	EMERGENCY STOP (OPTIOANL)	47	
.	48	.	48	
B	49	LOSS OF IGNITION (LESS THAN 90 VDC)		
A	50	OVERSPEED		
B	51	UNDERSPEED		
A	52	MANUAL STOP		
A	60	WATCHDOG TIMER		
A	61	LOSS OF SP1 LINK		
B	62	LOW DC VOLTAGE (ALARM)		

1 TB1
TERMINAL BLOCK LOCATED ON BACK OF TTD

TTD(J) SENSOR INPUT IS PHYSICALLY ON THE LEFT



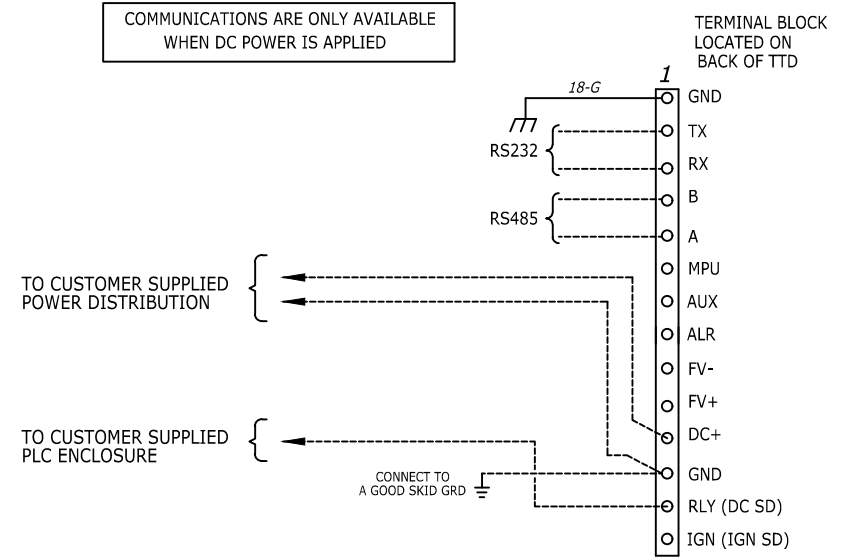
NOTE: TYPICAL CONNECTION IF N.O. SENSOR USED

ESD IS DESIGNED FOR ANNUNCIATION OF SHUTDOWN ONLY. ACTUAL SHUTDOWN SHOULD BE ACCOMPLISHED BY CUSTOMER'S SHUTDOWN DEVICE MOUNTED LOCALLY.

NON-INCENDIVE WIRING

INCENDIVE WIRING

COMMUNICATIONS ARE ONLY AVAILABLE WHEN DC POWER IS APPLIED



SETUP A = 1

July 08 2021 3:22PM

PERMIT / ENG. SEAL

REV.	DESCRIPTION	DATE	DRAWN	CHK	DESIGN	APP
0	FIELD AS BUILT (CHANGE FROM ENGINE TO MOTOR)	30 JUN 2021	RDW	MLA	MLA	MLA



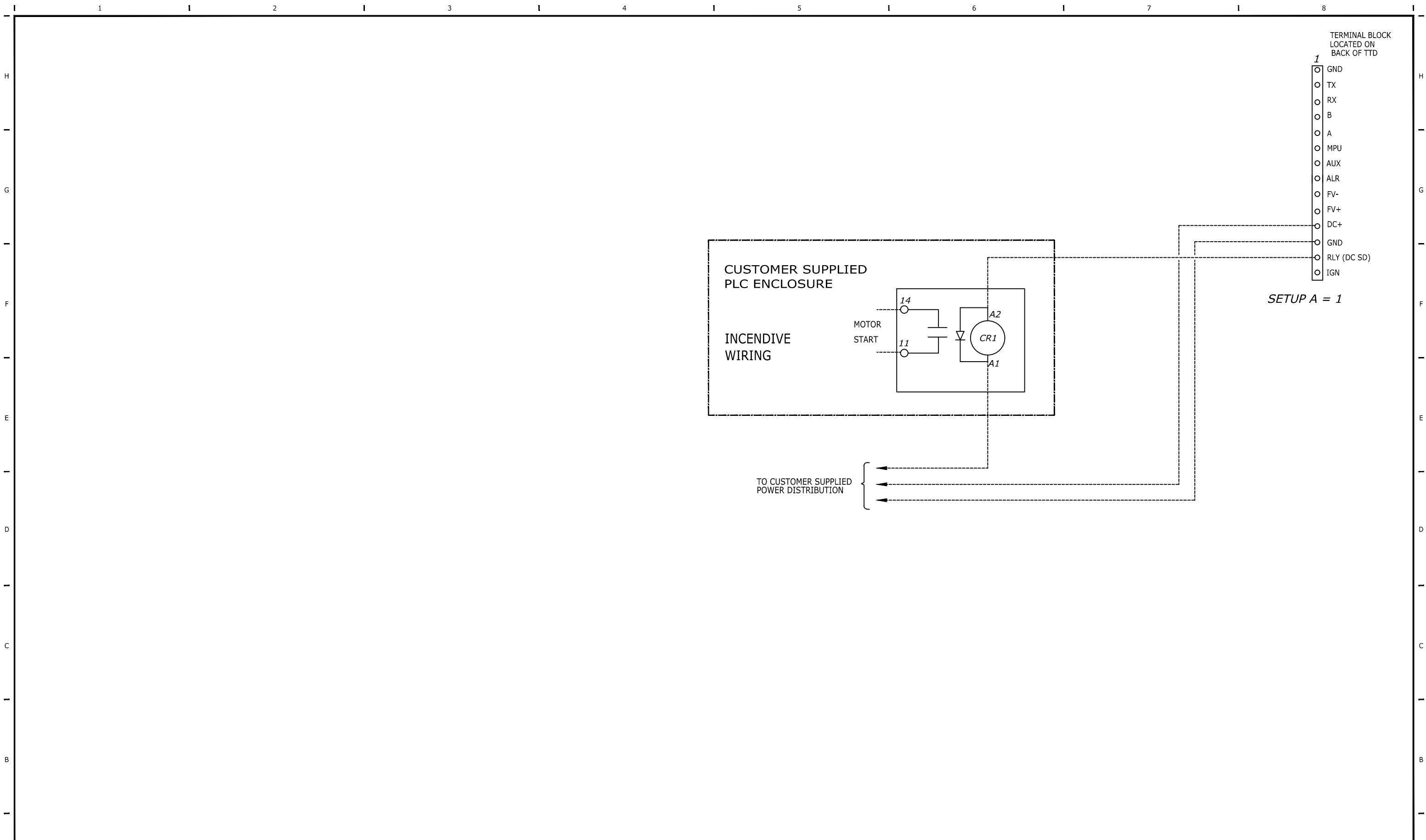
PROJECT: CAD1049
SCALE: NTS
DRAWING No.: CAD-1420-AA-600-00

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REF. #
NEXT COMPRESSION
COMPRESSOR CONTROL SYSTEM
MURPHY ANNUNCIATOR WIRING DIAGRAM

P.O.#
REV. 0



- TERMINAL BLOCK
LOCATED ON
BACK OF TTD
- 1
 - GND
 - TX
 - RX
 - B
 - A
 - MPU
 - AUX
 - ALR
 - FV-
 - FV+
 - DC+
 - GND
 - RLY (DC SD)
 - IGN

SETUP A = 1

TO CUSTOMER SUPPLIED
POWER DISTRIBUTION

JULY 08 2021 3:22PM
PERMIT / ENG. SEAL

REV.	DESCRIPTION	DATE	DRAWN	CHK	DESIGN	APP
0	FIELD AS BUILT (CHANGE FROM ENGINE TO MOTOR)	30 JUN 2021	RDW	MLA	MLA	MLA



PROJECT No. CAD1049 SCALE: NTS DRAWING No. CAD-1420-AA-700-00 P.O.# 0

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REV. 0

NEXT COMPRESSION
-
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COMPRESSOR CONTROL SYSTEM
RELAY BOX WIRING
REF. #

TTDJ Series Fully-Configurable Fault Annunciator Installation and Operations Manual

TTDJ-99062N
Revised 01-02
Section 50
(00-02-0412)



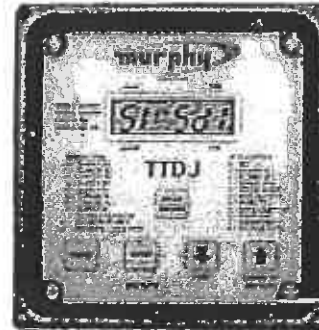
Please read the following information before installing. This installation information is intended for all TTDJ Series models. A visual inspection of this product before installation for any damage during shipping is recommended.

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.



US Patent 6,144,116
(model TTDJ-IGN-T only)

CSA Certified for Use in Class I, Div. 2,
Groups C and D Hazardous Areas.

Description

The TTDJ is a solid-state fault annunciator and shutdown control system, with hour meter, designed to protect engines, compressors and their associated equipment. Four TTDJ modules are available:

TTDJ-DC : Powered by 12 or 24 VDC systems without tachometer and overspeed sensing. Includes RS485 serial port.

TTDJ-DC-T : Powered by 12 or 24 VDC systems with internal tachometer and overspeed sensing. Includes RS485 serial port.

TTDJ-IGN : Powered by negative ground CD ignition systems without tachometer and overspeed sensing. Without RS485 port.

TTDJ-IGN-T : Powered by negative ground CD ignition systems with internal tachometer/overspeed sensing. Without RS485 port.

All TTDJ models will accept 32 sensor inputs from normally open and/or normally closed sensors. Each of the first 16 inputs can be configured for Shutdown or Alarm Before Shutdown*, and can be locked out by one of the Two Start-Run timers (B1:0-5 min.; B2:0-9:59 min.), or configured as Class C. The annunciator provides for both closing of a fuel valve, and grounding of an ignition after a time delay. The TTDJ has built-in Elapsed Time Meter. Run Hours and Tachometer Settings are stored in non-volatile memory, as well as the last 4 shutdowns and one alarm (alarm only stored if active at the time of shutdown). The TTDJ liquid crystal display annunciates any fault from the sensor inputs, displays engine speed and elapsed time.

Other features for all TTDJ models are: built-in Test Mode to test the sensor circuits without shutting down, on-board backup battery to retain the fault display after shutdown (IGN models only), and a history of the last 4 shutdowns with their associated Run Hours, also stored in non-volatile memory.

TTDJ-DC and TTDJ-DC-T models feature an RS485 serial communications port (MODBUS RTU slave) to interface with micro-controllers, PC'S, PLC's and controllers.

Module/ Head

The module is the brain of the control system. It contains the microcomputer, the Liquid Crystal Display (LCD), the membrane keys for configuring the sensors inputs, the Sensor Inputs Terminal Blocks and the Power Inputs and Control Output Terminal Block. The TTDJ-DC module also includes an RS485 serial communications port (MODBUS RTU slave).

*Alarm Before Shutdown is a function that causes annunciation and the alarm output, but will not cause a shutdown.

Liquid Crystal Display

The Liquid Crystal Display sequentially provides shutdown/alarm condition, run hours, rpm, and timer information. A shutdown or alarm condition is indicated by the appropriate sensor number in the first two leftmost digits. Hours display uses all the digits. RPM display is shown in the rightmost digits with a Run Indicator in the first digit. The Timer display shows the timer number in the first digit and the time in the last three digits.

Timers

Active Timers are indicated by the timer number in the first digit of the display, and the remaining time in the last three digits. Timer 1= Class "B1", Timer 2= Class "B2", Timer 3= Test, Timer 4= Ignition Ground Delay.

Power and Control Inputs/Outputs

The TTDJ power and control inputs and outputs are connected to the Power Inputs terminal block on the back of the TTDJ.

In the TTDJ-IGN and TTDJ-IGN-T the FV+ output is a non-switched output that supplies stored energy from an internal capacitor. -FV and ALARM outputs are non reversible switched outputs (switched OFF for normal operation, switched ON for alarm and shutdown). When a shutdown fault is detected, the -FV and ALARM turn ON and after a time delay, the IGN input switches to ground.

On the TTDJ-DC and TTDJ-DC-T the IGN, FV, and ALARM outputs are programmed to switch ON for normal operation.

Sensor Inputs and Terminals

Up to 32 dry contact sensor inputs or Murphy device transistor outputs can be connected to the back of the TTDJ via a terminal block (32 pair, screw type, each with a jumper). Sensor inputs 1 to 16 are configurable as Class "A", Class "B1", Class "B2" or Class "C" functions, Shutdown or Alarm Before Shutdown*. The Class "B" timers allow sensor inputs to be locked out at start-up. Sensor inputs configured for Alarm Only will cause the Alarm Output to turn on when tripped, and the sensor number will be annunciated while the unit continues to run. TTDJ sensor inputs 17-28 are dedicated as Class "A" Shutdown only. Sensor input 29 can be configured as a Class "A", or Class "ESD" input. Sensor input 32 is dedicated as Class "ESD". Sensor inputs 30 & 31 can have special functions or be Class "A". Any tripped sensor is detected within 1 second after faulted.

Emergency Shutdown

Sensor input number 32 is dedicated to Emergency Shutdown. The Emergency Shutdown sensor input overrides the Test timer. Additionally, sensor input 29 can be configured as a Class "A" or Class "ESD" input.

Remote Reset (optional, Setup 5 = 1 or 3)

When the Remote Reset feature is selected, point 30 with a closed contact resets the TTDJ in the same manner as when using the Reset key. The closed contacts to operate the Remote Reset feature should be kept closed only momentarily for approximately 1 second to cause a remote reset.

Remote Lockout (optional, Setup 5 = 2 or 3)

The Remote Lockout inhibits the Class B1 and Class B2 Lockout timers. These Lockouts are ignored when a closed switch is seen at Input 31. An open switch at Input 31 allows the Lockouts to function normally. When the Remote Lockout is active it resets Class "C", "B1" and "B2" Lockout timers. This is intended to be used with automatic starting systems. With a contact closure on terminals 31 with the unit not running, the display will alternate between either RPM (-T models) and the Class "B1" timer, or the display will flash (non-T models). The TTDJ should be put into remote lockout immediately before stopping the engine. The contact closure should be opened once the engine is running. At that time the "B1" and "B2" timers will be allowed to count down.

Reset Key

The Reset key resets All faults and initiates the Class "B" timers.

Overspeed (-T models only)

These models feature an internal tachometer with Overspeed Shutdown (50). This shutdown bypasses the Ignition Ground Delay. It is not locked out by the Test Timer.

Underspeed Annunciation (-T models only)

TTDJ-IGN-T models display (51) when an underspeed condition occurs. It is not locked out by the Test Timer.

Loss of Ignition Annunciation (non-T models)

The TTDJ-IGN models will display (51) when ignition input is lost. It is not locked out by the Test Timer.

Run/Stop Key (Manual Stop)

The Manual Run/Stop key is used for system shutdown from the panel. When pressed, the unit will shutdown the system without turning on the Alarm Output (on -DC models the Alarm Output is turned off on Manual Stop). Manual Stop (Shutdown 52) is not locked out by the Test Timer.

Low Backup Battery Voltage (-IGN models)

The TTDJ-IGN models have an internal backup battery. When the "Lowbatt" display appears (this message will alternate with other displays) the battery needs to be replaced, see page 3 for details.

Timer "O" Key

This key zeros the current displayed timer: Class "B1", "B2", Ignition Ground Timer, or Test Timer. If the TTDJ is in the Test mode, it exits Test.

Test Key

Initiates the Test Timer with 5 minutes. Test mode is indicated by the "3" in the first digit of the display. Faulted inputs are displayed as in normal operation, but the system is not shutdown and the Alarm Output is not turned on. Press "Reset" to reset the fault and press the Timer "O" to exit. The following shutdowns override Test: Emergency Shutdown (32), Overspeed (50), Manual Stop (52), Underspeed (51), and Loss of Ignition (51). If Class "C" functions are used, they will need to be bypassed to test other sensors. When exiting "Test" with Class "C" functions, press "Reset" and "Timer O" simultaneously.

Shutdown History

The TTDJ models store the last 4 shutdown codes and any alarm present

at shutdown, as well as the elapsed time reading at which they occurred. For instance, if the unit is shutdown from sensor input 1, the display will show "01 SD1" to indicate the last shutdown. Shutdown #1 was sensor input #1. Press the "Up" key for "Shutdown 2"; "3"; "4"; and for any present "Alarm". To view the elapsed time reading at which any of the shutdowns occurred, press "Push To Read Hours" key while viewing that shutdown.

Class "B" Lockout Timer

Allows the system to become fully operational without shutting down by start-up related conditions. Class "B1" and Class "B2" Sensor inputs are locked out until their corresponding timer expires. Class "B1" Timer is selectable from 0:00-5:00 minutes, and Class "B2" Timer from 0:00-9:59 minutes.

Class "C" Functions

There is a practical limit of sensor inputs defined as Class "C" Shutdown and/or Class "C" alarm of 8 points. The Class "C" function operation is that the sensor will be initially faulted on Start-up. If the sensor never clears there will not be any annunciation and alarm or shutdown. If the sensor clears for a full 2 seconds, then it is armed to alarm or shutdown. Pressing the Reset key will allow a Class "C" alarm function to go back to the Start-up state where it can remain faulted without annunciation and alarm. An example of a Class "C" function is Low Discharge pressure.

Ignition Ground Delay

This delay is selectable from 0-20 seconds. To select the delay use SETUP.A, see User Set Up Menus and To Enter User Set Up on page 5.

Hourmeter

The TTDJ internal hourmeter keeps track of Run Hours. To display Run Hours for 5 seconds, press the Push to Read key. Run Hours are stored in non-volatile memory, maintaining hours in the absence of power.

RS485 Serial Port (TTDJ-DC / TTDJ-DC-T)

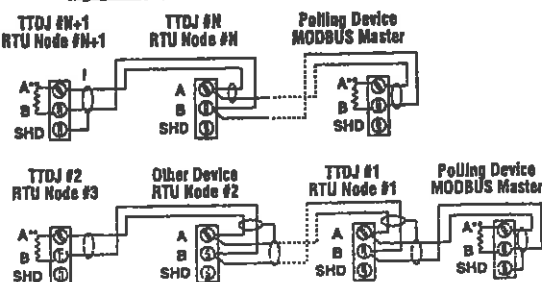
The RS485 serial port (MODBUS RTU slave) on the back of the module is provided for communicating with micro-controllers, PC's, PLC's and SCADA systems (see RS485 Typical Connections, below). It is recommended that a termination resistor** (customer supplied) be used on the first and last device connected in a daisy-chain configuration.

The communication parameters are 9600 baud, no parity, 8 bits with 1 stop bit (9600,N,8,1), half-duplex. The shield terminal on the TTDJ terminal block should only be used if the drain wire on the shielded cable is not connected to ground anywhere else. Each device must have a unique RTU node number. A retry delay of 0.3 second may be helpful (set up for 3 retries).

Modbus Integer Holding Registers

- 40001= RPM
 - 40002= ETM (elapsed Time Meter 0-65535 Hrs.)
 - 40003= Class B1 (in seconds)
 - 40004= Shutdown Numbers (0=OK) (1-32, 50-52 =SD shutdown)
 - 40005= Output Status (Bit 0= IGN, Bit 1= FV, Bit 2= ALR)
 - 40006= Inputs 1-16 (Bit 0 = TB1..., Bit 15= TB16) (True 1= Inactive)
 - 40007= Inputs 17-32 (Bit 0= TB17..., Bit 15= TB32) (True 1= Inactive)
- If 40006 and 40007 both contain "FF" there are no active shutdowns.*

RS485 typical connections



**Terminating resistor is 120 ohms. Install Terminating resistor at the master and the last slave. Use only Belden 9841 or 3105A cable or cabling with a characteristic impedance of 120 ohms.

SPECIFICATIONS

Power Input (Operating Voltages):

TTDJ-DC; TTDJ-DC-T Models: 10-32VDC, 500 mW max.

TTDJ-IGN; TTDJ-IGN-T Models: 90-350 VDC negative ground
CD ignition; approx. 650µA @ 100VDC.

Sensor Inputs: 32 N.O. or N.C. passive switches.

Inputs 1-16: Configurable as Class "A"; "B1"; "B2"; or "C" Shutdown or Alarm Before Shutdown*.

Inputs 17-28: Dedicated Class "A" shutdowns.

Inputs 29: Configurable as Class "A" or Class "ESD".

Input 30: Selectable Remote Reset or Class "A".

Input 31: Remote Lockout or Class "A"; inhibits the Class "B1 & B2" Lockout Timers.

Input 32: Class "ESD" Overrides Test Timer, typically used for emergency shutdown.

Outputs: 0.5 A @ 350 VDC.

Outputs Selection: Ground ignition immediately or trip fuel valve and ground ignition after time delay.

Communications: RS485 Serial Port, Modbus RTU slave (TTDJ-DC models).

Operating Temperature: -40 to 185°F (-40 to 85°C).

Storage Temperature: -40 to 185°F (-40 to 85°C).

Sensor Scan Rate: Within 1 second.

B1 Start/Run Timer: Adjustable, 0 - 5 minutes.

B2 Start/Run Timer: Adjustable, 0 - 9:59 minutes.

Pulses per Revolution Range for Tach. Calibration:

32-360 (TTDJ-DC-T); 1 - 16 (TTDJ-IGN-T).

Overspeed Set point: 0 - 9999 rpm.

Underspeed Set point: 0 - 5000 rpm.

Magnetic Pickup: 5 - 120 Vrms, 0-10 kHz.

On-Board Backup Power 00005125 (-IGN Versions only):

6 VDC, 1300 mAh, Duracell® DL223A or Sanyo® CR-P2 Lithium battery.

Tachometer Accuracy: ±0.5% of the display reading or ±1 RPM whichever is greater.

Hourmeter Range: 0 to 65535 hrs.

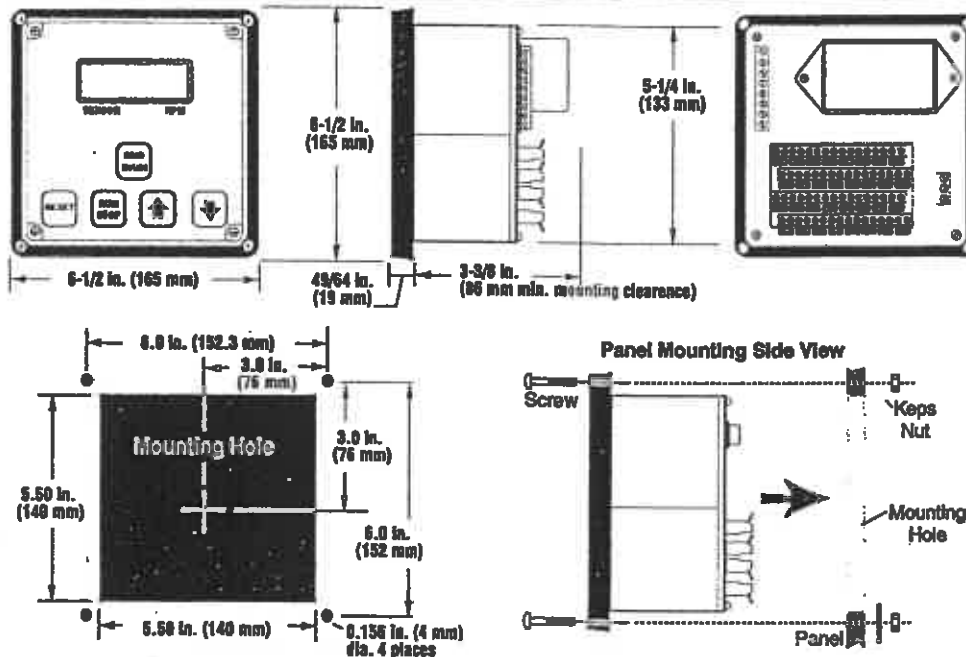
Hourmeter Accuracy: ±15 minutes per year.

*Alarm Before Shutdown is a function that causes announcement and the alarm output, but will not cause a shutdown.

TTDJ MOUNTING DIMENSIONS (All Models)



WARNING: PERFORM THE MOUNTING OPERATION WITH POWER SOURCE OFF. THE TTDJ SERIES MODULE WAS DESIGNED TO BE MOUNTED WITHIN A WEATHERPROOF ENCLOSURE. IT IS INTENDED FOR MOUNTING IN A FLAT PANEL. A SQUARE MOUNTING HOLE OF 5-1/2 IN. (140 MM) AND FOUR MOUNTING SCREW HOLES ARE NEEDED. INSERT THE MODULE FROM THE FRONT SIDE OF THE PANEL AND SECURE THE FOUR MOUNTING SCREWS AND NUTS THROUGH THE BEZEL.



REPLACING THE BATTERY (-IGN Models only)



WARNING: THE BACKUP POWER BATTERY IS LOCATED WITHIN THE TTDJ MODULE. THEREFORE, EXTREME CAUTION MUST BE EXERCISED WHEN REPLACING IT. FOR CLASS I, DIVISION 2, HAZARDOUS AREAS INSTALLATIONS, FIRST, SHUTDOWN THE SYSTEM AND MAKE SURE THAT THE HAZARDOUS AREA IS KNOWN TO BE NON-HAZARDOUS BEFORE OPENING THE POWER SUPPLY COVER.

The TTDJ-IGN models include a Backup Power Battery located within the TTDJ module. To gain access to and to replace the battery do the following:

1. Make sure the area is made Non-Hazardous and shut down the System (remove power).
2. Using extreme caution remove the Power Supply Cover Screws (located on the back of the TTDJ module).
3. Gently pull the Power Supply Cover away from the back of the TTDJ to

have access to the old Backup Battery.

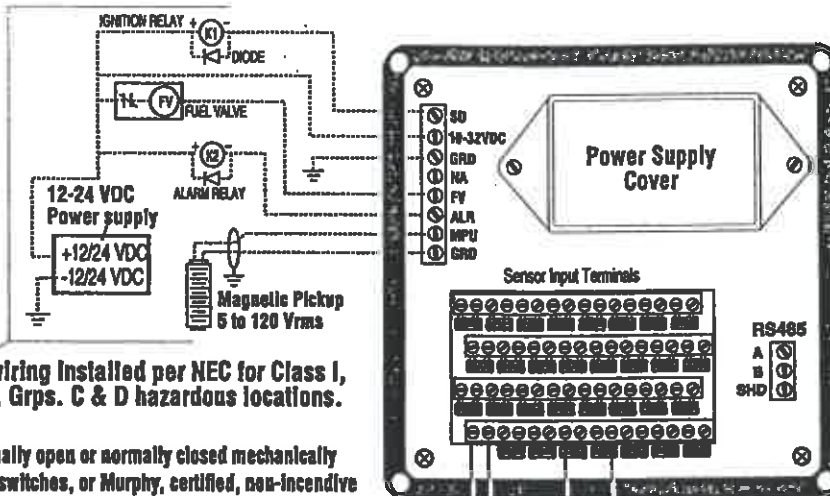
4. Locate the old Backup Battery.
5. Using extreme caution, not to damage any component, replace the battery with a 6 VDC, 1300 mAh, Duracell® DL223A or Sanyo® CR-P2 Lithium battery, available from Murphy (p/n 00005125).
6. Carefully proceed to replace the Power Supply Cover.
7. You are now ready to power up your system and resume operations.

TYPICAL WIRING DIAGRAMS (All Models)



WARNING: FOR HAZARDOUS APPLICATION REQUIREMENTS, THE TTDJ COMPLETE SYSTEM MUST BE INSTALLED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (NEC) CLASS I, DIVISION 2, GROUPS C & D (ARTICLE 504) SPECIFICATIONS AND PER MURPHY DRAWING 50-08-0039. SENSOR INPUT WIRES MUST BE SEPARATED A MINIMUM OF 2 IN. (51 MM) FROM OTHER WIRES.

TTDJ-DC AND TTDJ-DC-T TYPICAL WIRING

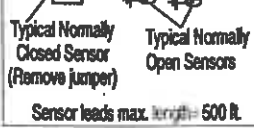


User wiring installed per NEC for Class I, Div. 2, Grps. C & D hazardous locations.

NOTES:

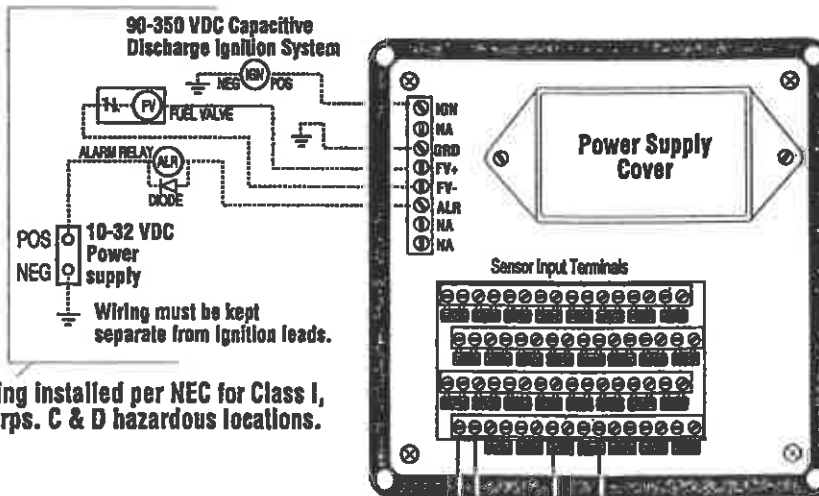
1. Sensors are normally open or normally closed mechanically actuated passive switches, or Murphy, certified, non-incendive or intrinsically safe products.
2. Non-Incendive field circuits—VOC= 10.5 VDC, ISC= 1.2 mA., CA= 21 uf, LA= 1000 mH.
3. SD, FV and Alarm outputs are rated 0.5 A continuous 350 VDC.
4. Power supply, power input 10-32 VDC, 16 W max.
6. K1 and K2 must be hermetically sealed relays, CSA or UL approved for use in Class I, Div. 2, Grps C & D hazardous locations.
7. Fuel Valve in this diagram could be another relay like K1 and K2.

– WARNING –
Explosion hazard.
DO NOT Connect or disconnect RS485 leads unless the area is known to be non hazardous.



Non-Incendive field wiring connections to passive switches. Route leads separate from other wiring, refer to Notes 1 and 2.

TTDJ-IGN AND TTDJ-IGN-T TYPICAL WIRING

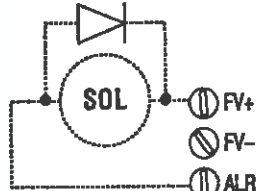


User wiring installed per NEC for Class I, Div. 2, Grps. C & D hazardous locations.

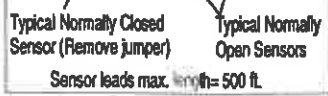
NOTES:

1. Sensors are normally open or normally closed mechanically actuated passive switches or Murphy certified, non-incendive or intrinsically safe products.
2. Non-Incendive field circuits—VOC= 10.5 VDC, ISC= 1.2 mA., CA= 21 uf, LA= 1000 mH.
3. IGN, FV and Alarm outputs are rated 0.5 A continuous 350 VDC.
4. Power input 90-350 VDC, CD Ignition.
5. ALR relay must be hermetically sealed relay, CSA or UL approved for use in Class I, Div. 2, Grps C & D hazardous locations.

Alternate hook-up for using latching 48 VDC coil solenoid for alarm at horn.



NOTE: FV- terminal cannot be used with this hook-up for a CO fuel valve.



Non-Incendive field wiring connections to passive switches. Route leads separate from other wiring. Refer to Notes (1,2).

TTDJ SENSOR SETUP MAP

TYPE SETUP

TYPE SETUP

3 00

3 01

01 00

01 01

01 02

01 03

01 04

01 05

01 06

01 07

01 08

01 09

01 10

01 11

01 12

01 13

01 14

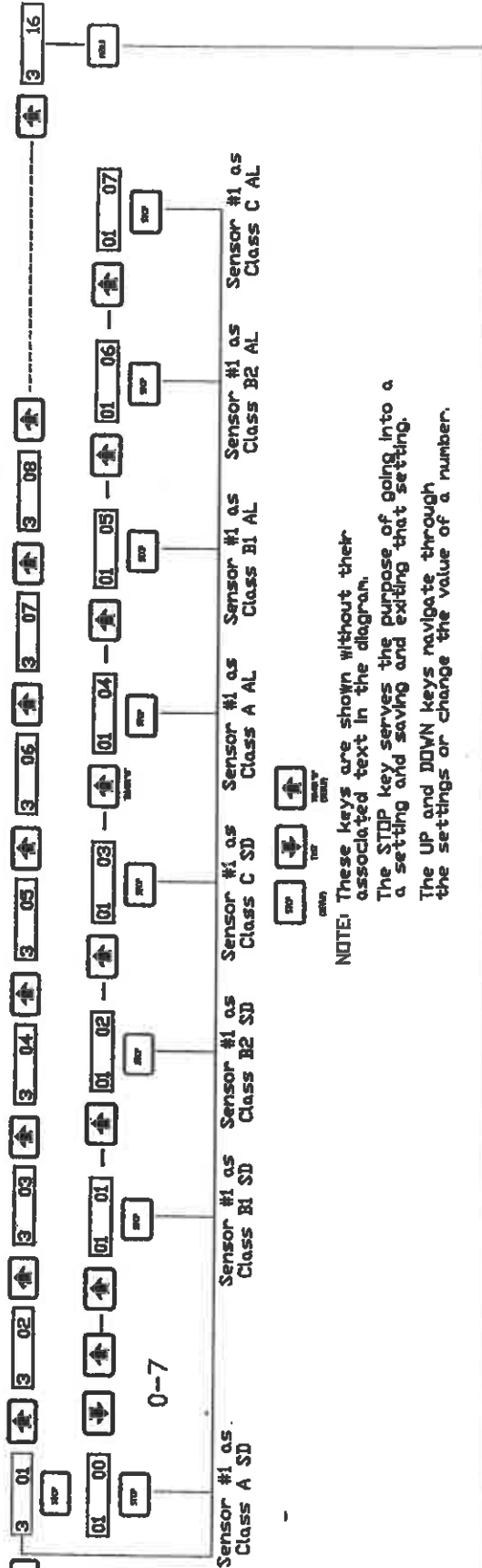
01 15

01 16

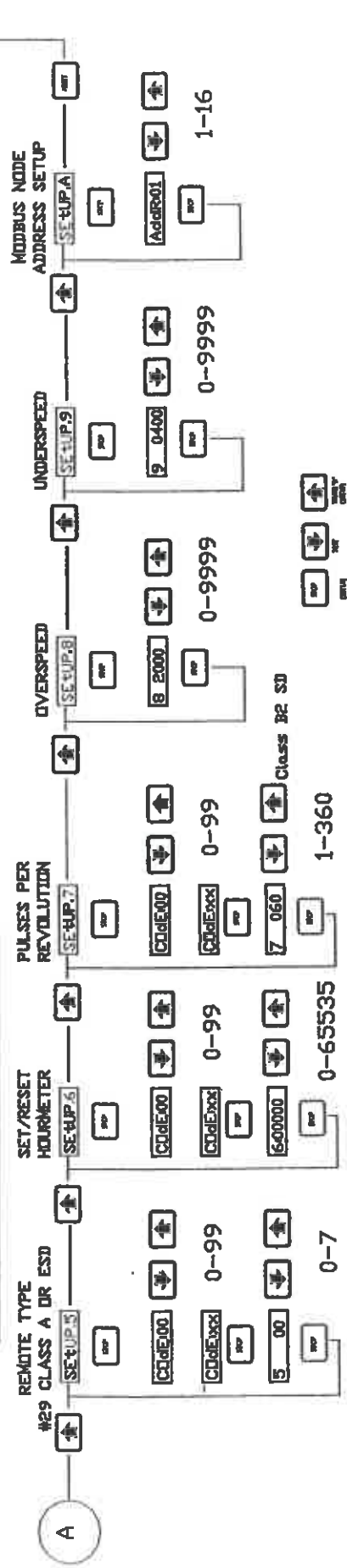
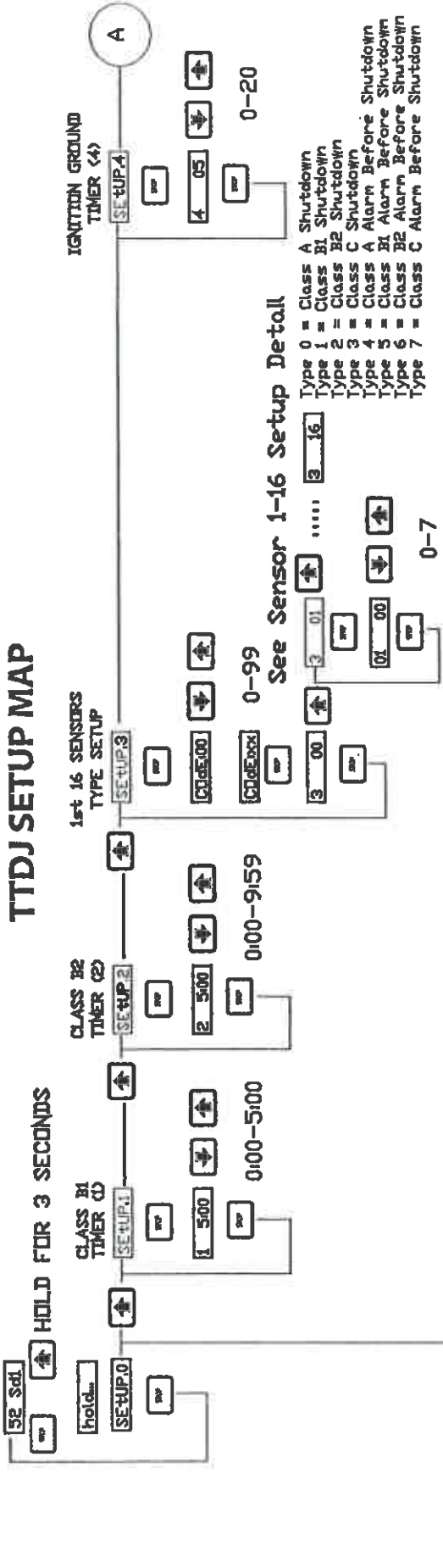
- Type 0 = Class A Shutdown
- Type 1 = Class B1 Shutdown
- Type 2 = Class B2 Shutdown
- Type 3 = Class C Shutdown
- Type 4 = Class A Alarm Before Shutdown
- Type 5 = Class B1 Alarm Before Shutdown
- Type 6 = Class B2 Alarm Before Shutdown
- Type 7 = Class C Alarm Before Shutdown

0-99

Sensor 1-16 Setup Detail



TTDJ SETUP MAP



NOTE: These keys are shown without their associated text in the diagram. The STOP key serves the purpose of going into a setting and saving and exiting that setting. The UP and DOWN keys navigate through the settings or change the value of a number.

0 = No Remote Lockout or Reset, #29 Is Class A
 1 = Remote Reset, No Remote Lockout, #29 Is Class A
 2 = Remote Lockout, No Remote Reset, #29 Is Class A
 3 = Remote Reset and Lockout, #29 Is Class A
 4 = No Remote Reset or Lockout, #29 Is Class ESD
 5 = Remote Reset, No Remote Lockout, #29 Is Class ESD
 6 = Remote Lockout, No Remote Reset, #29 Is Class ESD
 7 = Remote Reset and Lockout, #29 Is Class ESD

TTDJ USER CONFIGURATION AND SETUP

User Set Up Menus

The following are the User Setup Menus for All TTDJ models:

- SETUP.1 **SETUP.1** = Class B1 Timer (0 - 5:00)
- SETUP.2 **SETUP.2** = Class B2 Timer (0 - 9:59)
- *SETUP.3 **SETUP.3** = Sensor 1-16 Type Setup
- SETUP.4 **SETUP.4** = Ignition Ground Delay (0 - 20 sec.)
- *SETUP.5 **SETUP.5** = Remote Setup
 - 0= No Remote Lockout or Reset, #29 is Class "A"
 - 1= Remote Reset, No Remote Lockout, #29 is Class "A"
 - 2= Remote Lockout, No Remote Reset #29 is Class "A"
 - 3= Remote Reset, and Lockout, #29 is Class "A"
 - 4= No Remote Reset or Lockout, #29 is Class "ESD"
 - 5= Remote Reset, No Remote Lockout, #29 is Class "ESD"
 - 6= Remote Lockout, No Remote Reset #29 is Class "ESD"
 - 7= Remote Reset and Lockout, #29 is Class "ESD"

- *SETUP.6 **SETUP.6** = Hours Setup

The User Setup Menus shown below are also available for -T models:

- *SETUP.7 **SETUP.7** = Pulses per revolution
- SETUP.8 **SETUP.8** = Overspeed
- SETUP.9 **SETUP.9** = Underspeed

The User Setup Menu shown below is for ALL -DC models:

- SETUP.A **SETUP.A** = Modbus RTU node number 1-16 (-DC models)

*These Set Up Menus are code protected (for all models).

To Enter User Set Up Menus

(Must be in Manual Stop #52)

To enter the User Setup Menus the TTDJ unit Must be in the Manual Stop (#52) condition. If a shutdown is present other than Manual Stop, press the "Reset" key, then immediately Press and Hold Both the Run/Stop and Up (Timer 0) keys. Now follow these steps:

1. Press and hold both the Run/Stop and Up (Timer 0) keys until the LCD reads **hold...** (HOLD).
 2. Continue to hold both keys for 3 more seconds approximately. The display reads **SETUP.0** (SETUP.0), you are now in the User Setup Menu.
 3. Use the Up key (Timer 0) and Down (Test) keys to select the desired Setup Menu.
 4. Press the Run/Stop key to enter the desired Setup Menu.
- NOTE: Some settings are password protected.*
5. Use the Up and Down keys to preset the desired parameter. Press Reset to zero the value.
 6. When the desired value is entered, press Run/Stop.
 7. Repeat Steps 3-6 until all parameters are preset.
 8. To exit User Setup, select SETUP.0 and press Run/Stop.

Code Protection

For Setup Menus that are code protected, the LCD will read "CODE.00" prompting the user to enter a code before allowing setup. Use the Up and Down keys to enter the code. If the code is entered incorrectly, the LCD will read "Error". After 3 incorrect entries, the Code Setup is exited. Once the correct Code is entered, the Setup Menu is accessed.

To Calibrate the Tachometer (TTDJ-DC-T and TTDJ-IGN-T models)

The TTDJ measures RPM based on the number of pulses per engine revolution. To calibrate the tachometer first enter the User Set Up Menus, see steps 1-3 from "To Enter User Set Up Menus" above.

Select SETUP.7. Enter the code, then enter your number of pulses per engine revolution (refer to Pulses/Revolution, above right).

Pulses/Revolution

TTDJ-IGN-T (Ignition Model)

For this model the number of pulses per revolution is determined by the number of cylinders and cycles of the engine, according to the following table:

Cylinders	Cycles	Pulses	Cylinders	Cycles	Pulses
1	2	1	6	2	6
2	2	2	6	4	3
2	4	1	8	2	8
3	2	3	8	4	4
4	2	4	10	4	5
4	4	2	12	4	6
5	2	5	16	4	8

NOTE: Divide the number of cylinders by 2 for split capacitor ignitions. Multiply the number of cylinders by 2 for throw away spark ignitions.

TTDJ-DC-T (DC Model)

For TTDJ-DC-T models the pulses per revolution can come from a magnetic pickup. The number of pulses per revolution is simply the number of teeth on the flywheel gear (32 to 360).

Sensor Input Set Up

Sensor inputs 1-16 are configurable. The following types are available:

- Type 0 = Class A, Shutdown
- Type 1 = Class B1, Shutdown
- Type 2 = Class B2, Shutdown
- Type 3 = Class C, Shutdown
- Type 4 = Class A, Alarm Before Shutdown*
- Type 5 = Class B1, Alarm Before Shutdown*
- Type 6 = Class B2, Alarm Before Shutdown*
- Type 7 = Class C, Alarm Before Shutdown*

To configure a Sensor Input:

1. Enter the SETUP.3 menu (enter the code). The Display will read: **3 00** (3 00).
2. Use the Up and Down keys to select the input to be configured. For example if you select Input #1 the display reads: **3 01** (3 01).
3. Press the Run/Stop key. Assuming you selected Input #1, and that input is currently configured as a Class A, Shutdown, the display will read **01 0** (01 0).
4. Use the Up and Down keys to select the desired Sensor Input Type.
5. Press the Run/Stop key, the display reads: **3 01** (3 01).
6. Repeat Steps 2-5 as necessary.
7. To Exit press Reset, the display shows: **3 00** (3 00). Then press the Run/Stop key.

Elapsed Time Set / Reset

Enter the Elapsed Time Set Up, SETUP.6. First make sure the jumper for Input #30 is installed. To Set the time do the following:

1. Enter the SETUP.6 menu (enter the code). The display will read the elapsed time in hours, after the 6 (for example: **6.00001**) (6.00001) if the elapsed time is 1 hour).
2. Set the desired time using the Up/Down keys. Press Reset to zero the time.
3. When the desired time is entered, press the Run/Stop key.
4. To exit User Setup, press Reset, the display will show: **SETUP.0** (SETUP 0) and press the Run/Stop key.

NOTE: Decimal fractional of the elapsed time is lost when the Elapsed Time Setup is entered, and it can only be set to the nearest hours.

*Alarm Before Shutdown is a function that causes announcement and the alarm output, but will not cause a shutdown.

System Start Up

Press the **RESET** key to clear any faulted sensor input and unground/enable ignition for engine operation. Apply starting power to the engine.

Engine Speed (-T models only)

The first thing displayed on versions with Tachometer is the engine speed. While there is time remaining in either of the Class "B" timers, the display will alternate between engine speed and the Class "B" timers (4 seconds each). Once the Class "B1" timer expires, while there is time remaining in the Class "B2" timer, the display will alternate between the engine speed and the Class "B2" timer (4 seconds each). Once both Class "B" timers expire, the engine speed is displayed continuously.

Class "B1" Timer

While there is time remaining in the Class "B1" timer, the display will alternate between engine speed and the Class "B1" time remaining for example: "1 0.30" (4 seconds each). All sensor inputs configured as Class "B1" are locked out at this point. For non -T models the "B1" display will be steady. To zero this timer, press **TIMER "0"**.

Class "B2" Timer

Once the Class "B1" timer expires while there is time remaining in the Class "B2" timer, the display will alternate between engine speed and the Class "B2" time remaining for example: "2 0.30" (4 seconds each). All sensor inputs configured as Class "B2" are locked out at this point. For non -T models the "B2" display will be steady. To zero this timer press the **TIMER "0"** key, after the Class "B2" timer has expired.

Elapsed Time

To display the run hours, press the **"Display Hours"** key. The current Run hours will be displayed for 5 seconds. **NOTE:** On all non tachometer models (non -T) the **RUN HOURS** are displayed after the Class "B" Timers expire, instead of **ENGINE SPEED**. The decimal point flashes to indicate the unit is running.

Alarm Only Condition

If any one of the sensor inputs configured as an **ALARM-ONLY** is faulted, the Alarm Output will turn ON, and the sensor number will be displayed in the first two digits. Press the **RESET** key after the sensor input has cleared, to clear the display and to turn OFF the Alarm output.

Overspeed (-T models only)

If the engine speed exceeds the Overspeed Set point the engine will shutdown, bypassing the Ignition Ground Delay. The TTDJ-T models will display "50". Overspeed overrides the Test mode.

Underspeed (-T models only)

If after the Class "B1" Timer expires the engine speed falls below the Underspeed Setpoint, the engine will shutdown. The TTDJ will annunciate/display "51". Underspeed overrides the Test mode.

Manual Stop

To manually shutdown the engine, press the **STOP/RUN** key. The TTDJ will shutdown the system and the display will indicate "52". Manual Stop overrides the Test mode.

Ignition Ground Delay

Upon reaching a shutdown condition, the unit will trip the fuel valve, and, after the delay expires, ground the ignition. This delay is bypassed on **Overspeed (50)**, **Emergency Shutdown (32)**, and sensor input #29 if configured as Class "ESD".

Loss of Ignition

TTDJ-IGN models annunciate/display "51" when ignition input is lost. The energy stored in the FV+ circuit will trip the fuel valve.

Resetting Shutdown Fault

After the shutdown condition is cleared on the equipment, press **RESET** key.

Test Timer

The Test Timer is used to verify that sensors are wired properly and working correctly. To perform a sensor test while running do the following:

1. Press the **TEST** key and verify that the Test Timer is shown with 5 minutes: (3 5.00).
2. Trip the first sensor to be tested and verify that the sensor number and class type appear on the display (see displays below). The display will alternate between the Sensor Number and the Test timer.
3. Clear the sensor then press the **RESET** key. Verify that the sensor number is cleared from the display.
4. Repeat Steps 2 and 3 for each sensor.
5. To exit, press the **TIMER "0"** key or allow the Test Timer to expire.

NOTE: Any of the following conditions will override the Test Timer: **Emergency Shutdown (32)**, **Overspeed Shutdown (50)**, **Underspeed Shutdown -T models (51)**, **Loss of Ignition (51) non-T models**, **Manual Stop (52)**, and **sensor input #29, if configured as a Class "ESD"**.

Test Mode Display

In Test, when a sensor is tripped, the sensor number and the Class type are displayed, for example if sensor #1 (01) a Class "B1" shutdown is tripped in the Test the LCD reads "01 t1". The following are the Test Mode Displays:

E0	(t0): Class "A" Shutdown
E1	(t1): Class "B1" Shutdown
E2	(t2): Class "B2" Shutdown
E3	(t3): Class "C" Shutdown
E4	(t4): Class "A" Alarm
E5	(t5): Class "B1" Alarm
E6	(t6): Class "B2" Alarm
E7	(t7): Class "C" Alarm

Warranty

A two year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.



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CONFIDENTIAL

SECURITY ACCESS CODE

INFORMATION



MURPHY has made efforts to ensure the reliability of the TTDJ Series Digital Fault Annunciator. Please note that the TTDJ's "User Set Up Menus" are critical operating parameters. These numbers contain information that only qualified personnel should be allowed to access.

Items set improperly within these parameters can cause serious damage to the TTDJ Series Digital Fault Annunciator and to your equipment.

Access to the "User Set Up Menus" is password protected.

Please keep this access code away from unauthorized personnel. The access code is designated as follows:

User Set Up Menu code = 35

Read all TTDJ Series Installation and operation instructions before attempting to edit the User Set Up Menus, and make sure that the device is correctly installed.

Please contact Murphy if you have any questions.

Instructions for Installation and Maintenance For all 2 in. (51 mm) and 2-1/2 in. (64 mm) Dial Temperature MURPHYGAGE® and SWICHGAGE®

T-8446N
Revised 10-00
Section 10
(00-02-0168)



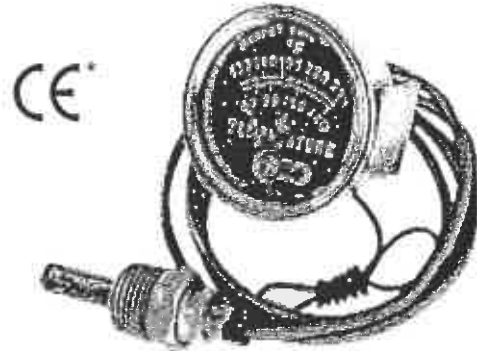
Please read the following information before installing. A visual inspection of this product for damage during shipping is recommended before mounting. General information and these installation instructions are intended for all 20T, 25T, A20T, and A25T series models.

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.



Description

Murphy 2 in. (51 mm) and 2-1/2 in. (64 mm) MURPHYGAGE® and SWICHGAGE® instruments have a remote sensing bulb connected to the gauge head by a sealed capillary system. **DO NOT CUT THIS CAPILLARY OR BEND AT A SHARP ANGLE.** The sensing bulb and capillary are filled with a liquid. When heat is applied to the sensing bulb the liquid turns to vapor which exerts pressure against the diaphragm movement of the gauge. This movement is read on the dial face as temperature.

Models having face adjustable contact(s) are rated for 2 A @ 30 V (pilot duty). If the case is steel (models 20T, 20SD, 25T, etc.), the ground path for the contact circuit is through the case. Therefore, the case must be installed in the ground plane of the electrical power supply.

If the case is polycarbonate (models A20T, A25T), the ground path is isolated and is made through the "C" or "P" terminal on the back of the case.

Models 20TE, A20TE, 25TE and A25TE have a snap-acting switch instead of the face adjusted pointer type contact. Electrical rating is 3 A @ 30 VDC, 4 A @ 125 VAC. Reset differential for the switch is approximately 10% of the scale below the trip point. Trip point is factory set and must be special ordered for field adjustable.

SWICHGAGE® models with Alarm Before Shut-down

The 20TABS, A20TABS, 25TABS and A25TABS feature a front limit contact for high temperature equipment shut-down and an internal SPDT snap switch for Alarm Before Shut-Down (see Wiring Diagram, page 3). When the high side (preset high temperature point) of the snap switch trips, the N.O. terminal completes a circuit to activate an alarm. A continued increase in temperature will complete the shutdown circuit. A decrease in temperature of approximately 10% of scale is necessary before the snap-switch (alarm) will RESET and open the circuit.

NOTE: The front contact shut-down limit setting (adjustable) and snap switch high point are preset at the factory; if settings other than standard are necessary, then specify when ordering.

Typical TATTLETALE® Magnetic Switch

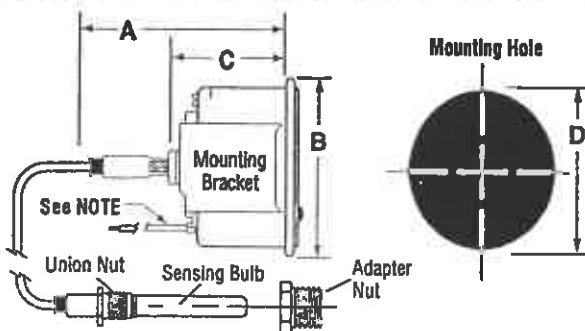
Murphy manufactures several, patented Magnetic Switches for protection of the light duty SWICHGAGE® contacts and to ensure positive shut-down of equipment. There are Magnetic Switches for Capacitor Discharge ignition, Magneto, or Battery systems, and models for electric motor driven equipment. TATTLETALE® annunciators are indicators that show the cause of shut-down. TATTLETALE® annunciators are used in conjunction with several different SWICHGAGE® instruments. The first one to trip will lockout all other TATTLETALE® annunciators. Be sure the type of Magnetic Switch matches the power source used to trip it.

NOTE: At equipment start-up, the Magnetic Switch reset button must be held in until normal operation occurs, or an external time delay may be used. See examples of typical wiring and instructions packed with each Magnetic Switch.

CAUTION: Certain dangers to human safety and to equipment may occur if some equipment is stopped without pre-warning. It is recommended that monitored functions be limited to alarm-only or to alarm before shutdown.

IMPORTANT: SWICHGAGE® instruments, Magnetic Switches and shut-down or alarm devices, properly used, are effective tools in any preventive maintenance program. For optimum performance, check these tools periodically: look for frozen pointers, kinked/worn tubing, broken wiring or loose connections; operate the contacts and watch for expected results. Replace damaged/worn parts; clean/repair as necessary. Check for correct/complete wiring, unbroken insulation and no accidental grounds. **DO NOT** run shut-down wires with ignition wiring. Check all tubing and connections for leaks. Mount Magnetic Switches and valves upright, to prevent moisture collection.

MOUNTING DIMENSIONS



For All 20, 25, A20, and A25 Series Temperature MURPHYGAGE® and SWICHGAGE® Instruments

	20 Series	A20 Series	25 Series	A25 Series
A	2-7/32 (56)	2-9/64 (54)	2-1/8 (54)	1-51/64 (46)
B	2-15/64 (57)	2-1/4 (57)	3-1/8 (79)	2-29/32 (74)
C	1-5/16 (33)	1-27/64 (36)	1-3/8 (35)	1-27/64 (36)
D	2-1/16 (53)	2-1/16 (53)	2-11/16 (68)	2-11/16 (68)

NOTE: The dimensions above are in inches and millimeters.

* Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility, except as noted.

NOTE: 20 and 25 Series have 18 AWG pigtail. A20 series has #4 screws. A25 series has #6 screws.

INSTALLATION



WARNING: DISCONNECT THE BATTERY OR POWER SOURCE BEFORE BEGINNING THE INSTALLATION. DO NOT OPEN RADIATOR CAP OR FITTINGS ON A HOT ENGINE. DANGEROUS BURNS CAN OCCUR.

Panel Mounting

The 20, 25, A20 and A25 series models can be installed in a panel from 0.032 in. (1 mm) to 0.250 in. (6 mm) thick. See Mounting Dimensions, page 1. Remove the mounting bracket completely and insert the MURPHYGAGE®/SWICHGAGE® from the front side of the panel. Replace the bracket and secure it in place. **IMPORTANT: Do NOT overtighten the mounting bracket. Shockmount the panel as necessary.**

LIQUID COOLED ENGINES:

1. Drain engine coolant to a level below the temperature sensing connection/plug. This connection is on the engine side of the thermostat generally near thermostat housing. *Consult your engine manual.*
2. Remove adapter nut from temperature sensing bulb and union nut.
3. Apply a non-hardening thread sealant to the adapter nut and screw securely into the water jacket opening in the engine.
4. Route the temperature capillary **AWAY** from hot surfaces such as exhaust manifolds.
5. Place the sensing bulb into the adapter nut and observe that the sensing bulb does not "bottom" in the water jacket nor are there other obstructions in the water jacket opening. Secure sensing bulb into the adapter nut with the 5/8-18 union nut. *See Figure 2.*



CAUTION: Do NOT cut or bend the temperature capillary at a sharp angle. Excess capillary must be carefully coiled and secured. The temperature sensing bulb must be immersed directly into the water jacket flow to sense coolant temperature. Do NOT install into a tee or other fitting. Use only Murphy adapter nuts.

6. Coil excess temperature capillary into a 2 in. (51 mm) diameter minimum coil. Tie the coil to prevent excessive movement.
7. Allow the engine to warm up and the thermostat to open. Slightly loosen the 5/8-18 union nut on the temperature sensing bulb to allow trapped air to escape from the cooling system. Retighten the nut.



WARNING: Perform this operation using appropriate protection. Trapped air and coolant may cause burns.

AIR COOLED ENGINES:

Temperature for air cooled engine can be measured in the cylinder head or in the lubricating oil. Oil temperature will give a more uniform reading than cylinder head since the oil circulates throughout the engine. Refer to specific instructions supplied, if any, for your specific application.

1. **Oil Temperature**
 - a. The SWICHGAGE® sensing probe must be fully immersed in the oil pan, oil filter housing, oil cooler, etc. depending on engine model and configuration.
 - b. Observe all precautions for liquid cooled engines.
2. **Cylinder Head Temperature**
 - a. Generally the cylinder head must already have a hole drilled and tapped for insertion of the temperature sensing probe.
 - b. If a hole is not provided in the cylinder head and no provision is made to drill and tap one, it may be possible to install an external bolt on heat sink such as the Murphy HS7.
 - c. Coat the temperature sensing probe with a high temperature grease. A mixture of silicone and graphite flakes is recommended although grease alone can be used.



CAUTION: Do NOT apply too much grease. If grease is pushed out of the hole when temperature probe is inserted, remove some grease.

- d. Observe all precautions for liquid cooled engines.

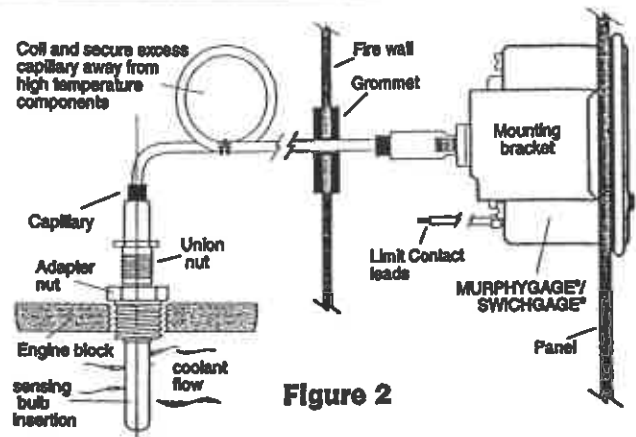


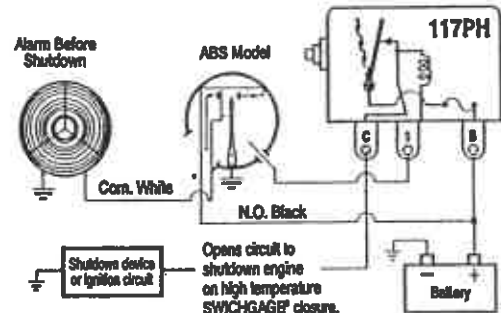
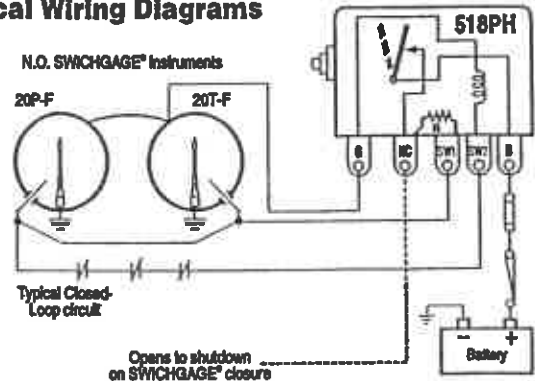
Figure 2

Connecting the TATTLETALE®/Magnetic Switch

1. Mount with electrical lugs down. If necessary, drill the case and pilot-stud holes (template provided).
2. Clean away burrs and filings. Position the Magnetic Switch in the panel, making sure the pilot stud is in place.
3. Add decal, then washer, then nut and tighten.

NOTE: Murphy components are easily wired and maintained. Use good quality wire and terminals. The type of Magnetic Switch differs for various applications. See examples of typical wiring (below). Wiring and instructions are packed with each Magnetic Switch.

Typical Wiring Diagrams



IMPORTANT INFORMATION: Do NOT clean MURPHYGAGE®, SWICHGAGE® and Magnetic Switch with steam or high pressure washes. Many solvents and cleaners can haze and permanently damage the clear, polycarbonate. Clean your devices with: mild soap and water, mineral spirits, methyl/isopropyl/isobutyl alcohols, or 1 & 3 denatured alcohols. **WARNING:** Do not clean the MURPHYGAGE®/SWICHGAGE® - Magnetic Switch when equipment is running or very hot.

INSTALLATION Continued

Setting the SWICHGAGE® contacts



IMPORTANT: For 20TE, 25TE, A20TE and A25TE models the switch trip point **CANNOT** be set at either the lowest or the highest extremes of the scale. Trip point **MUST** allow for the switch reset differential. For adjustable switch versions, the switch point is adjustable **ONLY** over the upper half of the scale.

1. All contacts are set using a 1/16 in. hex wrench (Figure 3).
2. Some models such as A20TE, A25TE, etc. may not have field adjustment. Consult the factory if in doubt.
3. Observe the "normal operating" temperature readings. Set the contact slightly above maximum reading observed or slightly below maximum temperature recommended by equipment manufacturer.

Testing the Contacts

1. With equipment running; use a 1/16 in. hex wrench to rotate contact until it touches the pointer. Do **NOT** force contact against the gage pointer. Equipment should shut down and/or alarm should operate.
Reset the contact (Figure 3).
2. **VERY IMPORTANT** Each time you start the machine, observe that the SWICHGAGE® is indicating temperature. Visual inspection and regular testing should be normal procedure to ensure proper operation and to achieve maximum results from your SWICHGAGE®.

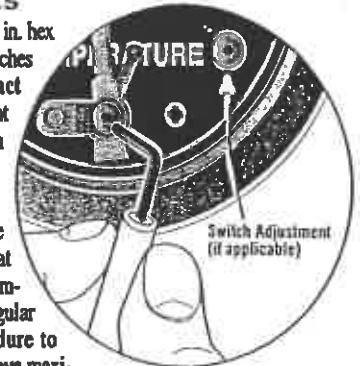


Figure 3

TYPICAL WIRING DIAGRAMS



WARNING: DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING INSTALLATION

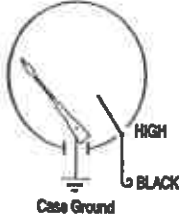
20 and 25 Series models

These diagrams are shown with the pointer in the at rest (shelf) position.

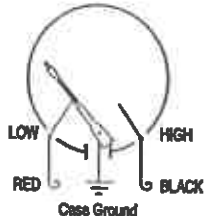
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

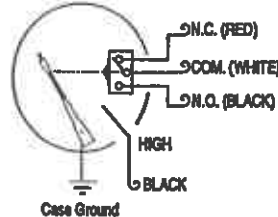
20T and 25T



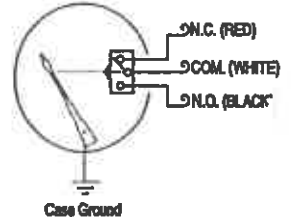
20T-HL and 25T-HL



20TABS and 25TABS



20TE and 25TE



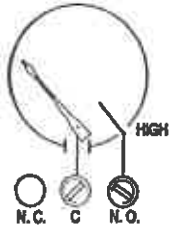
A20 Series models

These diagrams are shown with the pointer in the at rest (shelf) position.

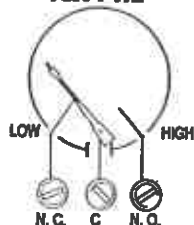
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

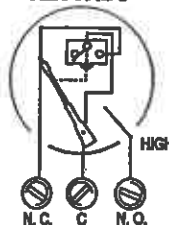
A20T



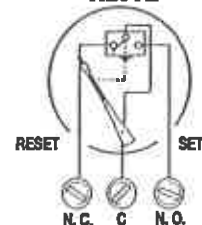
A20T-HL



A20TABS*



A20TE



* CAUTION Pointer contact and ABS switch share the same "Common." Voltage source **MUST** be the same. Maximum voltage is 30 V. Consult factory for 120 VAC applications.

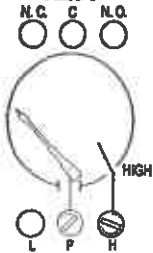
A25 Series models

These diagrams are shown with the pointer in the at rest (shelf) position.

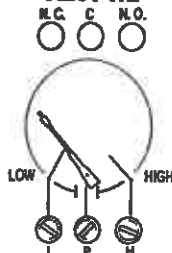
Pointer contact rating: pilot duty 2 A @ 30 VAC/DC.

Snap-switch rating: 3 A @ 30 VDC, 4 A @ 125 VAC.

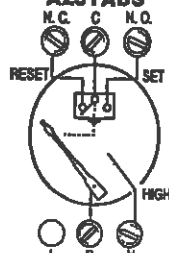
A25T



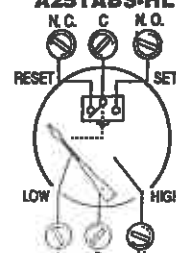
A25T-HL



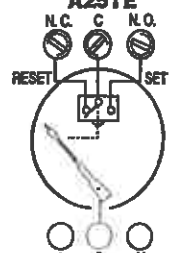
A25TABS



A25TABS-HL



A25TE



TROUBLESHOOTING TIPS

DO THIS FIRST:

- Verify that the SWICHGAGE® has not been damaged (hit or dropped).
- Check for kinked or broken/worn capillary tubing.
- Verify that the sensing bulb is immersed in coolant flow.
- Look for broken wiring, frozen pointer, dirty contacts (will not make).
- Verify that there is coolant or water flowing inside the engine.
- Reset Magnetic Switch and verify that it stays latched.

The following information will assist in the correction of most problems which you may encounter with the unit. If any problems persist after you have made these checks, consult your nearest Murphy facility.

SYMPTOM	CAUSE	TEST/REMEDY
Engine will not start.	<ol style="list-style-type: none"> Short or Open circuit, be sure that the Magnetic Switch latches and either puts out power to run device or removes ground (magneto or CD ignition). Check for power or ground at run device. Control circuit overloaded by accessories (blown fuse in Magnetic Switch). False ground in control circuit. 	<ol style="list-style-type: none"> Reset Magnetic Switch and make sure it stays latched. For 518PH check battery voltage and place a jumper between SW1 and SW2. If switch latches, check SWICHGAGE® wiring circuit and repair. If switch does not latch, repair or replace Magnetic Switch. Find the cause of the blown fuse and replace it (use a 14 A fuse). Reroute the accessories. Repair.
False shutdown.	<ol style="list-style-type: none"> SWICHGAGE® circuit has intermittent open or short. Vibration causes the Magnetic Switch to trip. 	<ol style="list-style-type: none"> Check all wiring and replace as necessary. Repair and relocate the switch as needed.
SWICHGAGE® closes but does not trip the magnetic switch or kill the engine.	<ol style="list-style-type: none"> Incomplete shutdown circuit. Dirty SWICHGAGE® contacts. Magneto not providing power to primary terminal post. SWICHGAGE® case may not be grounded. Incorrect Magnetic Switch for type of power. 	<ol style="list-style-type: none"> Locate open circuit and repair. Clean and check that contacts make. Repair magneto. Ground case. Replace with correct Magnetic Switch.
TATTLETALE® tripped but engine is still running (magneto or CD ignition)	<ol style="list-style-type: none"> Open circuit between the TATTLETALE® and the shutdown device. Lost ground to kill the engine. 	<ol style="list-style-type: none"> Check wiring from TATTLETALE® to shutdown device, repair or replace. Check all wiring and connections and repair.
Pointer will not operate properly. Inaccurate reading.	<ol style="list-style-type: none"> Frozen pointer Loose pointer spring (caused by hitting or dropping gauge). Bulb not inserted to full length or low coolant level. Kinked/crimped/broken capillary. 	<ol style="list-style-type: none"> Return for repair or replace. Return for repair or replace. Correct. Correct
Pointer or contact burned-in-two.	<ol style="list-style-type: none"> Without exception this condition is caused by incorrect wiring or a short circuit. 	<ol style="list-style-type: none"> Refer to wiring diagram and recheck wiring; replace SWICHGAGE® or return for repair. Observe voltage and current ratings.

WARRANTY

A two-year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.



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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 for 4-1/2 in. (114 mm) dial Pressure MURPHYGAGE® and SWICHGAGE®

Model Series: OPLC, OPLG, OPLBP, 45APE, 45APEBP and 45 Series
Options: -OS, -ES, -P4 and -P6



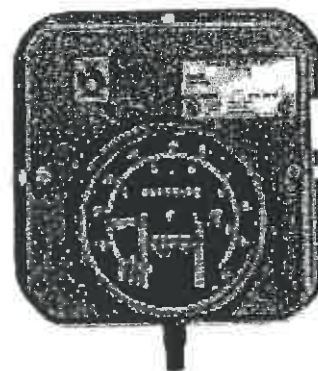
Please read the following instructions before installing. A visual inspection is recommended before mounting. General Information and these installation instructions are intended for all 4-1/2 in. (114 mm) dial pressure models.

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.



OPLC and OPLFC SWICHGAGE® instruments have high and low limit contacts to monitor, alarm or shut down. The OPLC has a flanged case. A method to override the low limit contact for start-up is provided on most models. See Operation Test section—page 3.

OPLFC can be direct or panel mounted (see page 2).

OPLG and OPLFG MURPHYGAGE® instruments are indication-only pressure gages. Same as OPLC and OPLFC models except without switch (limit) contacts.

45 Series includes a magnetic switch to stop an engine or electric motor each time the gage contact operates. A lockout push button overrides low contact for startup. Other variations available.

45APE and 45APEF Series are versions of the OPLC Series featuring 2 snap-acting SPDT switches instead of the pointer type contacts. These units do not include low contact lockout.

OPLBP and 45APEBP are versions of the OPLC and 45APE featuring pilot duty limit switches connected to an internal latching control relay for “on/off” control directly or through a motor starter.

Specifications

Dial: White on black, dual scale, psi and kPa standard, 4-1/2 in. (114 mm) diameter.

Case: Die cast aluminum, surface or panel mount.

Overrange: Do not exceed 10% FS above full range.

Process Connection: 1/4 NPTM thru 1000 psi;
1/2 NPTM 1500 - 20,000 psi; back connection optional.

Sensing Element: Bronze or 316 stainless steel bourdon tube.

Gage Accuracy:

Indicating pointer within switch points with hysteresis of <1%:
±2% for first and last quarters of scale; middle half of scale is ±1%.

Indicating pointer below low or above high set points (45APE Series only):
±4% for first and last quarters of scale; middle half of scale is ±3%.
For ranges <60 psi add ±1%.

Pressure Relief Disc: Back of case (except EX models).

Switch Reset Deadband: Approximately 10% FS.

Snap-Acting Switches: See wiring information (page 4).

Dry Relay Contact (“BP” Models): 10 A @ 28 VDC or 10 A @ 120 VAC.

Wire Connections (Surface Mount): 1/2 NPTM conduit/terminal block.

Wire Connections (Panel Mount): Wire leads, 18 AWG (1.0 mm²) x 9 in. (229 mm) long.

Wire Connections (-ES, -OS, -CC): 1/2 NPTM conduit and wire leads,
24 AWG (0.22 mm²) x 33 in. (838 mm) long.

Item Weight: 5 lbs 6 oz (2.4 kg) approximately.

Explosion-proof models: 21 lb. (9.5 kg) approx.

Item Dimensions: 10 x 9 x 6 in. (254 x 229 x 152 mm) approximately.

Explosion-proof models: 12 x 12 x 9 in. (305 x 305 x 229 mm) approximately.



Precautions: Do NOT exceed rated pressure range.

Do not use teflon tape on connection threads. Do not block the inlet orifice. For direct mount into the process, a vertical or ninety degree mounting is recommended.

Use wrench on shank to tighten or loosen connection. Do not twist case when installing, this will damage internal components and will void the warranty. Do not overtighten.

Use shock mounts as necessary to prevent excessive vibration.

If liquid in the system freezes, it will expand and will damage the tube.

For 45APE Series – Low setpoint should be limited to the lower 1/2 scale and upper setpoint should be limited to the upper 1/2 scale.

Warranty

A two-year limited warranty on materials and workmanship is given with these Murphy products. Details are available on request and are packed with each unit.

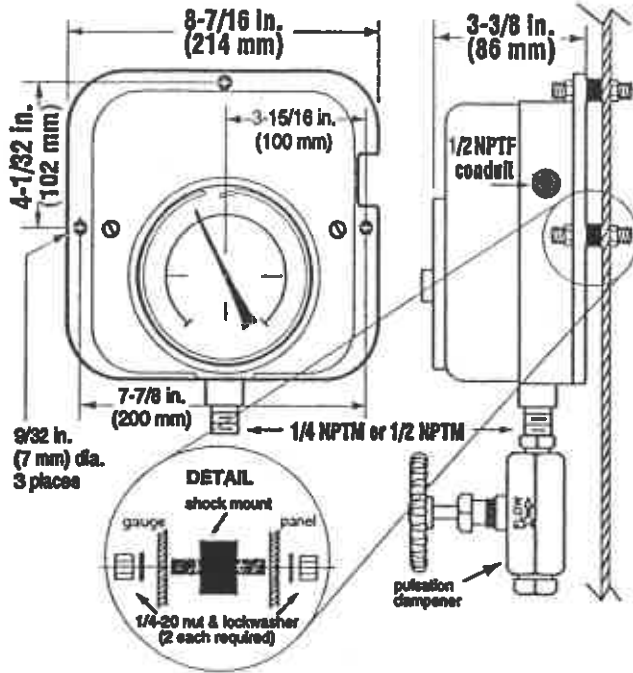
*Selected configurations are third party listed. Consult factory for details.

**Products covered by this bulletin comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted. Does not cover “BP” models.

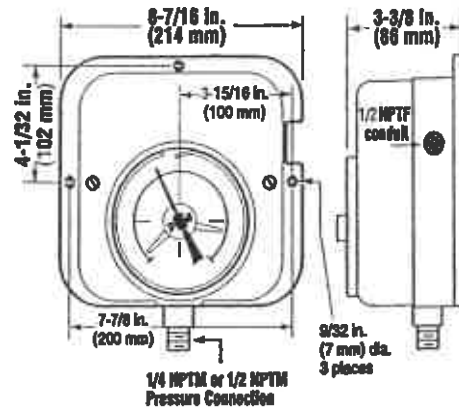
CASE MOUNTING

OPL Series Wall Mount

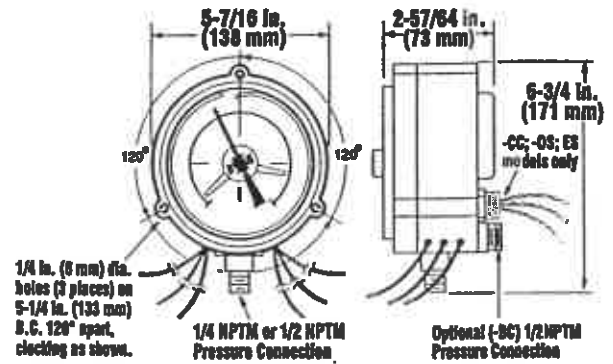
Flanged case design intended for wall mount, it can also be direct mounted. Shown with shock mounts and pulsation dampener.



45APE Series Wall Mount

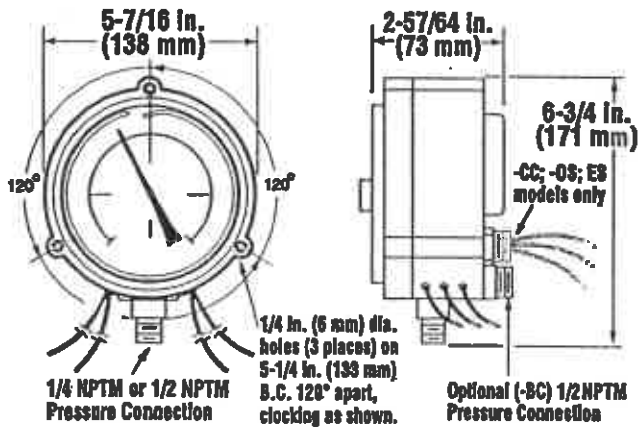


45APE Series Flush Mount

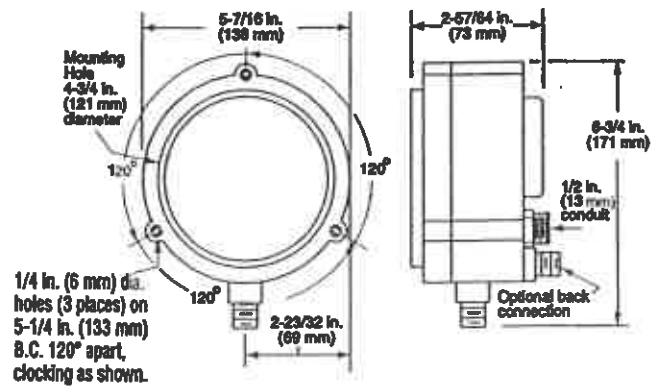


OPL Series Flush Mount

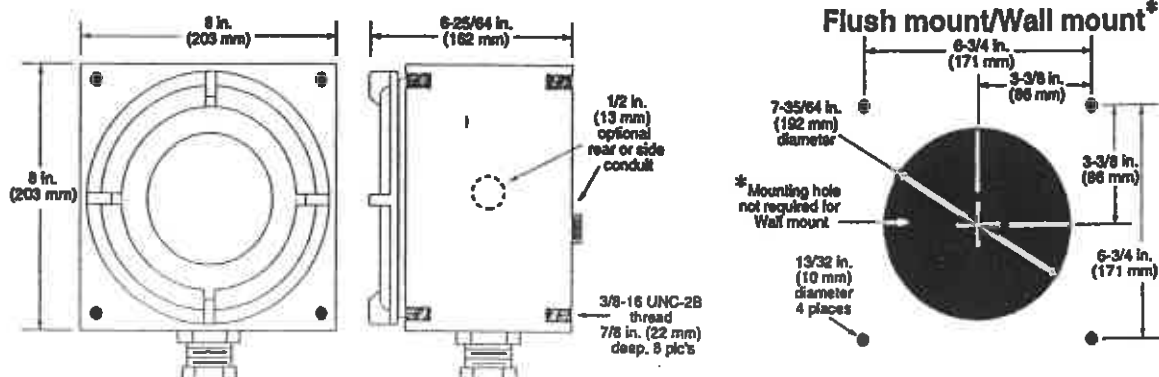
Round case design to be mounted in a panel from 1/32 in. (1 mm) to 1/8 in. (3 mm) thick. It can also be direct mounted. Shown with pulsation dampener.



Options "OS" and "ES" (flush mount case)



Explosion-proof Case Mount Explosion-proof case can be mounted from face or rear.

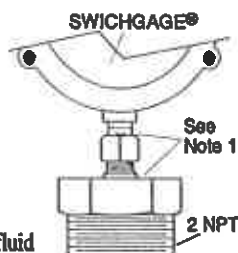


OPTIONS

OS and ES (oil sealed and environment sealed case) options for corrosive environment, feature a panel mount case design or screw directly into the process. See Case Mounting (p-2).

Pulsation Dampener Helps controls pressure instruments subject to pulsation. The PD8187 is NOT intended as a "shutoff" valve. See Case Mounting (p-2).

P6 is a sealed mechanism with a typical application for oil well lead lines. Its 2 NPT housing and diaphragm seal filled with silicon fluid attaches directly into a 2 NPT tee on the lead line. Tighten only the 2-5/8 in. (67 mm) hex fitting. **CAUTION: Do not tamper with or break sealed connections.**



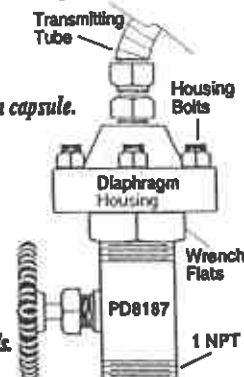
P4 is a remote seal mechanism with stainless steel armored capillary to protect the SWICHGAGE® from highly viscous and/or corrosive fluids.

1. Use thread sealant to install the PD8187 pulsation dampener into source pressure connection.
2. Loosen the eight housing bolts until the bottom housing is free to turn.

CAUTION: Do Not unscrew the green diaphragm capsule.

3. Tighten the bottom housing to the 1 NPT on the pulsation dampener.
4. Tighten the eight housing bolts to 25±3 foot lbs. by staggering the tightening for even clamping.
5. Route capillary away from heat source such as exhaust manifold. Excess capillary should be carefully coiled and secured to avoid damage.

CAUTION: Do Not cut capillary or make sharp bends.



ADJUSTMENTS

OPL/45 Series Limit Contact Adjustments

Facing the dial, left side knob is the "Low limit" contact and the "High limit" contact is located to the right. To set the limit contacts simply turn the fingertip type knob to the desired point on the scale.

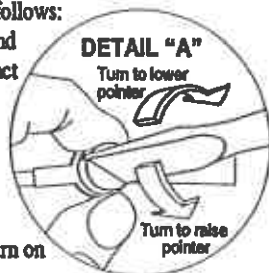
45APE Series Trip Point Adjustments

The 45APE Series features a stacked limit indicator adjustments knob. The bottom half knob adjusts the "Low" limit indicator, the top half is to adjust the "High" limit indicator. To set the limit contacts simply turn the fingertip type knob to the desired point on the scale.

OPL and 45 Series Indicating Pointer Adjustments

To reset to zero or to a known value do as follows:

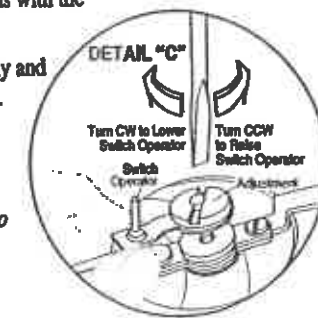
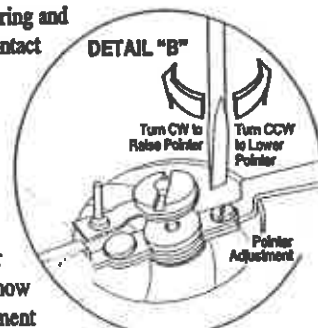
1. Turn off power. Remove the snap ring and very carefully remove the lens and contact assembly (or open hinged cover).
2. Hold the pointer hub with thumb and forefinger then turn screw to desired point. See DETAIL "A".
3. Replace lens and contact assembly and snap ring (or close hinged cover), and turn on the power.



45APE Series Pointer Adjustments

To reset to zero or to a known value proceed as follows:

1. Turn off the power. Remove the snap ring and very carefully remove the lens and contact assembly (or open hinged cover).
2. Hold the pointer hub with thumb and forefinger, then turn the Pointer Adjustment screw to the desired point. See DETAIL "B".
3. If the Switch Operator needs adjustment, hold the Switch Operator Hub with thumb and forefingers as show on DETAIL "C"; and turn the adjustment screw until the Switch Operator aligns with the indicating pointer.
4. Replace the lens and contact assembly and the snap ring (or close hinged cover). Turn the power back on.



NOTE: Span adjustments and recalibration must be performed by authorized mechanic or return the unit to FWMurphy. See addresses on p-4.

OPERATION TEST INSTRUCTIONS

OPLC, OPLFC and OPLBP

1. Perform operation test after the unit is installed and wired appropriately. (See the typical wiring diagram, on page 4.)
2. When pressure is applied to the instrument, the pointer will travel in a clockwise direction. Adjust the limit contacts to the desired settings.
3. To start, place the toggle switch in the "start" position or otherwise override low contact.
4. After the indication pointer rises above the low limit contact, return the toggle switch or override device to the "run" position.
5. To test the limit contacts, turn the limit contact to be tested until it touches the pointer. That will trip the control circuit.
6. Reset the shutdown or alarm circuit device and repeat above sequence for each contact/trip point.

45 Series

1. Repeat steps 1 and 2. (See OPLC operation test instructions.)
2. Press the semi-automatic pushbutton located on the low contact knob.
3. Reset the magnetic switch pushbutton.
4. After the indication pointer rises above the low limit contact, the lockout - pushbutton automatically disengages and the low limit is armed.
5. Repeat steps 5 and 6. (See OPLC operation test instructions.)

45APE, 45APEF and 45APEBP

1. Repeat steps 1 and 2. (See OPLC operation test instructions.)
2. To test the switches, turn the limit indicator until it touches the pointer, then continue to rotate until the snap switch operates*.
3. Reset the shutdown or alarm circuit device.

* The trip point indicator will stop the pointer movement slightly before the snap switch operates. As pressure continues to increase or decrease, the trip point setting is reached.

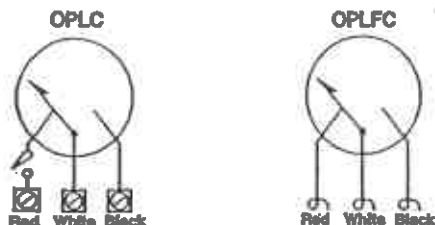
TYPICAL ELECTRICAL DIAGRAMS



WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF". MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE SWITCHGAGE® RATINGS. BEFORE WIRING DETERMINE VOLTAGE AND POLARITY FOR THE APPLICATION. USE THE APPROPRIATE WIRE SIZE. ALL CONNECTIONS SHOULD BE MADE USING A SPADE (FORKED) OR RING TERMINALS. FOR PIGTAIL CONNECTIONS USE WIRE NUTS. CONDUIT IS RECOMMENDED TO PROTECT WIRES FROM DAMAGE.

OPLC and OPLFC

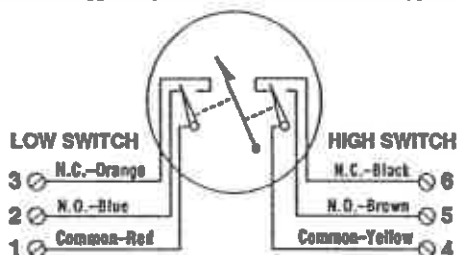
Contact Rating: 1 SPDT, Center Off; 2 A, 30 VDC, 1 A, 125 VAC pilot duty.



NOTE: Diagrams above show the pointer in the at rest (shelf) position.

45APE and 45APEF

Contact Rating: 2-SPDT snap-switches (one for high and low pressure), 4 A inductive, 250 VAC each switch. NOTE: Diagram below shows the pointer in the at rest (shelf) position. Low setpoint should be limited to the lower 1/2 scale and upper setpoint should be limited to the upper 1/2 scale.

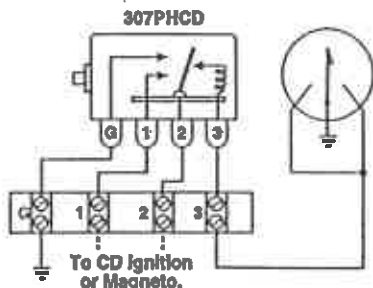


45 Series with 307PHCD

Contact Rating: 12/32 VDC coil, 10 A, 32 VDC battery ignition contacts; Magneto ignition coil, 10 A magneto ignitions contacts; CD ignition coil, 10 A CD ignition contacts; 120 VAC coil, 10 A, 120 VAC contacts. NOTE: Diagram below shows the pointer in the operating position.

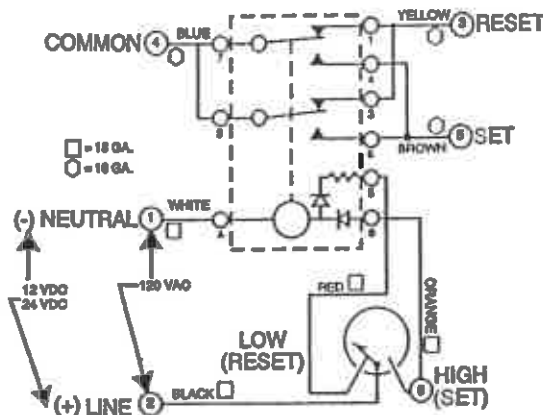
IMPORTANT:

Use with 110/120 VAC requires isolated ground SWITCHGAGE® instruments.



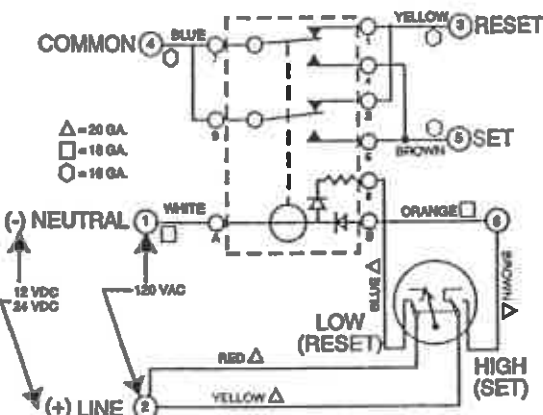
OPLBP

Contact Rating: SPDT dry relay contacts; 10 A, 125 VAC. NOTE: Diagram below shows the pointer in the at rest (shelf) position.



45APEBP

Contact Rating: SPDT dry relay contacts; 10 A, 125 VAC. NOTE: Diagram below shows the pointer in the at rest (shelf) position.



Transformer Relay Assemblies

For higher voltages, Murphy TR Assemblies can be used in conjunction with any SWITCHGAGE®.



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Installation Instructions for Pressure and Vacuum 2 and 2-1/2 in. (51 and 64 mm) Dial MURPHYGAGE® and SWICHGAGE® Instruments. 20, 25, A20, A25 Series

P-95033N
Revised 02-02
Section 05
(00-02-0182)



Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended.

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.

Description

The 2 and 2-1/2 in. (51 and 64 mm) dial size MURPHYGAGE® and SWICHGAGE® instruments are diaphragm-actuated, pressure or vacuum gages with a 1/8-27 NPTM pressure port connection (2 pressure ports for differential pressure models).

Models with face-adjustable contact(s) are rated for 2 A @ 30 V (pilot duty). If the gage case is steel (20P, 25P, 20DP, 25DP etc.) the ground path for the contact circuit is through the case. Therefore, the case must be installed in the ground plane of the electrical power supply.

If the case is polycarbonate (A20P, A20DP, A25P, A25DP etc.) the ground path is isolated and is made through the "C" or "P" terminals on the back of the gage case ("C" for A20 models; "P" for A25 models).

Models 20PE, 25PE, A20PE, A25PE etc. have a snap-acting switch instead of the face adjustable pointer type contact. Electrical rating is 3 A @ 30 VDC, 4 A @ 125 VAC. Reset differential for the switch is approximately 10% of the scale.

NOTE: Select a scale so your normal operating pressure is in the upper middle of the scale.

CAUTION: Certain dangers to human safety and to equipment may occur if some equipment is stopped without pre-warning. It is recommended that monitored functions be limited to alarm-only or to alarm before shutdown.

Alarm Before Shutdown Models

The 20PABS, A20PABS, 25PABS and A25PABS feature a front limit contact for equipment shut-down and an internal SPDT snap switch for Alarm Before Shut-Down. When the low side (preset point) of the snap switch trips, the N.C. terminal completes a circuit to activate an alarm. A continued decrease in pressure will complete the shutdown circuit. An increase in pressure of approximately 10% of scale is necessary before the snap-switch (alarm) will RESET and open the circuit.

NOTE: Face contact shut-down limit setting and snap switch low point are factory-set; specify when ordering if setting is other than standard.

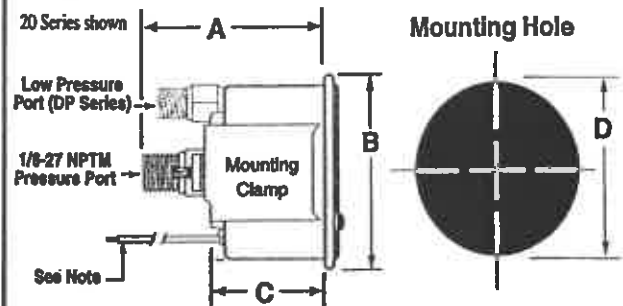
Typical TATTLETALE® Magnetic Switch

Murphy manufactures several, patented Magnetic Switches for protection of the pilot duty SWICHGAGE® contacts and to ensure positive shut-down of equipment. There are Magnetic Switches for CD ignition, Magneto, Battery systems and electric motor driven equipment. TATTLETALE® annunciators show the cause of shut-down. The first one to trip will lockout all other TATTLETALE® annunciators. Be sure the type of Magnetic Switch/TATTLETALE® matches the power source used to trip it.

NOTE: As equipment start-up (for models not having a built-in time delay) the reset button must be held in until normal operation occurs, or an external time delay may be used. Instructions are packed with each Magnetic Switch/TATTLETALE®.

Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted.

Typical Mounting Dimensions



	20 Series	A20 Series	25 Series	A25 Series
A	2-7/32 (56)	2-9/16 (65)	2-1/8 (54)	1-51/64 (46)
B	2-13/64 (57)	2-1/4 (57)	3-1/8 (79)	2-29/32 (74)
C	1-9/16 (33)	1-1/4 (32)	1-3/8 (35)	1-27/64 (36)
D	2-1/16 (53)	2-1/16 (53)	2-11/16 (68)	2-11/16 (68)

NOTES: 20/25 Series: 18 AWG pigtails. A20/A25 series: #4/#6 screws. The dimensions above are in inches and (millimeters).

Panel Mounting

All models can be installed in a panel from 0.032 to 0.250 in. (1 to 6 mm) thick. Remove the mounting bracket and insert the gage from the front side of the panel. Replace bracket and secure it. Do NOT overtighten. (See Figure 2).

Connecting the Pressure Port

1. Pressure tubing is generally not provided. Use of good quality flexible pressure tubing/hose and fittings is strongly suggested. Use at least 3/16 in. (5 mm) I.D. tubing. If using copper or rigid tubing, install at least 12 in. (305 mm) flexible hose from the gage to the rigid tubing. This prevents damaging vibration from reaching the gage. For most models a pulsation orifice, within the pressure port, is provided and it is removable for cleaning (Figure 2).

2. Connect tubing to the 1/8-27 NPTM port. Use of non-hardening thread sealing compound is recommended although thread is "dry seal".

IMPORTANT: Make sure NOT to foul pressure orifices with sealant. NEVER exceed maximum pressure rating for the gage range; see chart on p-2.

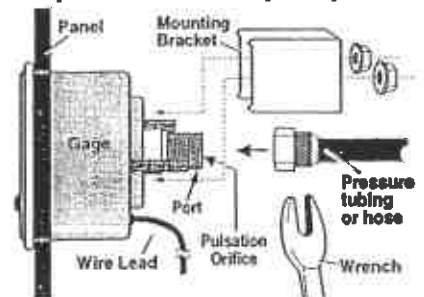


Figure 2

IMPORTANT: SWICHGAGE® instruments, Magnetic Switches and shut-down or alarm devices, properly used, are effective tools in any preventive maintenance program. For optimum performance, check these tools periodically: look for frozen pointers, kinked/worm tubing, broken wiring or loose connections; operate the contacts and watch for expected results. Replace damaged/worn part., clean/repair as necessary. Check for correct/complete wiring, unbroken insulation and no accidental grounds. DO NOT run shut-down wires with ignition wiring. Check all tubing and connections for leaks. Mount Magnetic Switches and valves upright, to prevent moisture collection.

Pressure Ranges and Factory Settings

Ranges Available		Maximum Pressure	Std. Settings*		HI Settings**		20/25PABS Settings				Start-up Lockout Settings					
psi	Bar		psi	Bar	psi	Bar	Low		Alarm†		Contact		Lockout		Release (max.)	
0-15 (103)	1.0	30 psi (21 MPa)	3 (21)	0.2	12 (83)	0.8	3 (21)	0.2	6 (41)	0.3	3 (21)	0.2	4 (28)	0.3	6 (41)	0.4
0-30 (207)	2.0	60 psi (21 MPa)	7 (48)	0.4	24 (165)	1.6	7 (48)	0.4	10 (69)	0.6	4 (28)	0.4	7 (48)	0.5	10 (69)	0.7
0-50 (345)	3.5	100 psi (21 MPa)	10 (69)	0.8	40 (276)	2.8	10 (69)	0.8	13 (90)	1.0	10 (69)	0.5	13 (90)	1.0	20 (138)	1.4
0-75 (517)	5.0	150 psi (21 MPa)	15 (103)	1.0	60 (414)	4.0	15 (103)	1.0	18 (124)	1.5	10 (69)	0.7	15 (103)	1.0	23 (159)	1.6
0-100 (690)	7.0	200 psi (21 MPa)	20 (138)	1.5	80 (552)	5.5	20 (138)	1.0	23 (159)	1.5	20 (138)	1.0	25 (173)	2.0	35 (241)	2.4
0-150 (1.0 MPa)	10	300 psi (3.4 MPa)	30 (207)	2.0	120 (827)	8.0	30 (207)	1.5	33 (228)	2.0	20 (138)	1.5	30 (207)	2.0	45 (310)	3.1
0-200 (1.4 MPa)	14	400 psi (3.4 MPa)	50 (345)	3.0	150 (1 MPa)	10	50 (345)	3.0	53 (365)	4.0	40 (276)	3.0	50 (345)	3.5	70 (482)	4.8
0-300 (2.1 MPa)	20	500 psi (3.4 MPa)	75 (517)	5.0	225 (1.6 MPa)	15	75 (517)	5.0	78 (538)	5.0	50 (345)	3.5	75 (517)	5.0	105 (724)	7.2
0-400 (2.8 MPa)	28	500 psi (3.4 MPa)	150 (1 MPa)	7.0	300 (2.1 MPa)	20	75 (517)	5.0	150 (1 MPa)	10	100 (690)	6.0	—	7.0	150 (1 MPa)	10

Values in () are mathematical conversions from psi to kPa/MPa—they do not reflect second scale range. U.S.A. standard scale is psi/kPa; U.K. standard scale is psi/bar. Consult factory for other scales.

* Standard setting for 20P/25P and 20PE/25PE models.

** Low settings for Hi/Lo option same as standard settings. Hi/Lo option available for 20P/25P models only.

† SPDT Snap-switch is the alarm switch.

Connecting Vacuum Models

The vacuum SWICHGAGE®/MURPHYGAGE® measures intake manifold vacuum and gives an indication of the load applied to the engine.

1. Mount the gage in a suitable location so that the face is visible and easily accessible.



CAUTION: Make SURE NOT TO FOUL the pressure orifices with pipe dope or dirt or the SWICHGAGE® instrument will not operate.

2. Connect suitable tubing to the 1/8-27 NPT port of the gage and to an open port in the intake manifold. Mounting kit V5179 is suggested and includes tubing and necessary fittings. The manifold fitting is 1/4 NPT. Figure 3 shows a typical mounting using V5179 kit. A Murphy PD2160 is also recommended.

3. Be sure connections are tight—gage will not operate properly if line leaks.

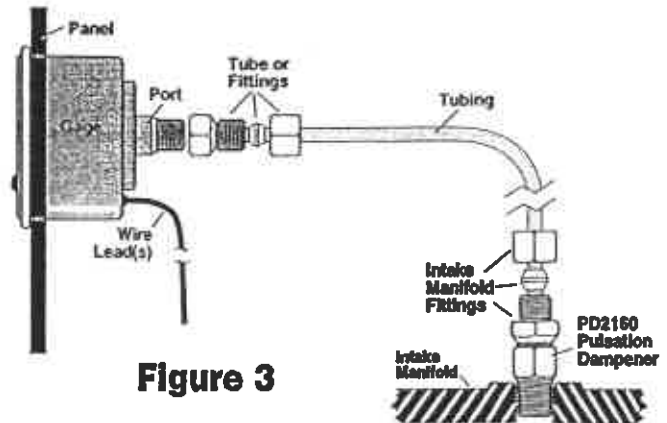


Figure 3

Connecting Differential Pressure Models

Differential pressure models are typically applied to indicate restriction in oil/fuel filters. The "High" pressure port (center mounted) is piped to the Inlet side of the filter. The "Low" pressure port (top center mounted) is piped to the Outlet side of the filter.



CAUTION: Make SURE NOT TO FOUL the pressure orifices with pipe dope or dirt or the SWICHGAGE® instrument will not operate.

1. To connect the high pressure tubing use at least 3/16 in. (5 mm) I.D. flexible pressure tubing/hose and fittings. If using copper or rigid tubing, install at least 12 in. (305 mm) flexible hose from the gage to the rigid tubing (to prevent damaging vibration to the gage, see Figure 2).

2. You **MUST** use a second wrench on the **Low Pressure** port when tightening tube fittings. (Figure 4). Notice that a wrench is used for holding the low pressure port while a second wrench will tighten the pressure tubing/hose fitting onto the port.



WARNING: Failure to use a second wrench on the low pressure port when tightening tube fittings may result in damage to the internal pressure tubing. Do NOT over-tighten connection to port.

IMPORTANT: NEVER exceed maximum static pressure or differential pressure ratings for your gage range; stated in chart below.

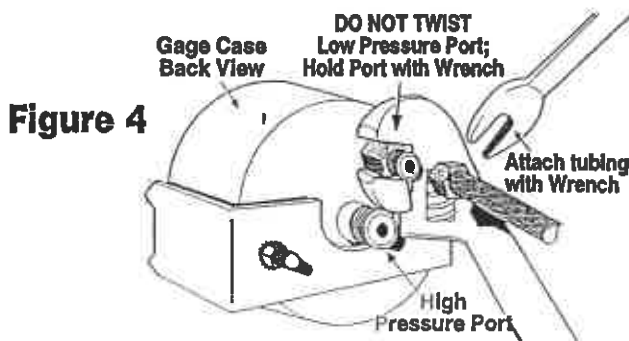


Figure 4

Ranges* Available	Max. Static Pressure	Max. Differential Pressure	Contact Setting
0-15 (0-103) [0-1.0]	200 (1.4) [14]	30 (207) [2.0]	10 (69) [0.8]
0-30 (0-207) [0-2.0]	300 (2.1) [20]	60 (414) [4.0]	20 (138) [1.0]
0-50 (0-345) [0-3.5]	300 (2.1) [20]	100 (690) [7.0]	30 (207) [2.0]
0-75 (0-517) [0-5.0]	300 (2.1) [20]	150 (1.0) [10]	50 (345) [3.5]
0-100 (0-690) [0-7.0]	300 (2.1) [20]	200 (1.4) [14]	60 (414) [4.0]

* Values are shown in psi, (kPa/MPa) and [bar]. Values in kPa/MPa and bar are mathematical conversions from psi—they do not reflect actual second scale range.

Setting the SWICHGAGE® contacts



IMPORTANT: If the SWICHGAGE® has a lockout push button on the face, a contact setting higher than the factory setting will make the lockout device inoperative.

For 20PE, 25PE, 25DPE, A20PE, A25PE and A25DPE models the switch trip point **CANNOT** be set at either the lowest or the highest extremes of the scale. Trip point **MUST** allow for the switch reset differential. For adjustable switch versions, the switch point is adjustable **ONLY** over the lower half of the scale.

1. All contacts are set using a 1/16 in. hex wrench (Figure 5).
2. Some models such as A20PE, A25PE, etc. may not have field adjustment. Consult the factory if in doubt. For adjustable models, 1/4 turn clockwise lowers switch operating point approximately 7% of scale.
3. Observe the "normal operating" pressure or vacuum readings. Set the contact slightly **below** minimum reading observed or slightly **above** minimum pressure recommended by equipment manufacturer. For differential pressure models set the contact slightly **below** the desired maximum differential pressure.

Testing the Contacts

1. With equipment running; use a 1/16 in. hex wrench to rotate contact until touches the pointer. Do NOT force contact against the gage points. Equipment should shut down and/or alarm should operate. Reset the contact (See Figure 5).
2. **VERY IMPORTANT** Each time you start the machine, observe that the SWICHGAGE® is indicating pressure or vacuum. Visual inspection and regular testing should be normal procedure to ensure proper operation and to achieve maximum results from your SWICHGAGE®.

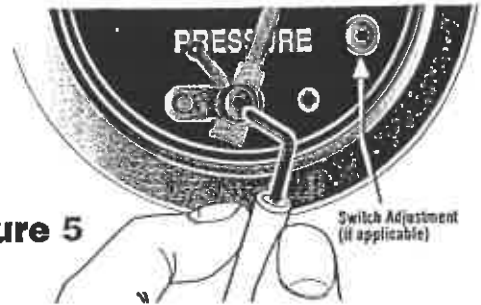


Figure 5

Wiring Installation



WARNING: DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING INSTALLATION. FOR BATTERY IGNITION SYSTEMS, DISCONNECT THE BATTERY GROUND STRAP. FACE ADJUSTED POINTER TYPE CONTACTS ARE PILOT DUTY. DO NOT EXCEED CONTACT RATINGS ON ANY SWICHGAGE® MODEL.

20 and 25 Series models wire leads are 18 AWG or 20 AWG, 12 in. (305 mm) long. A20 and A25 Series models have number 4 or number 6 screw terminals.

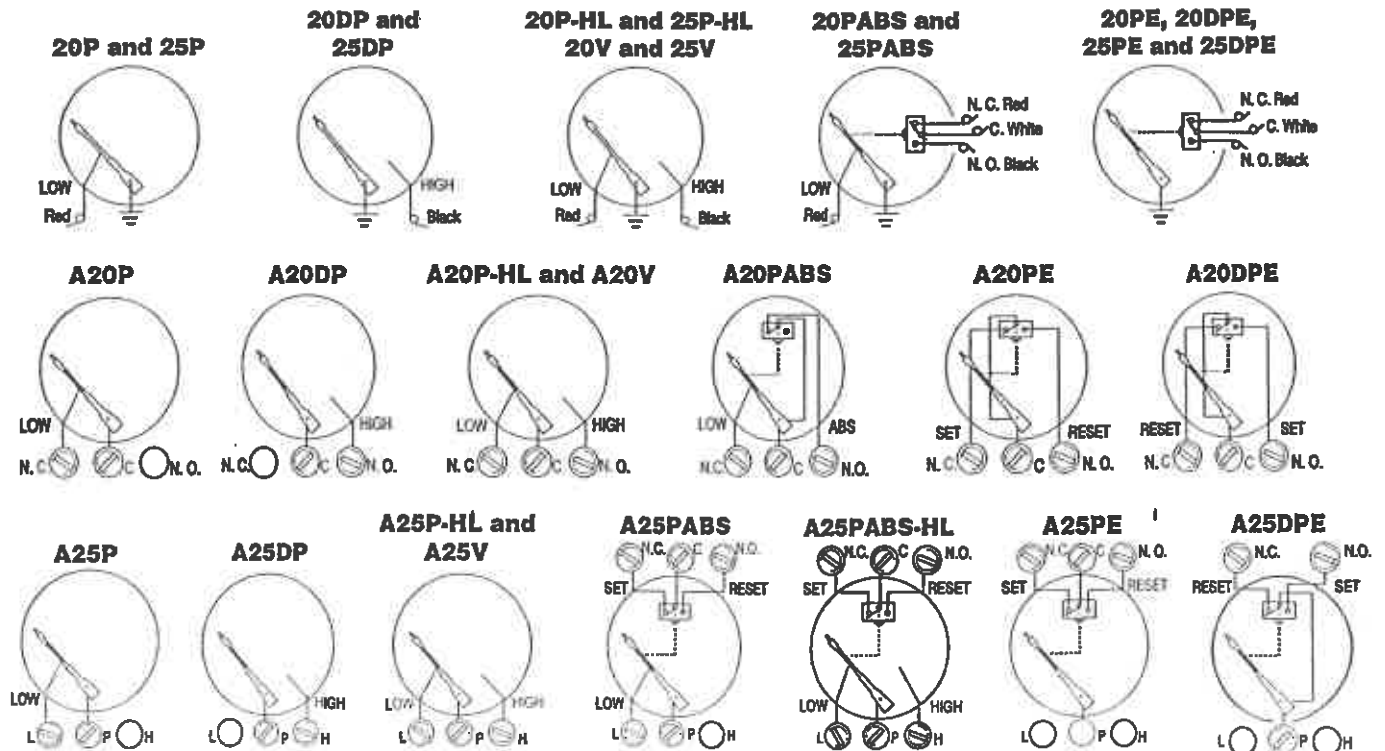
When installing the SWICHGAGE® on a ungrounded panel, you **MUST** provide a ground wire from the SWICHGAGE® to a common ground. Install **ONLY** in a 12 or 24 V system. Warning lights or audible signal **MUST** be of the same voltage as the battery. Current draw should **NEVER** exceed SWICHGAGE® contact ratings.

CAUTION: Ordinary incandescent lights are damaging to SWICHGAGE® contacts. We recommend using our direct connected alarms TL-7 flashing lamp and/or SAH MINI-SIREN.

The pictorial below shows typical wirings for each base model. Look for specific typical wiring diagram with your base model number and wire accordingly.

The pointer is shown in the **Shelf Position**. Face adjusted pointer type contacts are rated pilot duty 2 A @ 30 VAC/DC. Snap-switch contacts are rated 3 A @ 30 VDC; 4 A @ 125 VAC.

CAUTION: On some models pointer contact and ABS switch share the same "Common". Voltage source **MUST** be the same. Maximum voltage is 30 V. Consult factory for applications with 120 VAC systems.



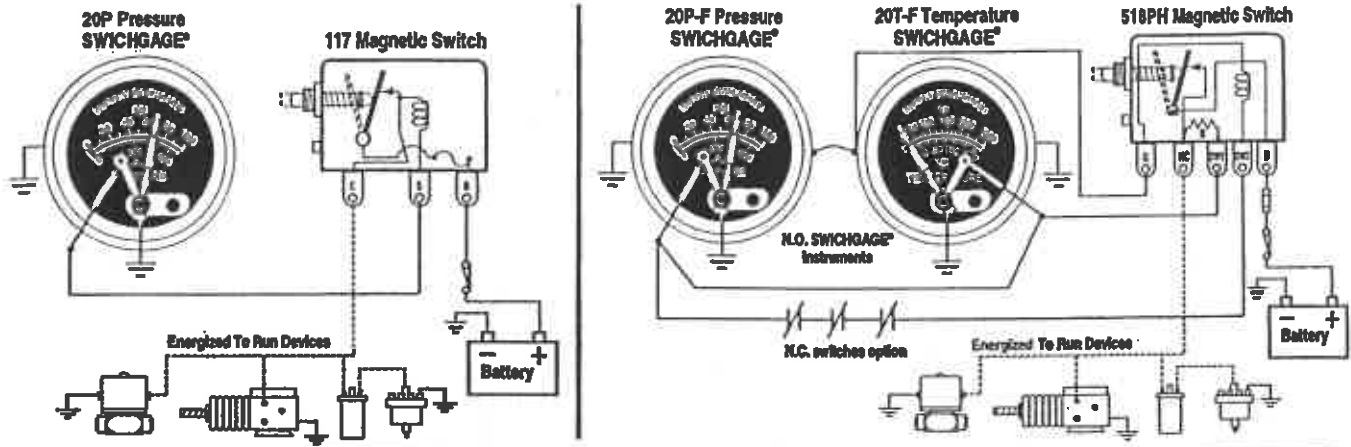
Installing The Magnetic Switch



WARNING: DISCONNECT THE BATTERY OR POWER SOURCE BEFORE BEGINNING THE INSTALLATION. SEE SPECIFIC WIRING INSTRUCTIONS PACKED WITH EACH MAGNETIC SWITCH / TATTLETALE®.

1. Mount with electrical lugs down. Drill mounting holes in panel.
2. Clean away burrs and filings. Position the Magnetic Switch in the panel, making sure the pilot stud is in place.
3. Add decal, then washer, then nut and tighten.

NOTE: Murphy components are easily wired and maintained. Use good quality wire and terminals. The type of Magnetic Switch differs for various applications. See typical wirings below. Wiring and instructions are packed with each Magnetic Switch.



Troubleshooting

DO THIS FIRST! Look for broken wiring, frozen pointer, dirty contacts (will not make), burnt pointer or contact. Verify that all wiring is intact and connections are tight. Verify that SWICHGAGE® has not been damaged (hit or dropped). Verify that there is pressure/vacuum supplied to the gage. Verify that the SWICHGAGE® is operative (it reads). Verify that the alarm or shutdown device is fully operable; and check other components such as spark plugs, ignition, fuel pump and filter, etc. Reset Magnetic Switch and verify that it stays latched.

SYMPTOM	CAUSE	TEST/REMEDY
Engine will not start.	<ol style="list-style-type: none"> 1. Short or Open circuit, be sure the Magnetic Switch latches and puts out power to the run device or removes ground (ignition). Check for power/ground at run device. 2. Control circuit overloaded by accessories (blown fuse in Magnetic Switch). 3. False ground in control circuit. 	<ol style="list-style-type: none"> 1. Reset Magnetic Switch and make sure it stays latched. Refer to installation instructions for 518PH Magnetic Switch (provided with unit). 2. Find blown fuse and replace (use 14 A fuse). Reroute the accessories. 3. Repair.
False shutdown.	<ol style="list-style-type: none"> 1. SWICHGAGE® circuit has intermittent open or short. 2. Vibration causes the Magnetic Switch to trip. 	<ol style="list-style-type: none"> 1. Check all wiring and repair/replace as necessary. 2. Repair and relocate the switch as needed.
SWICHGAGE® closes but does not trip the magnetic switch or kill the engine.	<ol style="list-style-type: none"> 1. Incomplete shutdown circuit. 2. Dirty SWICHGAGE® contacts. 3. Ignition not providing power to primary terminal post. 4. SWICHGAGE® case may not be grounded. 5. Incorrect Magnetic Switch for type of power. 	<ol style="list-style-type: none"> 1. Locate open circuit and repair. 2. Clean and check that contacts make. 3. Repair ignition. 4. Ground case. 5. Replace with correct Magnetic Switch.
Magnetic Switch tripped but engine is still running.	<ol style="list-style-type: none"> 1. Open circuit between the Magnetic Switch and the shutdown device. 2. Lost ground to kill the engine. 	<ol style="list-style-type: none"> 1. Check wiring from Magnetic Switch to shutdown device, repair or replace. 2. Check all wiring and connections and repair.
Pointer will not operate properly. Inaccurate reading.	<ol style="list-style-type: none"> 1. Frozen pointer 2. Loose pointer spring (caused by hitting or dropping gage). 3. Plugged pressure orifice. 	<ol style="list-style-type: none"> 1. Return for repair or replacement. 2. Return for repair or replacement. 3. Remove and clean.
Pointer/contact burned-in two.	Without exception this condition is caused by incorrect wiring or short circuit.	Recheck wiring; replace SWICHGAGE® or return for repair.

WARRANTY

A two year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.



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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.

Printed in U.S.A.

Installation Instructions for Level Maintainers

Model Series LM300

LM-92164N
Revised 08-02
Section 15
(00-02-0176)



Read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. These installation instructions are intended for all LM300 series models.

GENERAL INFORMATION

WARNING

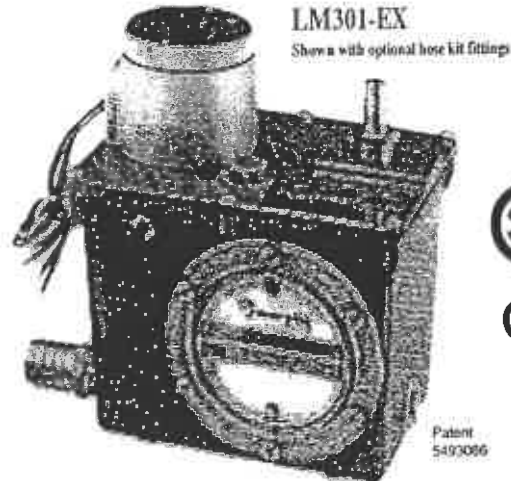
BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ 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.

- LM300:** Level Maintainer only (no switches).
- LM301:** Low switch contacts for low level shutdown or alarm. Four wires, SPDT.
- LM302:** Two switches for low and high level shutdown or alarm. Four wires, DPST, wired N.O. in normal operating ranges.
- LM303:** Two switches for low and high level shutdown or alarm. Four wires, DPST, wired N.C. in normal operating ranges.
- LM304:** Two switches. Alarm before shutdown on low level and shutdown on low-low level. Four wires, DPST, wired N.O. in normal operating ranges.
- LM305:** Two switches. Alarm before shutdown on low level and shutdown on low-low level. Four wires, DPST, wired N.C. in normal operating ranges.

Specifications

- Case/Cover:** Die cast aluminum.
- Switch Housing:** Aluminum.
- Approval Rating:** LM301 thru LM305 : CSA certified^{††} for non hazardous locations. Enclosure Type 4 certified.
LM301-EX thru LM305-EX: CSA certified^{††} for Class I, Groups C and D; Class II, Groups F and G hazardous locations. Enclosure Type 4 certified.
- Float:** Rigid polyurethane foam. Polyurethane coated.
- Maximum Ambient Temperature:** 250°F (121°C)
- Oil Inlet Connection:** Top entry 1/2-14 NPT with built-in filter screen (removable for cleaning).
- Inlet Orifices:** 1/4 in. (6 mm) standard. 1/8 in. (3 mm) available.
- Wire (switch models):** 18 AWG x 13 in. (1.0 mm² x 330 mm).
- Maximum Inlet Pressure (MIP):**
Max. Differential: 2 in. (51 mm) between running and stationary oil level.
30 psi (207 kPa) [2.07 bar].
with 1/8 in. (3 mm) orifice.
15 ft. oil (4.6 m oil)
with 1/4 in. (6 mm) orifice.
- Maximum Case Pressure (MCP):** 15 psi (103 kPa) [1.03 bar].
- Orifice Seal[†]:** Buna-N Thumb-Valve™
- Switch Contact:** Silver, SPDT snap acting, 10A @ 125, 250VAC; 10A @ 30VDC.
(1 only for low level; 2 only for high & low; or 2 only for low with alarm before shutdown)



- Outlet Connection:** 3/4-14 NPT left side, right side, and bottom.
- Crankcase Balance Vent Fitting:** 1/2-14 NPT.
- Mounting:** Accepts Murphy pipe mounting or universal mounting brackets.
- Lens:** Clear "Frog Eye" non-staining, high impact, high temperature nylon; UV and heat stabilized.
- Dial:** High visibility white background with green and white "index" lines for normal level indication.
- Test Knob:** Rotate to test switch operation. Turn clockwise for low level test and turn counterclockwise for high level test.
- Flow Rate Test:** Using SAE 30 @ 32°F (0°C).

Orifice Diameter	Pressure	Flow Rates
1/4 in. (6 mm)	4 ft. oil - 15 ft. oil (1.2 m oil - 4.6 m oil)	4.7 GPH - 31.0 GPH (17.8 LPH - 117.3 LPH)
1/8 in. (3 mm)	10 psig - 30 psig (68.9 kPa - 207 kPa) [.69 - 2.07 bar]	16.9 GPH - 32.1 GPH (63.7 LPH - 121.5 LPH)

*Standard
NOTE: Friction losses due to piping NOT considered.

Optional Hose Kit: 15000355

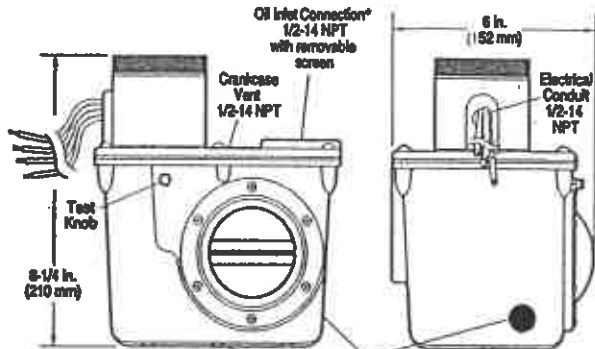
Quantity	Description
1	1/2 in. (13 mm) I.D. x 3 ft. (914 mm) long hose
1	1 in. (25 mm) I.D. x 3 ft. (914 mm) long hose
2	1/2 in. (13 mm) worm gear clamp
2	1 in. (25 mm) worm gear clamp
2	1/2 NPT x 1/2 in. (13 mm) barbed fitting
2	3/4 NPT x 1 in. (25 mm) barbed fitting

^{††} CSA certified with switch contacts rated at 10 A @ 250 VAC (standard).
^{**} Products covered by this bulletin comply with EMC Council directive 89/36/EEC regarding electromagnetic compatibility except as noted.

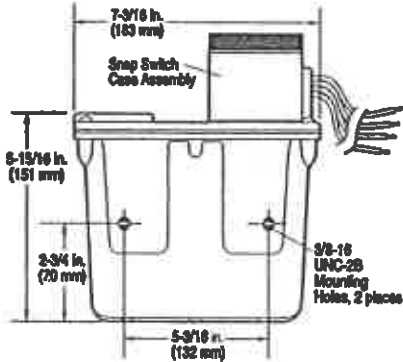
DIMENSIONS

LM300 Series Enclosures

The dimensions below are for the optional -EX model enclosure. The standard model enclosure dimensions are the same except the height and width which are: 7 in. (178 mm) H, 7-7/8 in. (200 mm) W.



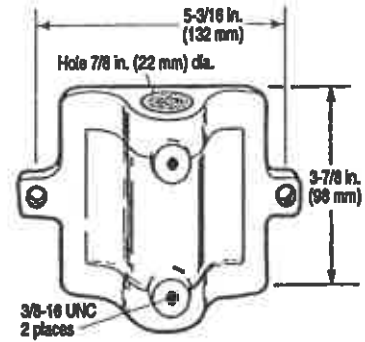
*Applies to level maintaining models only. Monitoring Port Connection 3 places, 3/4-14 NPT



Mounting Brackets with Hardware

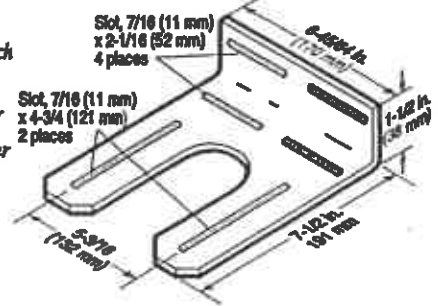
15000371 pipe bracket

Additional Hardware Supplied
 (4) 3/8-16 UNC x 1 inch (25 mm) screws
 (4) 3/8-16 nut
 (4) 3/8 I.D. lock washer
 (2) 3/8 I.D. flat washer



15000370 universal bracket

Additional Hardware Supplied
 (2) 3/8-16 UNC x 1 inch (25 mm) screws
 (4) 3/8 I.D. flat washer
 (2) 3/8 I.D. lock washer
 (2) 3/8-16 nut



TYPICAL INSTALLATION

Mounting (all LM300 Series models)

NOTE: Mount the LM300 series level maintainers as close as possible to the crankcase. Also, excessive vibration can cause overflow. Be sure mounting brackets are supported.

The following instructions are based on the usage of the pipe and universal mounting brackets shown above.

Pipe Bracket Mounting

1. Mount a nominal 1/2 inch (21 mm) diameter pipe to the deck of the engine.
2. Install the pipe bracket to the LM300 using two 3/8-16 UNC x 1 inch bolts supplied. See Figure 1A.
3. Slip the LM300 onto the pipe and install the two adjustment bolts. Each adjustment bolt consists of a 3/8-16 UNC x 1 inch bolt and two nuts. See Figure 1B. **DO NOT** tighten the adjustment screws too tightly because you will have to adjust the LM300 later in the installation process.

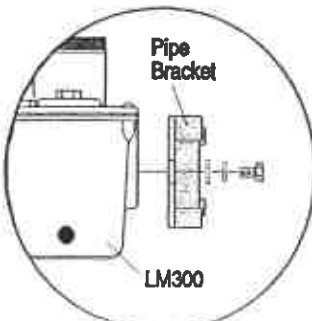


Figure 1A

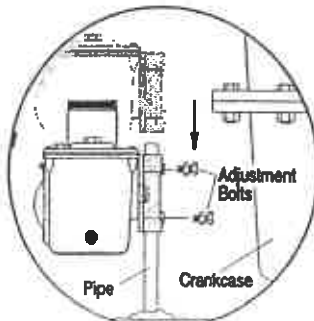


Figure 1B

Mounting with Universal Bracket

The universal bracket has two mounting methods: deck mounting and pan mounting.

Deck Mounting

1. Install the universal bracket to the deck as shown in Figure 2A with two flat washers and two 3/8 inch (10 mm) diameter bolts (not supplied).

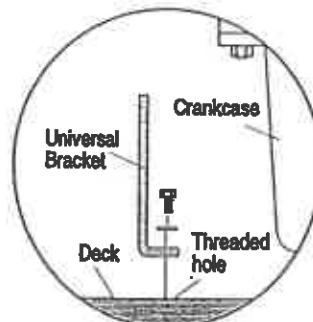


Figure 2A

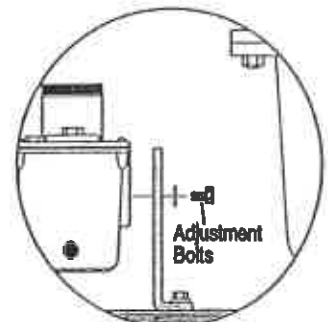


Figure 2B

2. Mount the LM300 to the universal bracket using two 3/8-16 UNC x 1 inch (25 mm) bolts supplied (Figure 2B). **DO NOT** tighten the adjustment screws too tightly. You will have to adjust the LM300 later in the installation process.

TYPICAL INSTALLATION continued

Crankcase (Oil Pan) Mounting

1. Install the universal bracket to the crankcase using the existing crankcase bolts (Figure 3A). Crankcase bolt diameter must be no larger than 7/16 inch (11 mm).

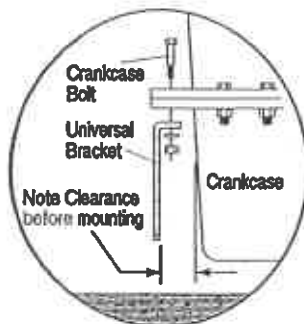


Figure 3A

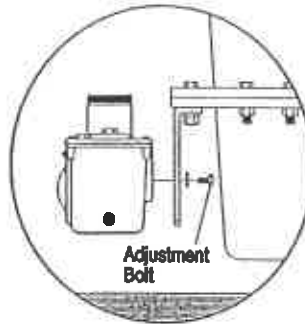


Figure 3B

NOTE: Check clearance between crankcase and mounting bracket before installing the mounting bracket. If space between the crankcase and mounting bracket does not allow installation and access to the adjustment bolts advance to Step 3.

2. Mount the LM300 to the universal bracket using two 3/8-16 UNC x 1 inch bolts supplied. **DO NOT** tighten the adjustment bolts too tight. You will have to adjust the LM300 later in the installation process.
3. If space between the crankcase and mounting bracket is narrow, install the universal mounting bracket to the LM300 before installing to the crankcase oil pan.

Connecting Fittings and Hoses

The following instructions are for all LM300 series level maintainers. All steps that reference oil inlet or oil supply tank **DO NOT** apply to non-level-maintaining models. Also, these instructions are based on the Murphy optional hose kit described on page 1. If you did not order the optional hose kit, gather the hoses, clamps and fittings as specified in the optional hose kit.

1. Install the LM300 fittings in their proper locations. **NOTE:** Apply a sealant such as teflon, to all threaded connections.
2. Attach the 1 inch (25 mm) diameter, flexible monitoring hose to the crankcase and the monitoring port on the LM300. See Figure 4. **CAUTION:** The hose must slope slightly downward from the LM300 and **MUST NOT** have any droop or low spots.

NOTE: If the drain plug on the crankcase is used for the connection, we recommend installation of a tee to allow draining of the crankcase for service.

3. Install the 1/2 inch (13 mm) I.D. x 3 ft. (914 mm) hose to the vent connection on the LM300 to the vent connection on the crankcase. See Figure 4.
4. The vent connection on the crankcase must be well above the regulated oil level. All hoses must be clear of obstructions.

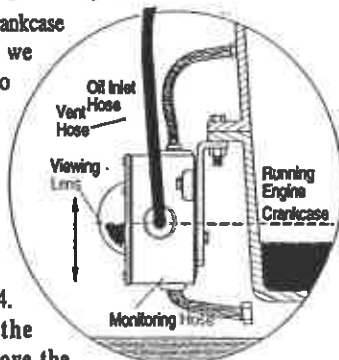


Figure 4

BEFORE CONTINUING, VERIFY THAT ALL HOSE CLAMPS ARE TIGHT.

4. Fill the crankcase to the proper oil levels. With the engine running and warm, loosen the mounting bracket adjustment bolts and adjust the LM300 so that the oil level in the sight gauge is aligned with the white "index line" on the dial (Figure 4). Tighten the adjustment bolts securely.

Connecting the LM300 to an Oil Supply Tank (level maintaining models only)

1. Remove the caplug from the oil inlet connection. Be sure the filter, inside the connection, is clear of debris. Install the oil inlet connection.
2. Connect a 1/2 inch I.D. (13 mm) or larger hose to oil inlet fitting on the LM300 and to the shutoff valve on the oil supply tank. See Figure 5. The hose must maintain a downward slope and not have low spots or droops. Maximum head pressure rating using standard 1/4 in. (6 mm) orifice is 15 ft. (4.6 meters). See Flow Rate test on page 1 for additional orifice pressure ratings.

3. Before filling the supply tank with oil, be sure the tank is clean and dry and the shutoff valve is closed. Also, be sure all hoses and clamps are tight. Fill the tank with **CLEAN** oil.

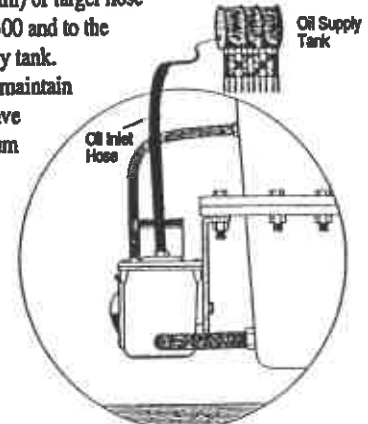


Figure 5

WARNING: Overfill condition can be caused by excessive inlet pressure, (maximum inlet pressure depends on orifice), and/or improper "vent to crankcase" installation. See Flow Rate Test on page 1 for maximum pressure.

4. After oil supply tank is full, open the shutoff valve.

Next, make the proper electrical connections for the application. See contact ratings on page 1 and schematics on page 4.

Switch Test (switch models only)

To test the shutdown and/or alarm functions perform the following:

1. Unscrew protective boot from test knob. **IMPORTANT:** Always replace boot after testing.
2. Turn the test knob 1/4 turn to the right (clockwise), for low test indication (Figure 6).
3. Turn the knob 1/4 turn to the left (counterclockwise), for high test indication. **DO NOT FORCE THE TEST KNOB TO TURN.**



Figure 6

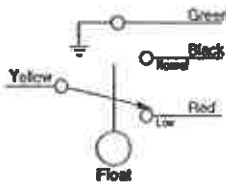
NOTE: After the engine shuts down, you will notice that the oil in the sight gauge glass will rise above normal running level, possibly showing an overfill condition. This is a result of "drain-back" to the engine crankcase and it is normal. Therefore, on models LM302 and LM303 it may be necessary to wire the high level shutdowns into a class "B" or "C" (bypass until first time safe) lockout, so as to allow a permissive start. After the engine is re-started the level will pull down to the normal running level and the shutdown features will be active. A modulating valve (Thumb-Valve™) in the level maintaining models will allow oil usage to be made-up continuously during operation.

SWITCH WIRING DIAGRAMS

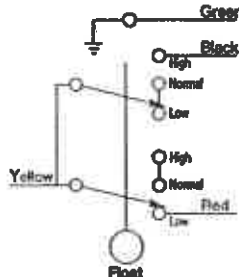


WARNING: DISCONNECT ALL ELECTRICAL POWER BEFORE CONNECTING ANY WIRES.

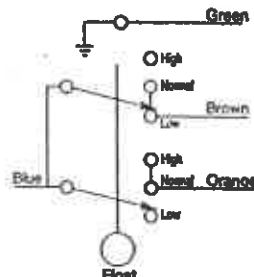
LM301
SPDT



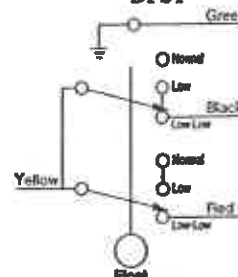
LM302
High/Low N.O.
DPST



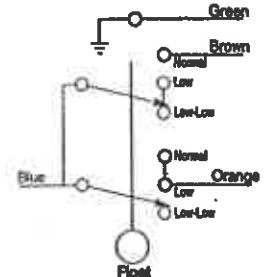
LM303
High/Low N.C.
DPST



LM304
Alarm before
shutdown N.O.
DPST



LM305
Alarm before
shutdown N.C.
DPST



OPERATING RANGES OF SWITCHES

This section applies only to models that have built-in switches. The illustrations below and to the right show the dials and their operating ranges of the switches. If levels are within the designated zones the switch(es) will activate. Notice that a switch is capable of activating approximately 3/8 in. (10 mm) from the top of the high zone and 3/8 in. (10 mm) from the bottom of the low zone. The dial in Figure 9 shows that if level continues to drop into the low-low zone, a shutdown will occur.

NOTE: Color zones on dial face show approximate normal operating zones. Actual conditions may vary depending upon operating characteristics of the engine. Placement of the LM300 according to the above instructions will compensate for these conditions.

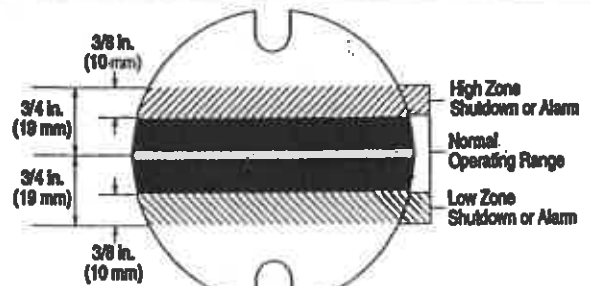


Figure 8: LM302/LM303

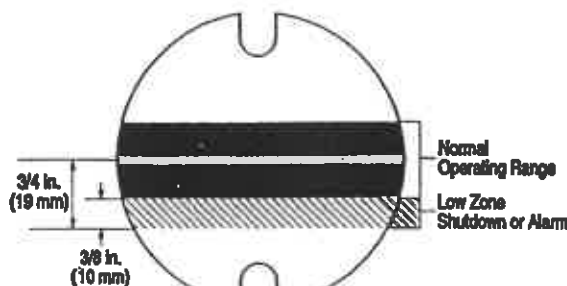


Figure 7: LM301

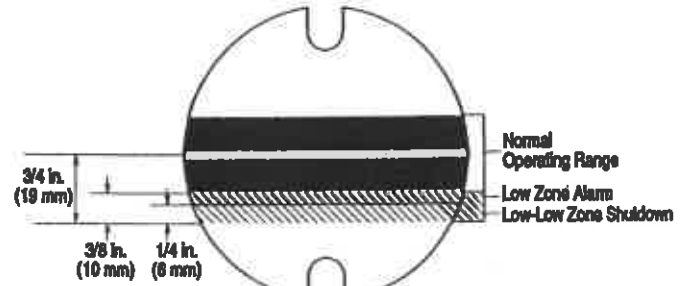


Figure 9: LM304/LM305

Warranty

A two-year limited warranty on materials and workmanship is given with this Murphy product. Details are available on request and are packed with each unit.



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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.

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Installation for L1100, L1200, L1200N Series Liquid Level Switches and DVU150, DVU175, and DVU2105/2115/2120 Series Dump Valves.

LDV-92151N
Revised 02-03
Section 15
(00-02-0175)



Please read the following instructions before installing. A visual inspection for damage during shipping is recommended before mounting.

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.
- ✓ OBSERVE all pressure and electrical ratings and requirements for the devices and the operating environment.
- ✓ BE SURE all pressure HAS BEEN REMOVED from the vessel before opening any pressure connections.

Description

Series L1100 and L1200 Liquid Level Switches are float activated to operate an electrical SPDT snap switch (optional DPDT on some models) for alarm or shutdown of an engine or electric motor. They screw directly into the wall of the vessel. Series L1200 can also be used with a weld collar or external float chamber.



Series L1200N is a float-activated, pneumatic-vent level device used to operate dump valves or similar devices. This model screws directly into the vessel or can be mounted via an external float chamber. It cannot be used with weld collar 15050375. Model variations include a dump valve operator with or without a filter/pressure regulator and indicating pressure gauge.

NOTE: All stainless steel versions of L1100, L1200, L1200N, L1200NDVO, and L1200NDVOR series carry Canadian Registration Number OF1476.2.

Series DVU150, DVU175, DVU2105/2115/2120 Dump Valves receive a pneumatic input signal to cause an orifice to open or close allowing liquid condensate to be drained from a pressure vessel. A pop up button indicates valve open/closed. Stainless steel versions available.

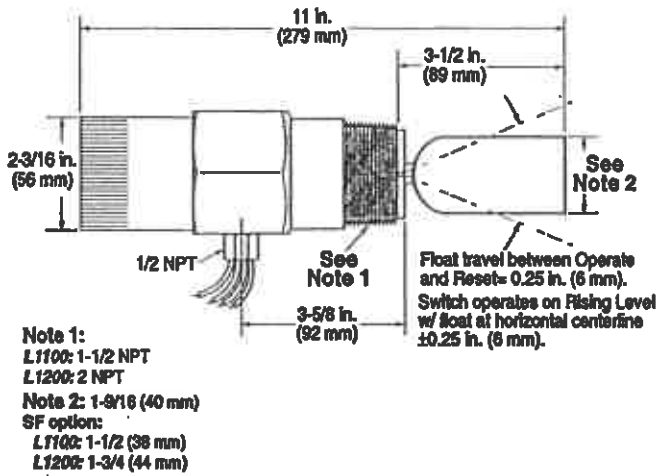
Specifications	L1100	L1111	L1150	L1200	L1250	L1200N	L1200NDVO	L1200NDVOR
Body								
• Standard: Electroless Nickel plated steel	x ^A	x ^A	x ^A	x ^B	x ^B	x ^B	x ^B	x ^B
• Optional: 316 Stainless Steel†	x ^A	x ^A	x ^A	x ^B	x ^B	x ^B	x ^B	x ^B
Pressure Rating								
• 15 psi (103 kPa) [1.03 bar] Polyethylene Float			x		x			
• 1500 psi (10.3 MPa) [103.42 bar] Stainless Float	x	x		x		x	x	x
• 2000 psi (13.8 MPa) [138 bar] BUOYGLAS™ Float	x	x		x		x	x	x
Temperature Rating								
• Standard: -20/175°F (-29/79°C)			x		x			
• Standard: -20/300°F (-29/149°C)	x	x		x		x	x	x
• Optional: -20/400°F (-29/204°C)*	x			x		x	x	x
Specific Gravity								
• Standard: 0.5 with BUOYGLAS™ float	x	x		x		x	x	x
• Optional: 0.65 with 304 Stainless Steel†	x			x		x	x	x
• Standard 0.73 Polyethylene Float			x		x			
Electrical								
• Standard SPDT: 5 A @ 125/480 VAC (see p. 3 for full ratings)	x	x	x	x	x			
• Optional DPDT: 10 A @ 250 VAC (see p. 3 for full ratings)	x	x	x	x	x			
Wire: 18 AWG x 36 in. (1.0 mm ² x 914 mm)	x	x	x	x	x			
O-Rings: Viton	x	x	x	x	x	x	x	x
Valve: Two-way snap-action vent type								
• 1/8 in. (3 mm) orifice w/Viton "A" seat								
• 1/8 NPT inlet; 1/4 NPT outlet						x	x	x
• 30-70 psi (207-483 kPa) [2.07-4.83 bar] operating pressure								
Dump Valve Operator: Operates Murphy DV Series dump valves or similar.							x	x
Pressure Regulator/Filter and Murphy 20BPG: 0-75 psi (0-517 kPa) [0-5.17 bar] pressure gauge. Maximum input 300 psi (2.07 MPa) [20.68 bar].								x
Operation: H=For high level, L=For low level	H	L	H	H	H	H	H	H

^A=1-1/2 NPT ^B=2 NPT [†]Meets NACE standard MR-01-75 for direct exposure to H₂S service. *Not available with DPDT snap-switch.

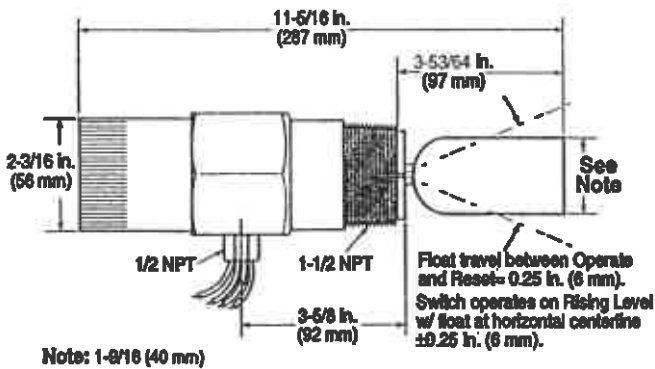
**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility.

DIMENSIONS

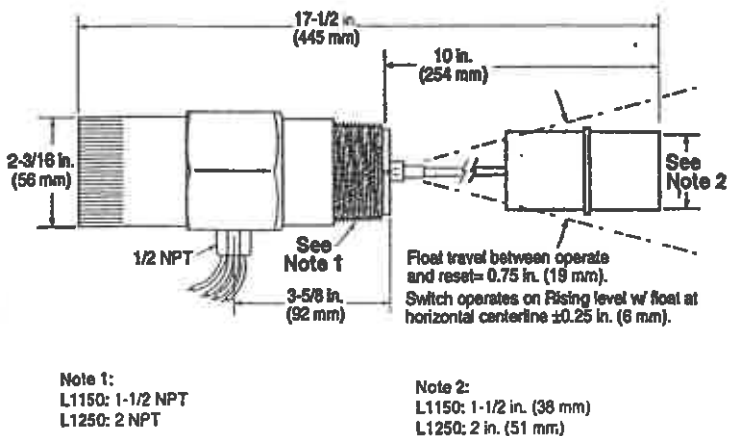
L1100 and L1200



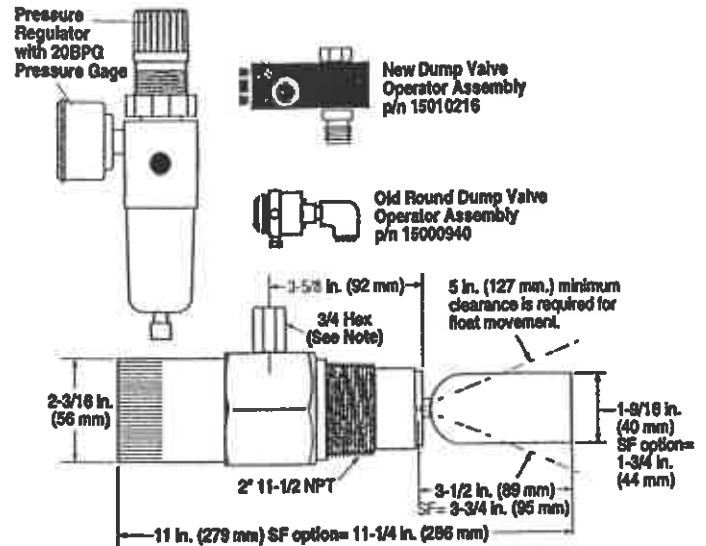
L1111



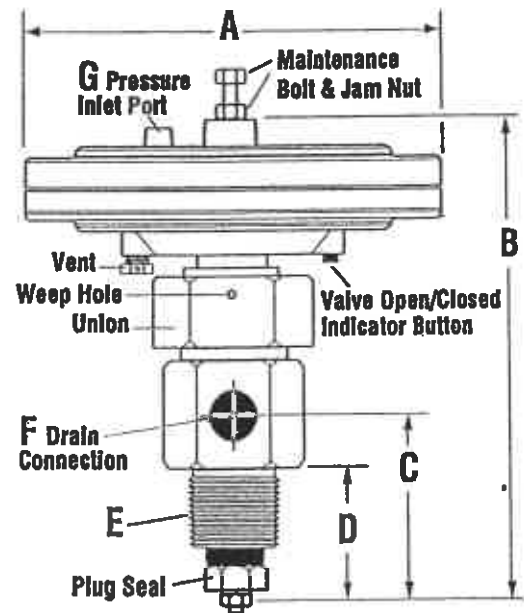
L1150 and L1250



L1200N, L1200NDVO and L1200NDVOR with Dump Valve Operator, Pressure Regulator and Gage



DVU150, DVU175, DVU2105/2115/2120 Series Dump Valves



	DVU150	DVU175	DVU2105	DVU2115	DVU2120
A	7.5 (191)	7.5 (191)	7.5 (191)	7.5 (191)	7.5 (191)
B	7.86 (200)	7.86 (200)	8.94 (227)	9.00 (229)	9.09 (231)
C	3.04 (77)	3.04 (77)	3.58 (91)	3.64 (92)	3.73 (95)
D	2.04 (52)	2.04 (52)	1.92 (49)	1.98 (50)	2.07 (53)
E	1-11.5 NPT	1-11.5 NPT	2-11.5 NPT	2-11.5 NPT	2-11.5 NPT
F	1/2-14 NPT	3/4-14 NPT	1-11.5 NPT	1-11.5 NPT	1-11.5 NPT
G	1/8-27 NPT	1/8-27 NPT	1/8-27 NPT	1/8-27 NPT	1/8-27 NPT

NOTE: Dimensions are in inches and (millimeters)

REPLACING AND INSTALLING THE DVOA ASSEMBLY

When replacing/installing the old style DVO assembly with the new style (DVOA), tubing and fitting modifications are required. We suggest removing the L1200NDVO/DVOR from the vessel. Relieve pressure from the vessel or use block valves before removing the L1200NDVO/DVOR.

Replacing and Installing the DVOA Assembly For Models L1200NDVO & L1200NDVOR

Tools Needed: Strap or pipe wrench; 3/4" Hex wrench; 9/16" hex wrench; needle nose pliers; tubing cutters and benders and the appropriate tools for the fittings.

1. Block off and bleed the instrument gas pressure supply to the L1200NDVO.
2. Remove the tubing between the L1200NDVO and the separator dump valve, and remove the supply gas tubing (regulator [-R] if used).
3. Remove the L1200NDVO from the vessel (optional).
4. If the L1200N was removed from the vessel, mount it in a suitable vise on a work bench (if possible).
5. Using the proper tools, disconnect the Inlet, Outlet and Exhaust fittings from the existing DVO (see fig. 1). You will re-connect these to the new DVOA in a later step.

NOTE: The following steps must be done with the DVO in the upright position (on top of the L1200N).

6. Remove the L1200N cover (this will aid with the alignment of the new DVOA Valve Bushing). The use of a strap wrench or a pipe wrench may be needed.
7. Insert the new Valve Bushing through the new DVOA (see fig. 2). The markings on top of the DVOA must be facing up. This will be needed in step 9.
8. With a 3/4" hex wrench loosen the existing DVO, valve stem, and static seal (see fig. 3). Once the assembly is loosened, **VERY CAREFULLY** use needle nose pliers to hold the Valve Seat Assembly in place. Remove the existing DVO making sure the Valve Seat Assembly inside the L1200NDVO is aligned and straight (see fig. 4).



CAUTION: MAKE SURE the Valve Seat Assembly inside the L1200N remains in place after removing the DVO.

9. Holding the Seat Assembly up with the needle nose pliers inside the L1200NDVO body, place the tip of the new DVOA valve bushing through the spring and into the hole in the center of the valve seat, and tighten the valve bushing. The Valve Seat Assembly should be able to move freely up and down after the bushing has been tighten. The DVO red button must face away from the vessel.
10. With the new DVOA aligned over the hex on the L1200NDVO body, tighten the Valve Bushing using the 9/16" hex wrench. You may need to hold the DVOA while tightening the Valve Bushing to keep it from rotating (see fig. 5).
11. If the L1200N is in the vise, operate the float and inspect for smooth and proper operation of the Valve Seat Assembly.
12. Replace the L1200NDVO cover (see fig. 6).
13. Using the appropriate tools re-install the Inlet, the Outlet and the Exhaust fittings to the new DVOA (see fig. 5).
14. If the L1200N was removed from the vessel re-install it at this time.
15. Modify existing or install new tubing to connect the Inlet, the Outlet and Exhaust fittings.

NOTE: Clean, dry instrument quality gas should be used. Use of filters will improve service life and reliability.

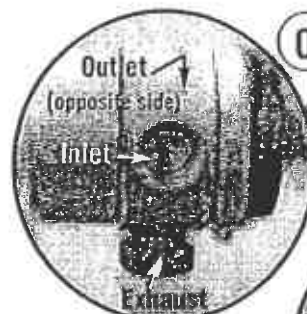


Figure 1



Figure 2

New DVOA



Figure 3



Figure 4

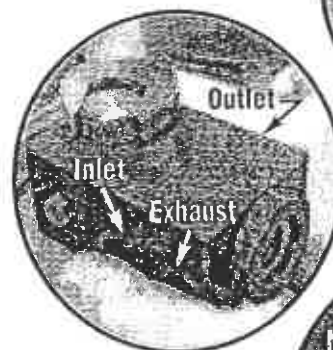


Figure 5

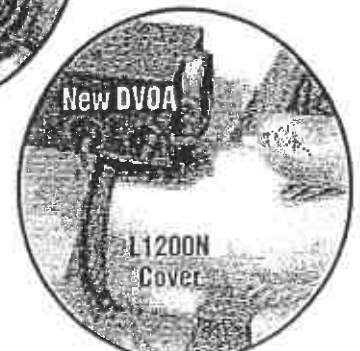
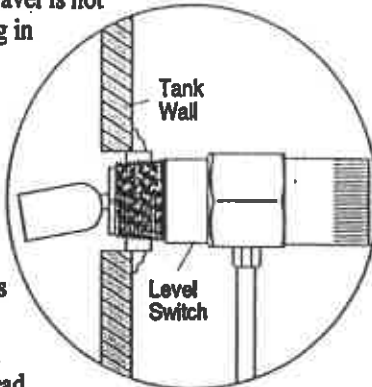


Figure 6

PRESSURE VESSEL INSTALLATION: L1100, L1200, and L1200N

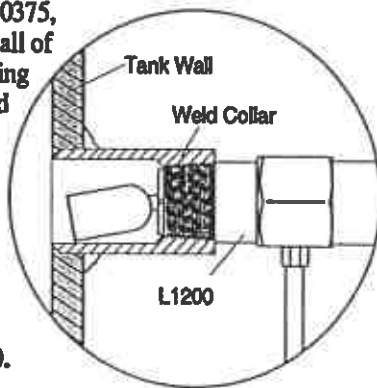
Direct Installation into the Wall of the Pressure Vessel

1. Determine that the float travel is not obstructed by the coupling in the vessel wall, internal baffles, etc.
Do NOT use more than one arm extension P/N 15050395.
2. BE SURE that the float and extension are tight and that the lock washer is in place.
3. Before installing the level switch a suitable pipe thread sealant is recommended. Screw the unit directly into the threaded connection in the wall of the pressure vessel.
4. Be sure that the electrical connection is positioned at the bottom. For L1200N the 1/8 NPT pneumatic connection should be on top (the 1/4 NPT vent connection should be on the bottom). See "Pneumatic models" section for further instructions for the L1200N.
5. Make the electrical wiring connections according to appropriate wiring diagrams for the alarm or shutdown system to be used. The electrical connection is 1/2-14 NPT.
6. BE SURE all electrical connections are insulated and the cover is fully installed before reconnecting electrical power.
7. BE SURE all pressure connections are tight before pressurizing the system.



Installation with a Weld Collar

1. The weld collar, P/N 15050375, must be welded into the wall of the pressure vessel according to code standards and good welding practices.
2. Follow above instructions for installation directly into the wall of the pressure vessel.
3. NOTE: Weld collar 15050375 can be used ONLY with model L1200.



Installation Using External Float Chamber 15051098

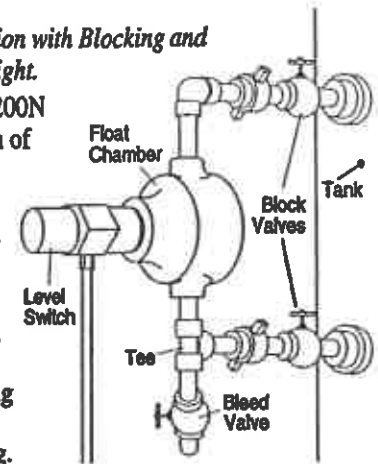
CAUTION: USE "NON SPARKING TOOLING".

1. Install the float chamber 15051098 on the outside wall of the pressure vessel using 1 NPT piping. Position the 2 NPT threaded connection at the height where you want the level switch to operate. The 2 NPT threaded connection must be positioned away from the tank wall.

2. A tee is typically installed at the bottom of the lower 1 inch pipe riser to allow draining of the float chamber for servicing or replacement.

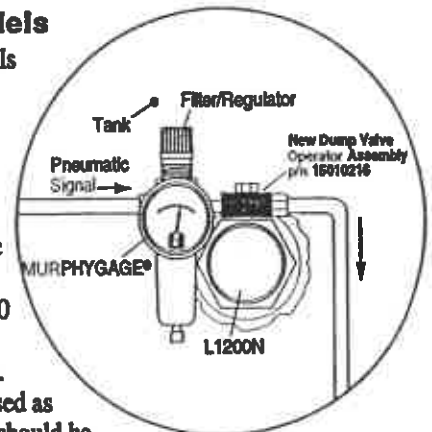
NOTE: A typical installation with Blocking and Bleed valves is shown at right.

3. Install the L1200 or L1200N in the 2 NPT connection of the float chamber. BE SURE float travel is not restricted and that the float is tight onto the float shaft.
4. To complete installation and wiring, follow the instructions for mounting directly into wall of the vessel and for wiring.



Pneumatic Models

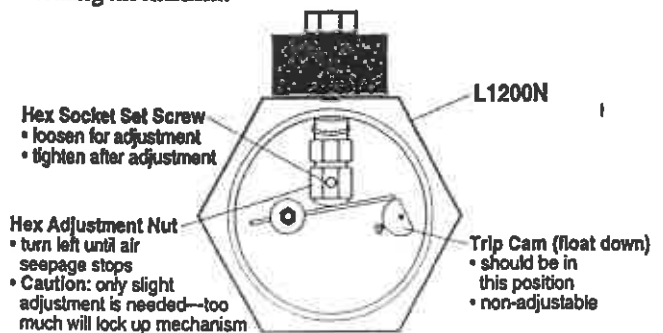
1. All pneumatic models operate on the vent principle. The pneumatic signal source MUST BE CLEAN AND DRY. The input pneumatic signal must be regulated between 30 and 70 psi (207-483 kPa) [2.07-4.83 bar].



If produced gas is used as the signal source, it should be taken after gas passes through the final scrubber. A suitable filter must be positioned before the L1200NDVO to prevent liquids and/or particulates from entering the dump valve operator.

NOTE: Check filter periodically for wear and tear and elements that hamper the flow of the pneumatic signal.

2. All pressure connections must be tight and maintained tight so as not to leak air/gas.
3. Valve seat adjustment can be made if air/gas begins to leak. Care should be taken when adjusting as only slight movement is necessary to stop the leakage; excessive force will bind the seating mechanism.



TYPICAL INSTALLATION ON GAS COMPRESSORS

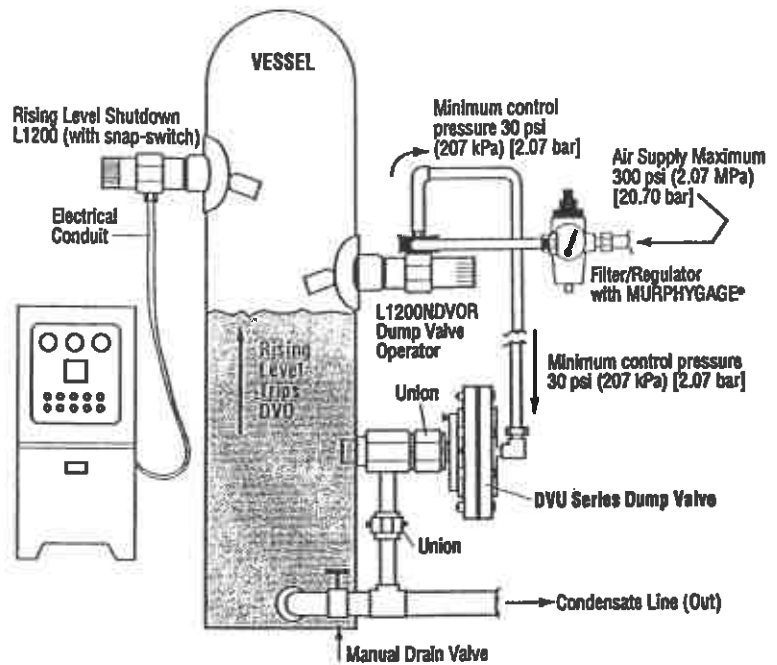
Basic Operation

As condensate rises in the scrubber, the float on the L1200NDVOR rises and trips its pneumatic valve. The valve opens allowing pressure to enter the dump valve pilot chamber. Once the pressure enters the pilot chamber it forces the diaphragm and valve stem forward thus opening the valve seat (valve open/closed indicator button pops out) and releasing condensate through the valve stem and out the drain. As the condensate level drops, the L1200NDVOR pneumatic valve closes to shut off the pressure to the dump valve causing it to close.

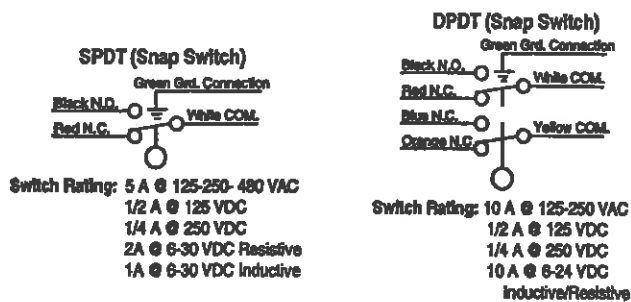
If for any reason the condensate continues to rise beyond normal dump levels, model L1200 operates the alarm and/or shuts down the equipment.

The L1200NDVOR Filter/Regulator and the MURPHYGAGE® help keep the control pressure clean and dry. They also allow the operator to adjust pressure to recommended levels.

Typical/Scrubber/Separators



ELECTRICAL INFORMATION



REPLACEMENT PARTS

Order by part number designation.

L1100/L1200*

- 15000893: BUOYGLAS™ float
- 15000894: Stainless Steel float for L1200
- 15000937: Stainless Steel float for L1100
- 15000124: SPDT snap switch assembly
- 15010213: L1100 counter balance assembly
- 15010214: L1200 counter balance assembly

L1200N

- 15050420: Cam spring return
- 15050421: Cam
- 15000893: BUOYGLAS™ float
- 15000894: Stainless Steel float for L1200N
- 15050453: Valve stem
- 15010189: Counter balance assembly

L1200NDVO and L1200NDVOR

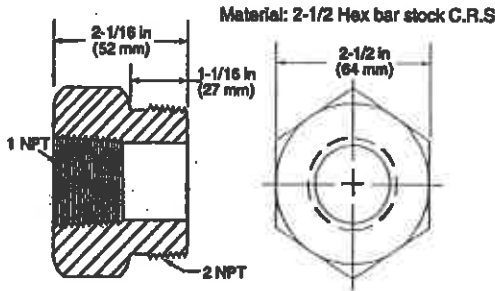
- 55050621: Regulator only
- 05706499: 20BPG-D-75 Pressure MURPHYGAGE®
0-75 psi (517 kPa) [5.17 bar]
- 15010216: DVOA assembly (New rectangular style)
- 15000940: DVO assembly (Old round style)

*To maintain hazardous location listings, all other repairs must be made by the factory.

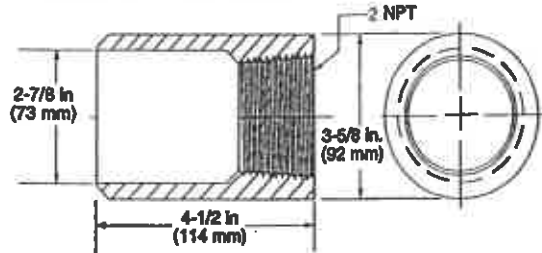
ACCESSORIES

Order by part number designation.

55050617: DVU150/DVU175 Adapter Bushing

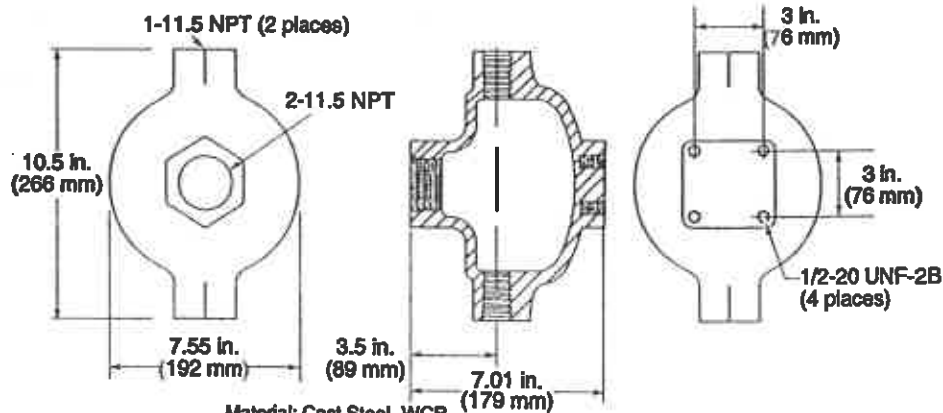


15050375: Weld Collar



Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
Operating Temperature: 400°F (204°C).

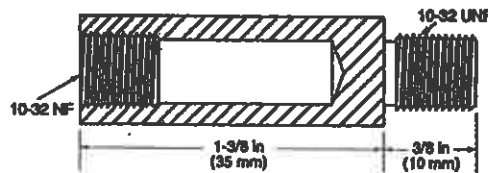
15051098: External Float Chamber



Material: Cast Steel, WCB

Operating Pressure: 2000 psi (13.8 MPa) [138 bar].
Operating Temperature: 400°F (204°C).

15000892: Float Shaft Extension



Warranty

A two-year limited warranty on materials and workmanship is given with this Murphy product.
Details are available on request and are packed with each unit.



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M2582, M5081, and M5180 Series Electromechanical and Pneumatic, Fuel Gas Shut- off Valves Installation and Operation Instructions



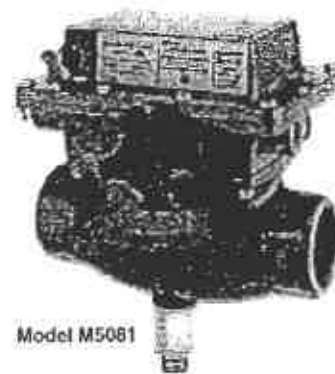
Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit and make sure installation conforms with NEC and local codes.

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 M5081



M2582 and M5081 Series

Tripping Power From Engine Ignition System or Battery (Models available for magneto, CD ignition or 12/24 V battery)

These fuel shut-off valves are semi-automatic devices for shutdown of natural gas fueled engines. The standard valve opens by manual operation of the reset handle. A latch in the upper body of the valve will set and hold the valve open. At this point no electric power is used. The electromagnetic coil is de-energized, the snap-switch(es) is SET.

If a SWITCHGAGE® contact closes, a circuit is completed from power through the snap-switch and coil. Now energized, the electromagnet trips the latch, (latch can be tripped manually), the valve closes, and the snap-switch resets. Power switches from the coil circuit to your choice of an open line, an electrical ground, or an alarm. After tripping, the vent seal opens, and on the M50 models, the open/close indicator (green button) retracts to indicate that the valve is closed.

Valve body is sandcast aluminum. Optional cast steel for M5081 models.

M2582-P and M5180-P

MURPHY-NUMATIC™ Pneumatic Version for Pressure

The M2582-P and M5180 pneumatically controlled valves can operate from pressure, and are designed to open and close automatically or semi-automatically (the supply can be air, oil or gas).

NOTE: If using oil as a pressure source, use a lightweight oil.

These valves will open on rising control pressure and close on decreasing control pressure. M2582-P and M5180-P automatically open at 2 psi (14 kPa) [0.14 bar] and fully open at 3 psi (21 kPa) [0.21 bar].

All models include a built-in lever to aid in opening the valve manually. The M2582-P can be manually opened against inlet pressure of 80 psi (552 kPa) [5.52 bar]. The M5180-P valve can be opened against inlet pressure of 100 psi (689 kPa) [6.89 bar].

Standard models include an escape vent for gas trapped forward in the line after shut-off.

M5081FS

Normally Energized Circuit

The M5081FS is manually opened, electrically latched open and tripped by interrupting the coil power circuit.

Magnetic Switch Adapter

As ignition systems wear from usage, their power output becomes less and less. Ignition may not have the capacity to reliably trip the Fuel Valve. Therefore, the use of a Magnetic Switch Adapter for CD ignition systems is recommended. The Magnetic Switch Adapter is a device that stores energy from the CD ignition to trip the Fuel Valve.

Three models are available:

65700053 (was 65020126): For use with negative ground ignitions up to 240 VDC.

65700054 (was 65020127): For use with positive ground ignitions up to 450 VDC.

65700055 (was 65020155): For use with negative ground ignitions up to 450 VDC.

100 ohm, 2 watt Resistor

For Capacitor Discharge Ignitions that are specified to be grounded when the valve closes, and a Magnetic Switch Adapter is in use. The resistor must be connected in the system to prevent damage to the snap-switches in the fuel shut-off valve (see typical wiring diagrams).

Diode Package

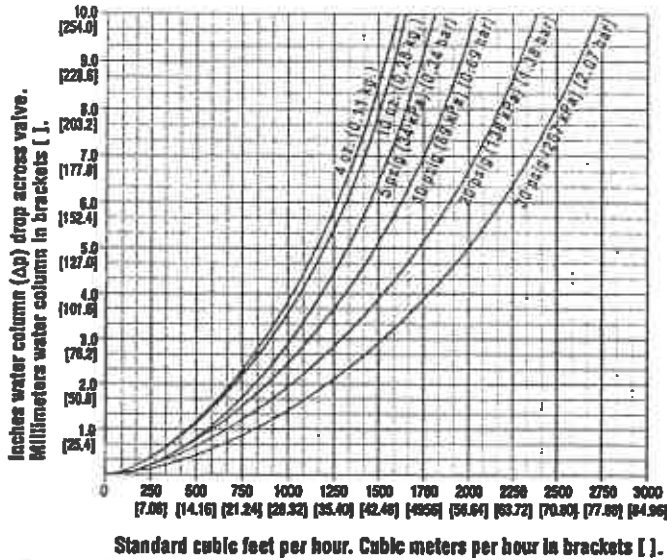
The Murphy diode package (65010065) is designed to allow the fuel shut-off valve to be used with dual Magneto Ignition systems.

NOTE: All aluminum versions of the M5081 Series Fuel Valve carry Canadian Registration Number OC1476.2.

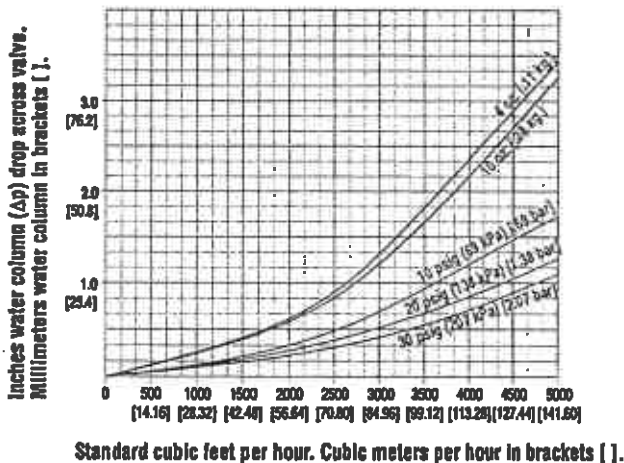
* M5081 model is CSA approved for Class I, Division I, Groups C and D. See Specifications on page 12.

FLOW CHARACTERISTICS

M2582 Series



M5081 and M5180 Series



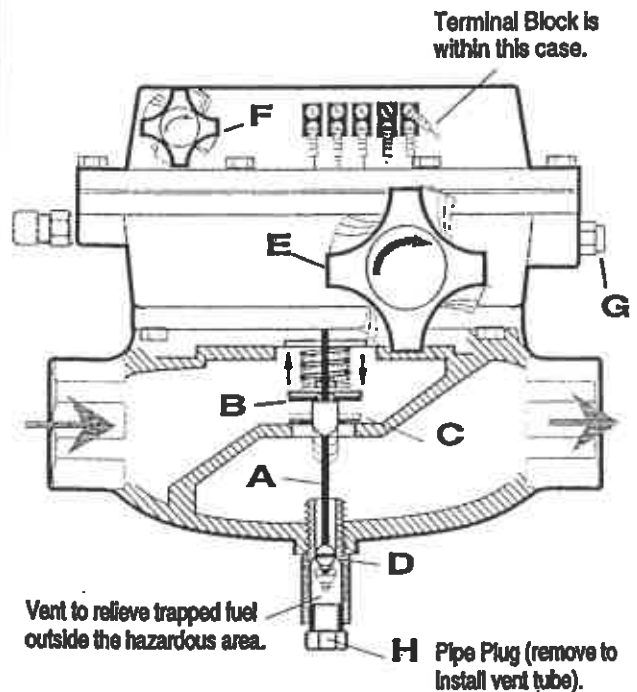
VALVE CUT-OUT

Understanding the Basic Operation of the Fuel Shut-off Valve

The valve below is shown in the run (open) position. Pressure is equalized, seat (B) is open, allowing the fuel to flow. When valve is in the tripped position (closed), seat closes (C).

The vent (D) opens to relieve trapped downstream fuel to vent to a non-hazardous area.

TYPICAL MODEL (M5081) SHOWN



- A. Main Stem
- B. Pressure Disc/seal (in run/open)
- C. Pressure Disc/seal (in trip/closed)
- D. Vent Seal Gland
- E. Reset Knob (latches valve open)
- F. Manual Trip Knob (not available for M5081FS)
- G. Indicator Button (out with valve open)
- H. Pipe Plug

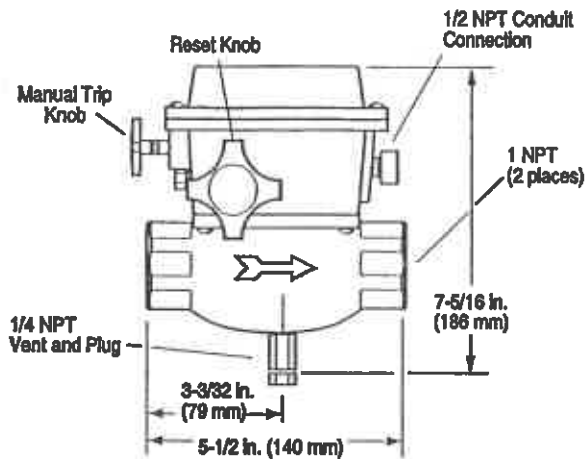
NOTE: If the vent-after-tripping feature is not used, remove O-ring (D), to avoid condensation accumulation that can hamper trip action. Be sure to replace Pipe Plug (H) and to clean vent periodically.

DIMENSIONS

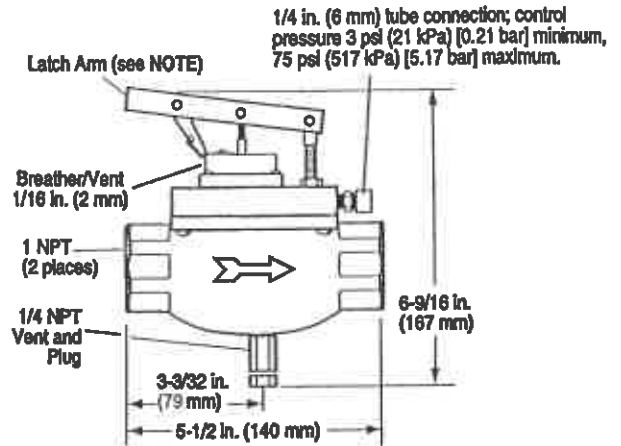


CAUTION: THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE ONLY TO FUEL PIPE, NOT TO THE FUEL VALVE.

M2582

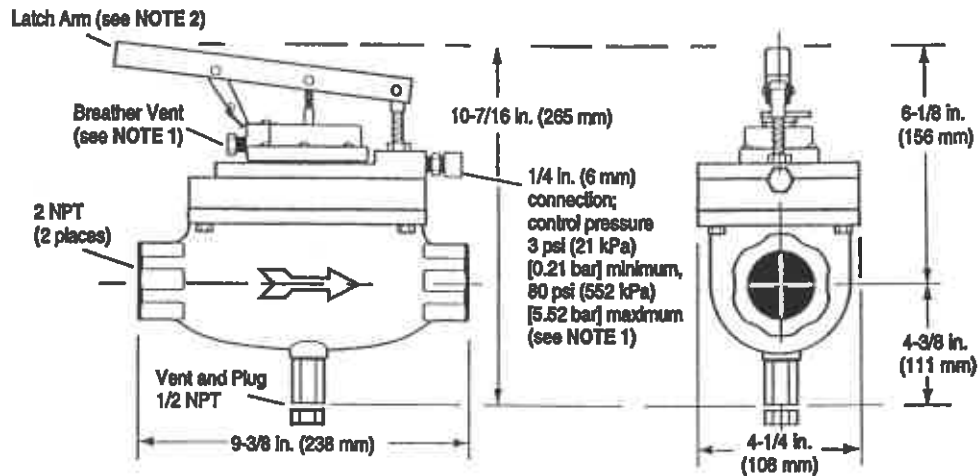


M2582-P



NOTE: Thumb operated opening latch (2.5 psi [17 kPa] [0.17 bar] required to release cocking latch)

M5180-P

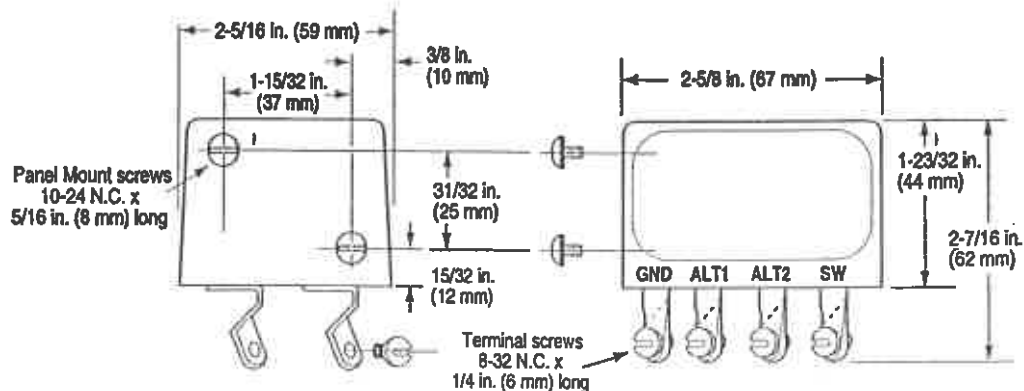


NOTE 1: Control pressure connection fitting and breather vent fitting can be swapped to convert to vacuum control.

NOTE 2: Thumb operated opening latch (2.5 psi [17 kPa] [0.17 bar] required to release cocking latch).

Magnetic Switch Adapters

65700053 (was 65020126); **65700054** (was 65020127); **65700055** (was 65020155)

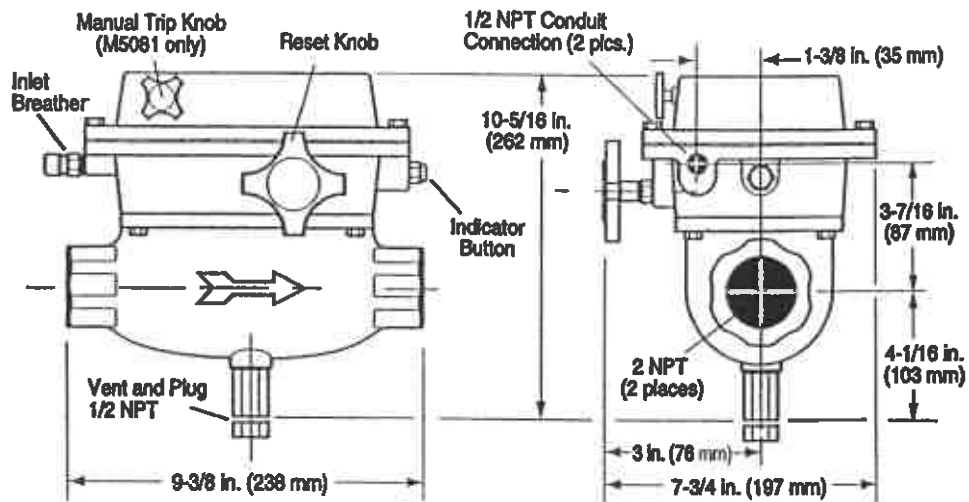


DIMENSIONS *continued*

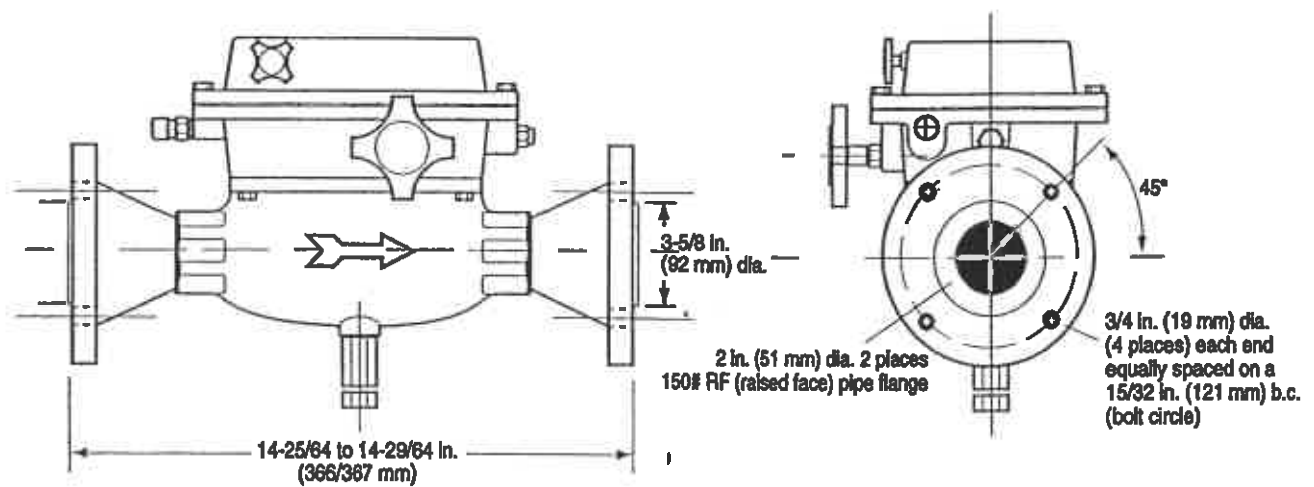


CAUTION: THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE ONLY TO FUEL PIPE, NOT TO THE FUEL VALVE.

M5081 and M5081FS



M5081-3 Steel Flanged Option



INSTALLATION



WARNING: STOP THE ENGINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION. BEGIN THE INSTALLATION BY SECURING AREA OF ANY HAZARDOUS CONDITIONS. SHUTOFF THE FUEL GAS SUPPLY. FOR HAZARDOUS APPLICATIONS REFER TO NATIONAL ELECTRICAL CODE SPECIFICATIONS.

Connecting the Fuel Shut-off Valve

1. Before connecting the unit, apply pipe dope to plumbing male threads that will be inserted into the valve. Do not apply pipe dope to the valve.
2. Make sure that the arrow on the side of the valve indicates the correct direction of the flow.
3. Fuel shut-off valves can be installed in all three planes. However, mounting the valve horizontally (with vent pointing down) is recommended. Do not install valve with top down. (Refer to Figure 1.)
4. Hold valve in position, (use a tool on valve wrench flats) and tighten plumbing into inlet and outlet ends. (Refer to dimensions on pages 3-4.)



CAUTION: DO NOT TWIST THE VALVE BODY HOUSING.

5. To mount flanged models, follow the appropriate installation codes and ordinances for the application. (For dimensions see page 4.)
6. A vent line (to allow gas trapped forward between fuel valve and the carburetor to escape) should be attached to the vent connection at the bottom of the valve housing. Remove the plug and install the line. (Refer to Figure 1.)

Connecting Pneumatic Models M2582-P and M5180-P

1. Repeat the steps above (1 thru 5), and observe the necessary cautions.
2. A lever/arm (handle) and a cocking latch are provided to allow manual opening of the valve. The thumb-operated latch can be locked in place to hold the lever/arm latched. The cocking latch will be released when pilot pressure reaches 2.5 psi (17 kPa) [0.17 bar]. M2582-P and M5180-P automatically open at 2 psi (14 kPa) [0.14 bar], and fully open at 3 psi (21 kPa) [0.21 bar]. See Specifications, page 12 for maximum control pressure.



CAUTION: BE SURE PNEUMATIC SOURCE RELEASES THE MECHANICAL LATCH WHEN RUNNING.

3. If vacuum control is desired, swap the Control Pressure connection fitting and the Breather Vent fitting on your M5180-P model (see Fig. 2).

Figure 1
Physical Location and Plumbing (typical)

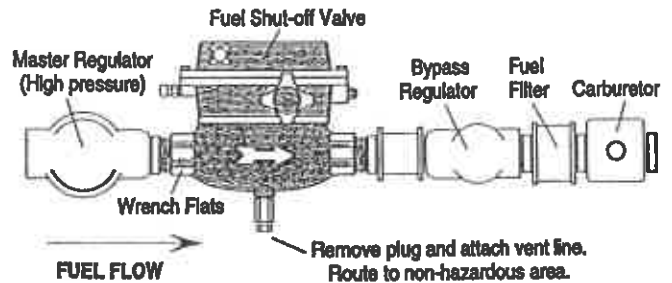
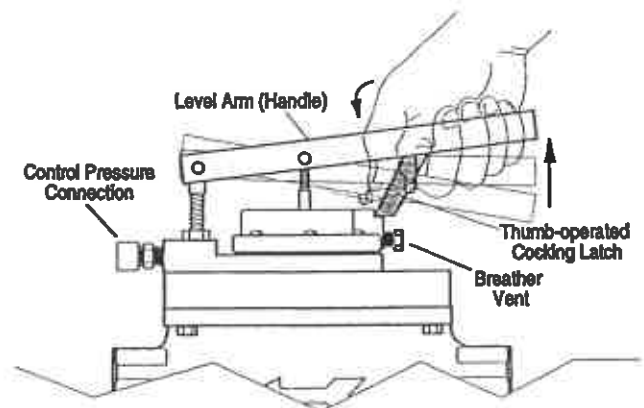


Figure 2
Pull the lever up, and press the latch down into ridge with thumb.



WIRING INFORMATION



WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

M2582 Internal Wiring

Wiring shown in normal mode of operation (seat open). The 20 AWG (0.75 mm²) wire is color coded to the coil:

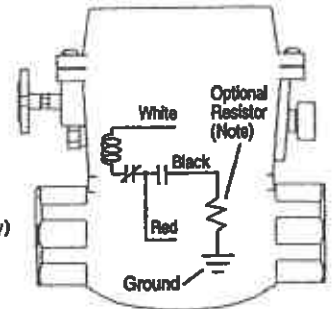
- For CD ignitions: White and Orange
- For Magneto ignitions: White and Green
- For Battery: White and Blue

Conduit Installation

Install a 1/2 NPT conduit from the M2582 conduit connection to the power source. See M2582 Dimensions (page 3) for location.

For wiring the M2582 fuel valve to Solid-State TATTLETALE[®] annunciators, refer to pages 9, 10, and 11.

Internal Wiring for M2582



NOTE:

For grounding the ignition (CD models only) through the fuel valve snap-switch, use a Magnetic Switch Adapter (see Magnetic Switch Adapter, below) and install a 100 ohm; 2 watt resistor (included on page 11).

M5081 Internal Wiring

Wiring shown in normal mode of operation (seat open). The 18 AWG (1.0 mm²) wire is color coded to the coil:

- For CD Ignitions: White and Orange
- For Magneto Ignitions: White and Green
- For Battery: White and Blue

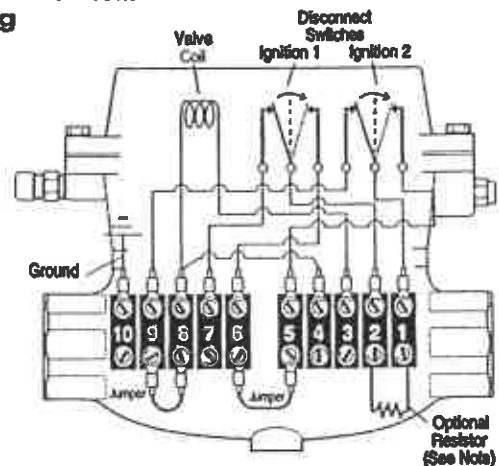
Conduit Installation

Install a 1/2 NPT conduit from the M5081 conduit connection to the power source. Refer to Dimensions (on page 4) for location.

For typical wiring of the M5081 models refer to pages 7 and 8.

For wiring the M5081 fuel valves to Solid-State TATTLETALE[®] annunciators, refer to pages 9, 10, and 11.

M5081 Internal Wiring



NOTE: For grounding the ignition (CD models only) through the fuel valve snap-switches, use a Magnetic Switch Adapter, see Magnetic Switch Adapter, below and the "TO CLOSE THE FUEL VALVE and GROUND THE IGNITION" attachment, and install a 100 ohm; 2 watt resistor (included with your attachment).

M2582-C-LS Wiring



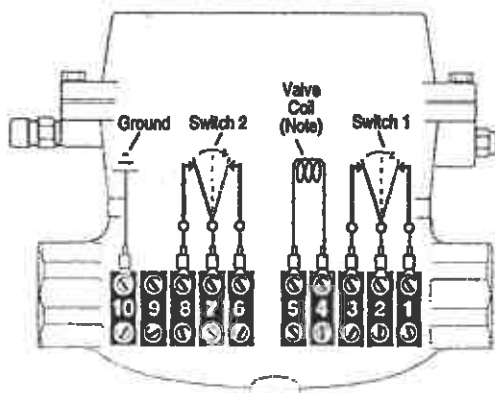
M5081-C-LS Wiring



M5081FS Internal Wiring

For typical Wiring refer to page 8.

For wiring the M5081FS to MARK IV 12/24 refer to page 10.



NOTE: Wiring shown in normal mode of operation (seat open). The 18 AWG (1.0 mm²) wire is red color for both options; 12 VDC and 24 VDC.

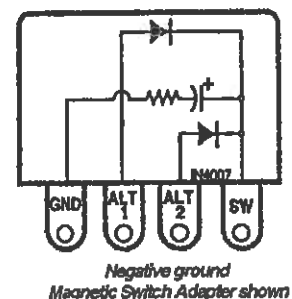
Magnetic Switch Adapters for Use with Capacitor Discharge Ignitions

Connect the Magnetic Switch Adapter between the fuel Valve terminal 1 and the CD Ignition. See wiring diagrams (pages 7 and 11).

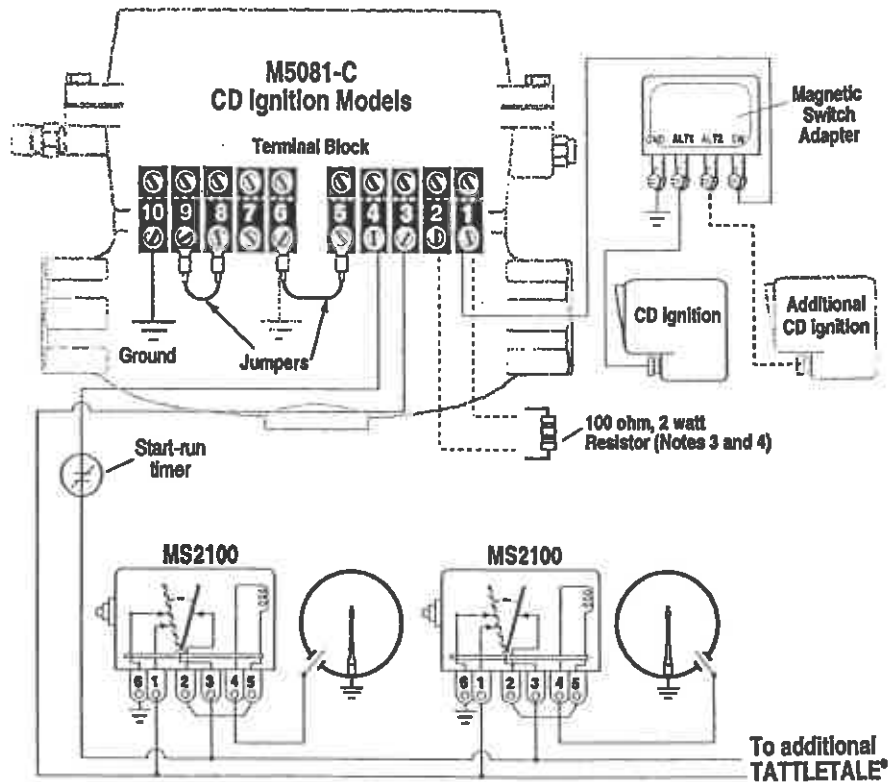
65700053 (was 65020126): For use with negative ground ignitions up to 240 VDC.

65700054 (was 65020127): For use with positive ground ignitions up to 450 VDC.

65700055 (was 65020155): For use with negative ground ignitions up to 450 VDC.

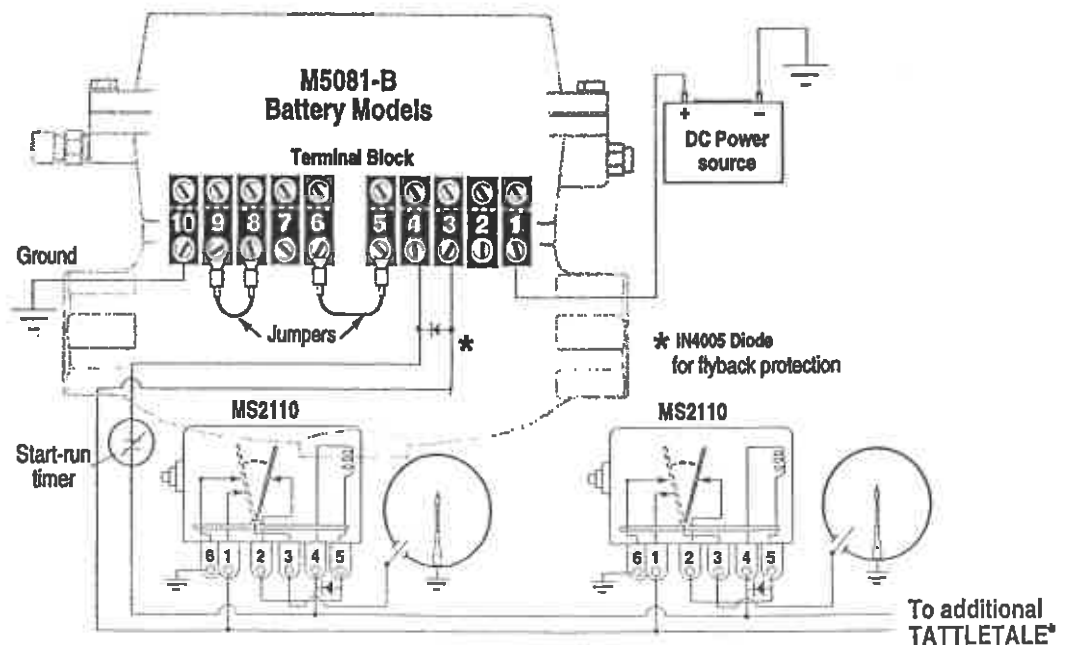


TYPICAL WIRING for M5081-C (CD IGNITION MODELS)

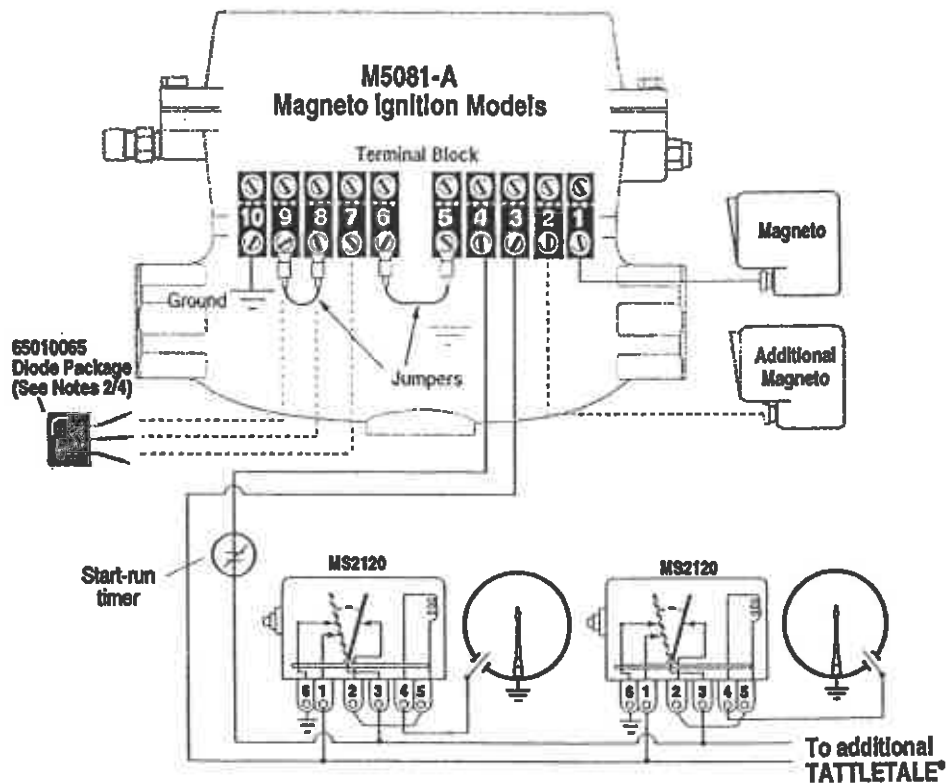


- NOTE 1:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single CD Ignition Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 6.
- NOTE 2:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual CD Ignition Systems) Remove the jumper on terminals 6-5. Connect second ignition to Magnetic Switch Adapter terminal ALT2.
- NOTE 3:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Single CD Ignition Systems) Remove the jumper on terminals 6-5. Connect a 100 ohm, 2 watt resistor between valve terminals 1-2. Ground terminal 6.
- NOTE 4:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Dual CD Ignition Systems) Remove the jumper on terminals 6-5. Connect a 100 ohm, 2 watt resistor between valve terminals 1-2. Ground terminal 6. Connect second ignition to Magnetic Switch Adapter terminal ALT2.

TYPICAL WIRING for M5081-B (BATTERY IGNITION MODELS)



TYPICAL WIRING for M5081-A (MAGNETO IGNITION MODELS)



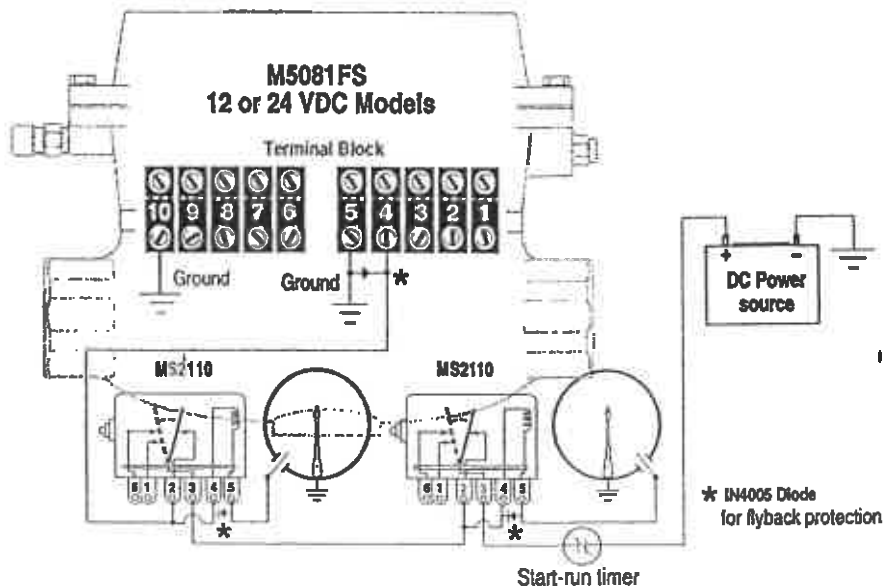
NOTE 1: To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single Magneto Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 5.

NOTE 2: To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual Magneto Systems) Remove the factory-installed jumpers on terminals 6-5 and 9-8. Add 65010065 diode package as shown. Do NOT ground terminals.

NOTE 3: To CLOSE FUEL VALVE and GROUND THE IGNITION (Single Magneto Systems) The factory-installed jumpers (6-5 and 9-8) must be in place. Add ground wire to terminal 5.

NOTE 4: To CLOSE FUEL VALVE and GROUND THE IGNITION (Dual Magneto Systems) Remove the jumper on terminals 9-8. Add 65010065 diode package as shown. Add ground wire to terminal 5.

TYPICAL WIRING for M5081FS (NORMALLY ENERGIZED MODELS)



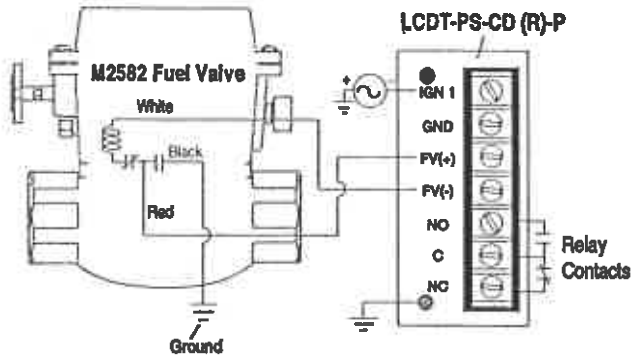
* IN4005 Diode for flyback protection

TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators

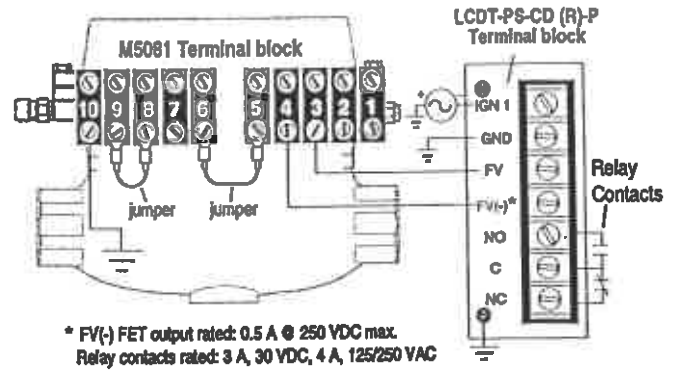


WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

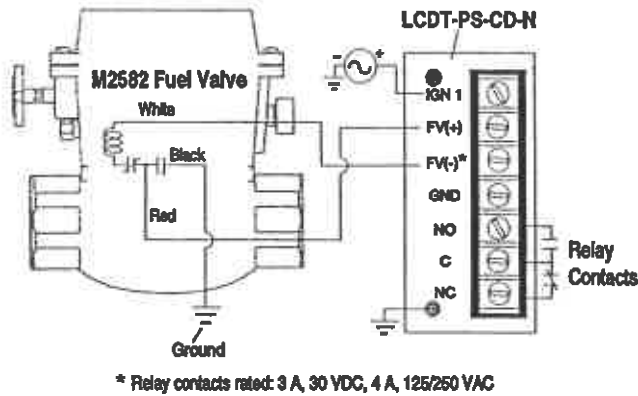
M2582-C to LCDT-PS-CD (R)-P (positive ground)



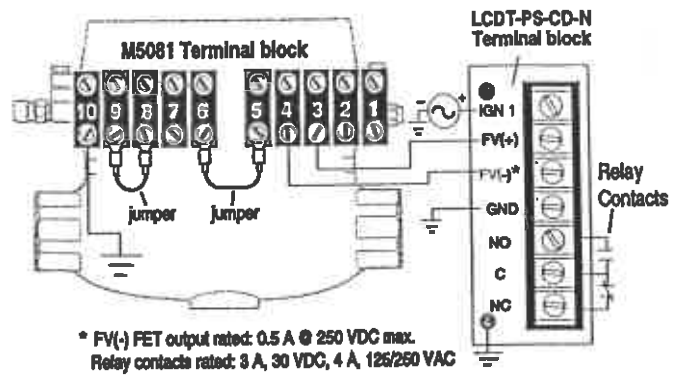
M5081-C to LCDT-PS-CD (R)-P (positive ground)



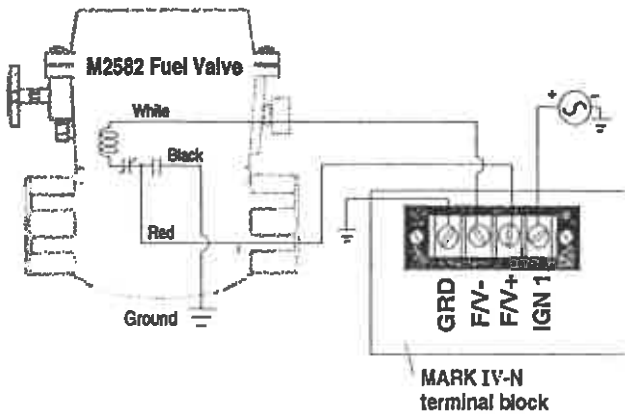
M2582-C to LCDT-PS-CD-N (negative ground)



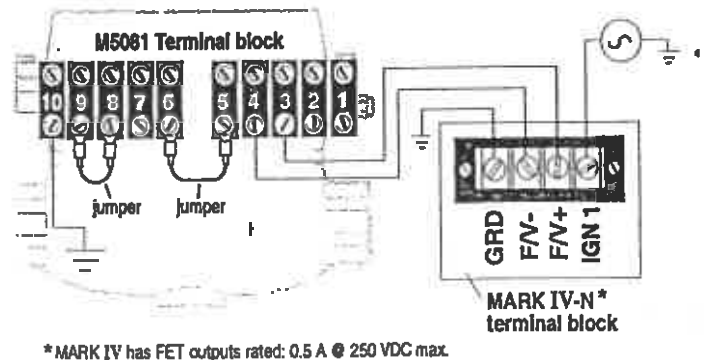
M5081-C to LCDT-PS-CD-N (negative ground)



M2582-C to MARK IV-N (negative ground)



M5081-C to MARK IV-N (negative ground)

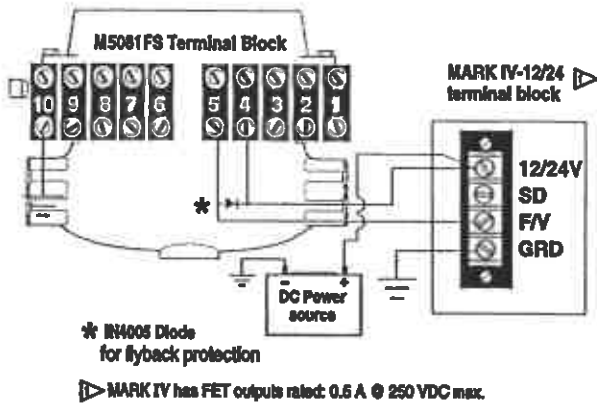


TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators

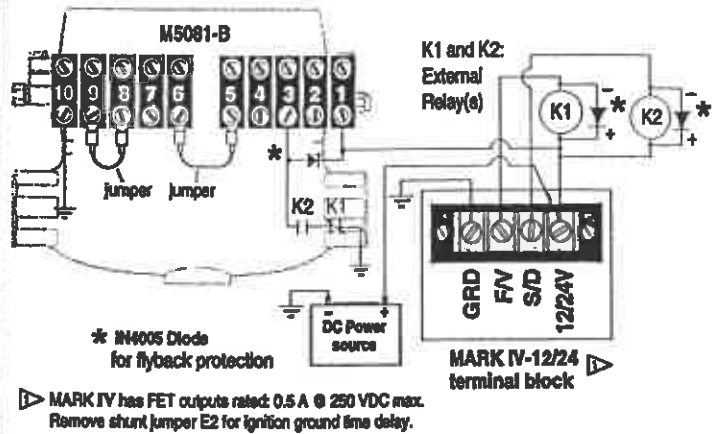


WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

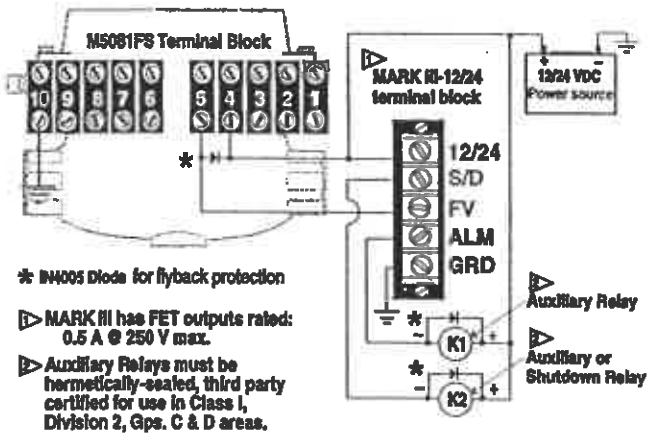
M5081 FS to MARK IV-12/24



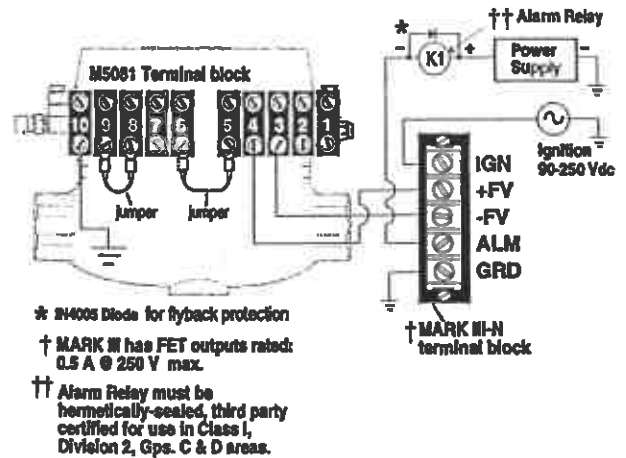
M5081-B to MARK IV-12/24



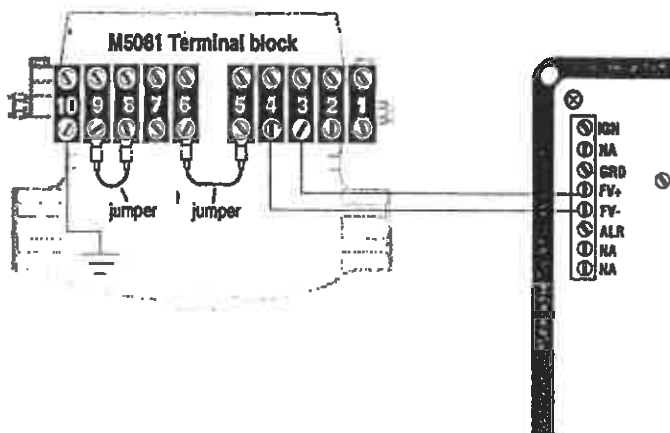
M5081 FS to MARK III-12/24



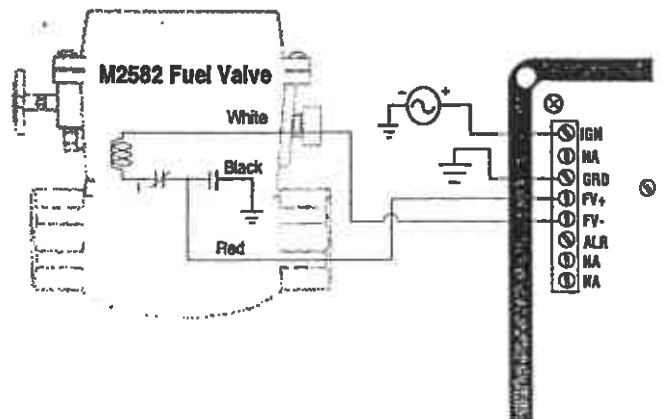
M5081-C to MARK III-N



M5081-C to TTDJ-IGN-(T)



M2582-C to TTDJ-IGN-(T)

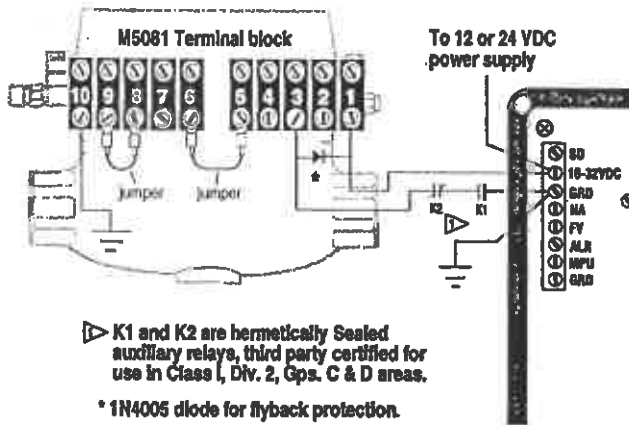


TYPICAL WIRING to SOLID-STATE TATTLETALE® Annunciators *continued*



WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

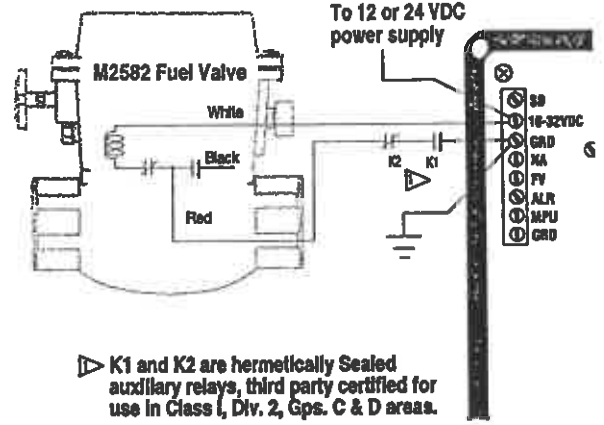
(A) M5081-B to TTDJ-DC-(T)



▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.

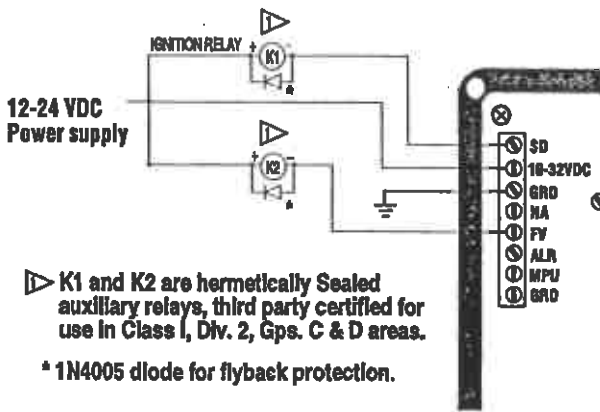
* 1N4005 diode for flyback protection.

(B) M2582-B to TTDJ-DC-(T)



▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.

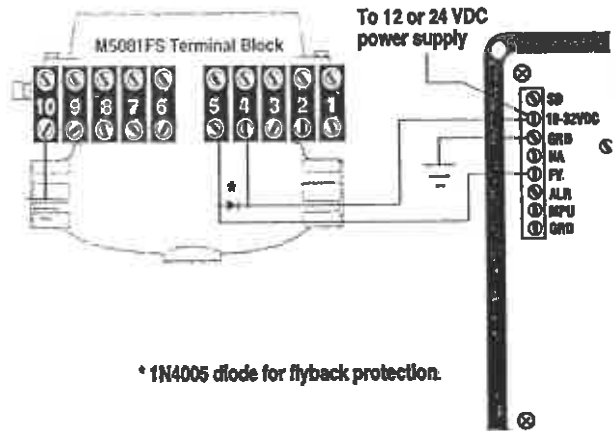
TTDJ-DC-(T) to Relays
Connections Shown for Use with Diagrams (A), (B), (C), and (D) on this page.



▷ K1 and K2 are hermetically Sealed auxiliary relays, third party certified for use in Class I, Div. 2, Gps. C & D areas.

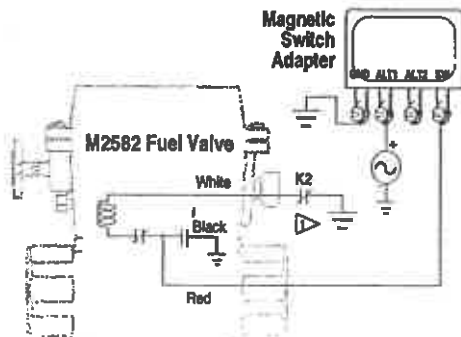
* 1N4005 diode for flyback protection.

M5081FS to TTDJ-DC-(T)



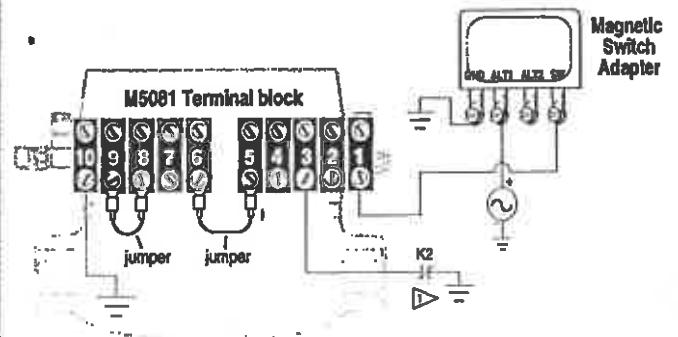
* 1N4005 diode for flyback protection.

(C) M2582-C w/Magnetic Switch Adaptor to CD Ignition



▷ K2 is hermetically sealed auxiliary relay, third party certified for use in Class I, Div. 2, Gps. C & D areas.

(D) M5081-C w/Magnetic Switch Adaptor to CD Ignition



▷ K2 is hermetically sealed auxiliary relay, third party certified for use in Class I, Div. 2, Gps. C & D areas.

SPECIFICATIONS

Valve Body: Sandcast aluminum, painted red (corrosion resistance);
Optional cast steel available for M5081 and M5081FS models only.

Valve Seat: Buna-N

Maximum Valve Inlet Pressure:

- M2582/M2582-P: 80 psi (552 kPa) [5.52 bar]
- M5081/M5081FS/ M5180-P: 100 psi (689 kPa) [6.89]

Maximum Control Pressure (Pneumatic Models):

- M2582-P: 75 psi (517 kPa) [5.17 bar]
- M5180-P: 80 psi (552 kPa) [5.52 bar]

Snap-switch: M2582: One SPDT, 5 A @ 480 VAC
M5081, and M5081FS: Two SPDT, 5 A @ 480 VAC

Wiring: M2582: Wire leads; M5081, and M5081FS: Terminal blocks

NOTE: All aluminum versions of the M5081 Series Fuel Valve carry Canadian Registration Number OC1476.2.

Coil Rating: Intermittent duty; coil type must match power source;

- CD ignition coil resistance: 72 Ω
- CD ignition primary voltage: 1.38 to 3.8 A
- M5081FS: Energized to Run (continuous-duty coil) coil resistance:
12 V model: 33 Ω;
24 V model: 136 Ω
- Magneto ignition coil resistance: 0.5 Ω
Magneto primary voltage: 1 to 5 A
- Battery coil resistance : 7 Ω
12 or 24 VDC: 1.2 to 2.4 A

Laboratory Approval: CSA listed for Class I, Groups C and D Hazardous Locations. 5 amps maximum; intermittent duty; models M5081 and M5081-CD engine ignition powered, and model M5081-B, 12 or 24 VAC or VDC; switch contacts rated 5 A @ 480 VAC maximum. Maximum pressure 100 psi (689 kPa) [6.89 bar].

SERVICE PARTS	M2582	M5081	M5081FS	M2582-P	M5180-P
Coil Assembly					
Battery	55000128	55000126	-----	-----	-----
CD Ignition	55000129	55000127	-----	-----	-----
Magneto Ignition	55000094	55000080	-----	-----	-----
M5081FS Coil Assembly					
12 VDC	-----	-----	55000158	-----	-----
24 VDC	-----	-----	55000159	-----	-----
Latch Block Assembly					
Latch block assembly	55000095	55000074	-----	-----	-----
Latch block switch and coil assembly	-----	-----	-----	-----	-----
Latch block switch and mounting bracket assembly	-----	55000118	55000196	-----	-----
Handle and Latch Kit					
Handle and latch kit	-----	55000102	55000102	5500148	55000154
Handle kit	55000096	-----	-----	-----	-----
Manual Disconnect Assembly					
Manual Disconnect Assembly	55000097	55000137	-----	-----	-----
Snap Switch Assembly					
Snap Switch Assembly	55000098	55000072	55000160	-----	-----
Close/Open Indicator Assembly					
Close/Open Indicator Assembly	-----	55000138	55000138	-----	-----
Stem and Seat Kit					
Stem and Seat Kit	55000093	55000075	55000135	55000147	55000135
Top Works Complete Valve Less Body and Vent					
Top Works Complete Valve Less Body and Vent	55000146	55000131	55000161	55000150	55000155
Vent Bushing Assembly					
Vent Bushing Assembly	55000143	55000132	55000132	55000143	55000132
Diaphragm Assembly					
Diaphragm Assembly	-----	-----	-----	55000184	55000153
Pilot Diaphragm					
Pilot Diaphragm	-----	-----	-----	00007908	55050420
Diode Package for Dual Magneto Ignitions					
Diode Package for Dual Magneto Ignitions	-----	65010065	-----	-----	-----
Magnetic Switch Adapter for CD Ignitions					
Single/Dual ign. - negative ground up to 240 VDC	65700053	65700053	-----	-----	-----
Single/Dual ign. - positive ground up to 450 VDC	65700054	65700054	-----	-----	-----
Single/Dual ign. - negative ground up to 450 VDC	65700055	65700055	-----	-----	-----

Warranty

A two year limited warranty on materials and workmanship is provided with this Murphy product.
Details are available on request and are packed with each unit.



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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 for L150, EL150K1, and EL150 EX Level SWICHGAGE®s for Engine Liquids



Please read the following instructions before installing. A visual inspection for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit.

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.

CAUTION: Certain danger to human and to equipment such as applied in a mobile or marine application may occur if some equipment is stopped without pre-warning. It is therefore, recommended that monitored functions be limited to alarm only or to alarm before shutdown in such applications.

Description

The L150, EL150K1 and EL150EX Level SWICHGAGE® instruments are a combination liquid level gauge and low limit switch. Each unit includes a float chamber, an indicating pointer, a dial, and a low level contact. When properly installed and maintained, the float operates the pointer which, in turn, both indicates level during normal operation, and closes a switching circuit if the level falls to the low-limit set point.

Applications

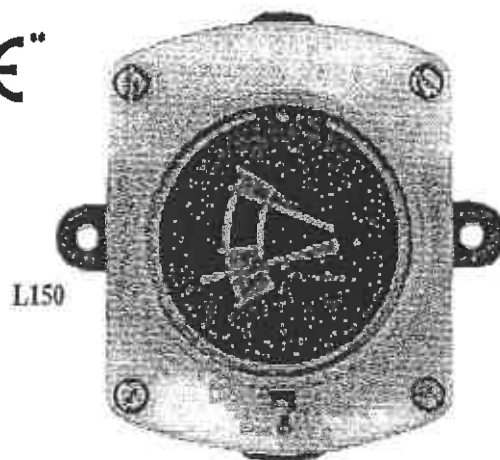
The primary use of these level SWICHGAGE® instruments is for engine cooling systems, surge or expansion tanks, condenser radiator or vapor phase systems, whether pressurized or atmospheric. These instruments can also be used to monitor lube oil, hydraulic fluid or diesel fuel reservoirs and activate alarms and/or shutdown at a predetermined minimum level.

These instruments are built for low pressure systems.

Cold Weather Warning

BEFORE FREEZING WEATHER COMES, CHECK TO BE SURE YOUR L150 OR EL150 SERIES COOLANT LEVEL SWICHGAGE® IS FILLED WITH ANTIFREEZE SOLUTION THE SAME AS YOUR ENGINE BLOCK AND RADIATOR. On many engines, such as condenser radiator systems, the coolant in your level SWICHGAGE® remains static until the level falls to drain point. When 'winterizing' it's a good idea to make certain all water drains from your level SWICHGAGE®, to check against clogged connections, and then BE SURE IT REFILLS WITH ANTIFREEZE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN EQUIPMENT DAMAGE.

CE**



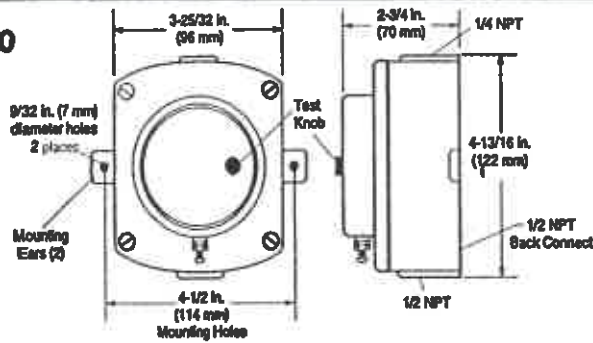
L150

Specifications	L150	EL150K1	EL150EX
Case			
• Die cast aluminum, polyurethane coated	•	•	
• Sand cast aluminum, painted.			•
Float			
• Brass	•	•	
• Stainless Steel (AISI 304)			•
Lens			
• Polycarbonate	•	•	
• Tempered glass			•
O-Rings: Saturated Nitrile, suitable for coolant or hydrocarbons. Maximum temperature 250°F (120°C)	•	•	•
Cover Gasket			
• Neo-cork	•	•	
• Buna			•
Contact Rating			
• Pilot duty 2 A @ 30 VAC/DC resistive SPST	•		
• SPDT rated 10 A @ 125 VAC; 0.5 A @ 125 VDC; 10 A @ 30 VDC		•	•
Vent Tube: 1/4 x 5 in. (6 x 127 mm) with fittings.	•	•	•
Maximum Working Pressure: 25 psf (172 kPa) [1.72 bar]	•	•	•
Electrical Connection			
• (1) 16 AWG x 24 in. (1.5 mm ² x 610 mm) with terminals.	•		
• (3) 18 AWG x 14 in. (1.0 mm ² x 356 mm)		•	
• Terminal Block			•
CSA Listed for Hazardous Location: Class I, Division 1, Groups C & D.			•

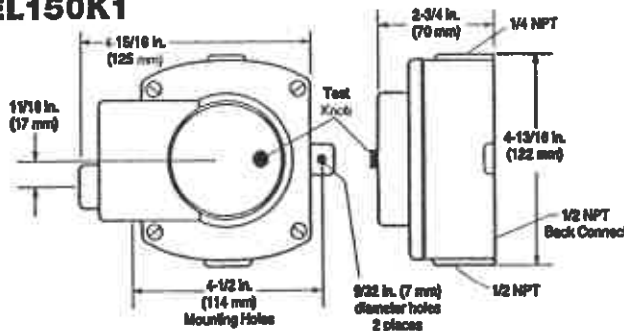
**Products covered by this literature comply with EMC Council directive 89/336/EEC regarding electromagnetic compatibility except as noted.

DIMENSIONS

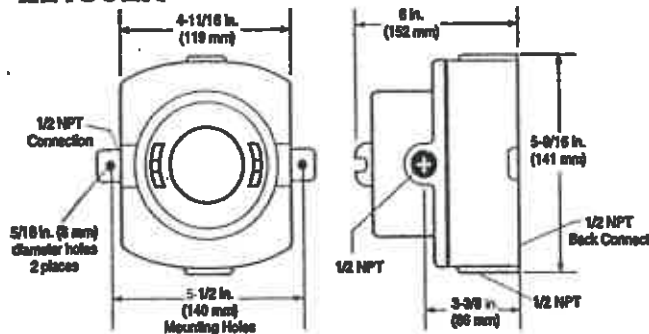
L150



EL150K1



EL150EX



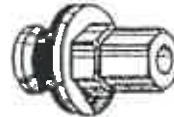
PS FITTINGS INSTALLATION

A Murphy PS fitting is used when there is no threaded fitting in the top tank of the radiator to attach tubing for the L150/EL150 series level SWICHGAGE®.

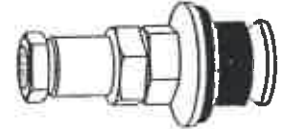
- P/N 15-00-0107 (PS) Accepts 1/4 in. (6 mm) O.D. copper tubing.
- P/N 15-01-0167 (PS Barbed) Barbed fitting accepts 1/4 in. (6 mm) I.D. flexible tubing and hose clamp.
- P/N 15-01-0202 (PS-D) Accepts 1/2 in. (13 mm) I.D. hose; 1/4 in. (6 mm) copper tube.

1. Determine the entry point into the radiator top tank. See *Level SWICHGAGE® Installation* for proper location. Drill 5/8 in. (16 mm) diameter hole in top tank of radiator. Be sure chips do not fall inside the tank. Remove any burrs on the hole wall.
2. Insert the rubber grommet of the PS Blind Hole Fitting. Tighten the jam nut while holding the fitting from turning in the hole. The jam nut will pull the tapered grommet into the hole from the inside of the top tank causing the grommet to expand and seal the hole.
3. Attach the appropriate tubing or hose for the PS Fitting.

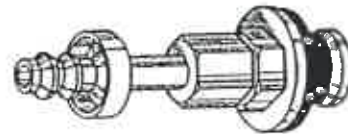
15-00-0107



15-01-0202



15-01-0167



LEVEL SWICHGAGE® INSTALLATION



WARNING: Perform all installations with the power source "OFF". Be sure engine and radiator have cooled and coolant pressure has been relieved. SEVERE BURNS can result. Never remove radiator cap on a hot engine.

IMPORTANT: Operation of the L150/EL150K1 is different for a pressurized cooling system than for an atmospheric (non-pressurized) system. Installation of the L150/EL150K1 is only slightly different for each system. Connection of the top tube connection is the major difference. Differences will be noted in the installation instructions.

Installation Notes

1. All top radiator connections must be away from the return hose turbulence.
2. All bottom radiator connections must be away from the suction hose.
3. The L150/EL150K1 must be attached to a mounting plate on the radiator or other framework.

CAUTION: If the L150/EL150K1 is NOT attached to the radiator, use high temperature quality flexible hose for the top and bottom connections to maintain the shock mounting protection for the radiator.

Pressurized and Atmospheric Systems

1. Drain the cooling system.
2. For a PRESSURIZED COOLING SYSTEM (Figure 1) the shutdown point is determined by the entry point A of the tube connection into the top tank. The engine will shutdown when coolant level drops below this connection (see step 4).
If the radiator has a SHALLOW UPPER TANK, you can make entry from the top as illustrated in Figure 2. Insert the copper tube until it is slightly above the core. Secure the fitting.

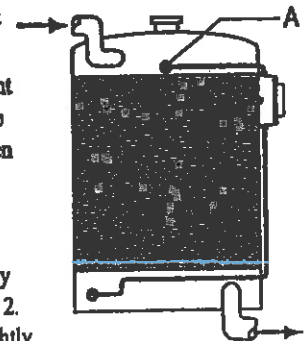
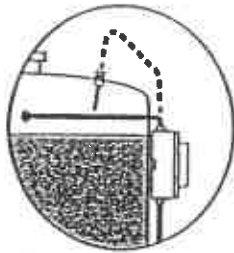


Figure 1: Pressurized System

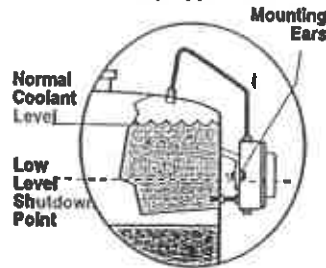
LEVEL SWITCHGAGE[®] INSTALLATION (continued)

Figure 2:
Shallow Upper Tank



For a PRESSURIZED system the tip of the copper tube will be the shutdown level.

Figure 3:
Deep Upper Tank



- 3. For ATMOSPHERIC (non-pressurized) and PRESSURIZED CROSS FLOW COOLING SYSTEMS** the shutdown point is determined by the mounting position of the L150/EL150K1 relative to the top tank of the radiator (see step 5).

- 4. For a PRESSURIZED SYSTEM,** determine the point of entry (tube connection) in the radiator top tank (away from the top hose connection). Many radiators have a pipe nipple provided. If a connection is not provided, you must either weld or solder a fitting or use one of the Murphy PS fittings (see *PS Fittings Installation* page 2). This connection should be as close to the radiator core as possible.

For MARINE AND MOBILE EQUIPMENT installations, the top tank connection should be near the vertical centerline of the radiator. This will compensate for changing level due to roll and pitch of the machine during operation.

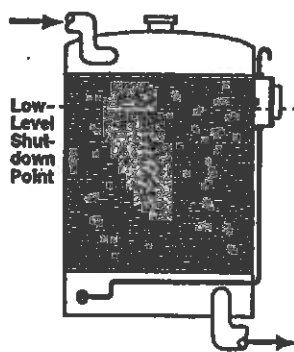
- 5. For an ATMOSPHERIC SYSTEM** a tube connection in the top tank may not be required. Determine the lowest desired level of coolant in the top tank. Mount the L150/EL150K1 so that the mounting ears are approximately 1/4 in. (6 mm) above that level (Figure 3). A back mounting option is available for the L150 and EL150K1 for radiators with fabricated steel top tank and/or for use with some condenser cooling systems.

For an ATMOSPHERIC system install a 1/4 in. (6 mm) diameter tube in the top fitting of the L150/EL150K1. This tube MUST EXTEND ABOVE the top tank. Form the tube into a cane so that the open end of the tube points down but still extends ABOVE the HIGHEST coolant level. The tube can be connected to the top tank if desired. Follow instructions for a PRESSURIZED SYSTEM.

- 6. For most applications,** the bottom tube connection is made at the drain cock. Remove the drain cock and install a brass tee. Reinstall the drain cock into the tee. Attach a copper or other suitable tube to the remaining opening of the tee and to the bottom connection of the L150/EL150K1.

If a drain cock is not provided, you must attach a fitting or use a Murphy PS fitting the same as for the top tank instructions.

Figure 4: Atmospheric System



- 7. Wire** according to appropriate alarm or shutdown circuits (see *Standard Electrical Diagrams* on page 4).

- 8. Refill** the cooling system according to manufacturer's instructions.

- 9. Start** the engine and allow it to run until the thermostat opens. Increase engine speed to the FULL operating speed and observe that the indicating pointer remains at or near the full position. If the pointer drops to the LOW position shutdown or alarm will occur due to coolant flow through the L150/EL150K1. If alarm or shutdown occurs, drain the coolant - or clamp off the upper and lower hoses.

CAUTION: BE SURE SYSTEM PRESSURE IS RELIEVED AND HOT COOLANT CANNOT ESCAPE. Remove the four (4) mounting screws holding the cover assembly. Invert the float chamber so that the 1/2 NPT connection is on top and the 1/4 NPT connection is on bottom. Reinstall the float and cover assembly in the upright position. Install larger I.D. tubing from the top of the float chamber (1/2 NPT) to the radiator top tank. The smaller 1/4 NPT connection on the bottom will restrict coolant outflow from the L150/EL150K1. Check for unrestricted float movement by rotating the switch test knob. Refill the cooling system and repeat step 9.

- 10. Place** a catch basin under the drain cock. Open the drain cock and observe that coolant is leaving the radiator.

For a PRESSURIZED cooling system, shutdown will occur when coolant drops below the entry point of the top tank tube connection. For an ATMOSPHERIC OR CROSS FLOW PRESSURIZED COOLING SYSTEM, shutdown will occur when coolant drops approximately 1/4 in. (6 mm) below the level of the case mounting ears. If shutdown does not occur, adjust the L150/EL150K1 mounting as described above.

CAUTION: DO NOT ALLOW ENGINE TO RUN WHEN COOLANT DRAINS BELOW THE UPPER TANK. ENGINE DAMAGE CAN OCCUR.

- 11. Periodically test** switch operation by rotating the test knob on the face of the L150/EL150K1. Rotating the knob forces the pointer mechanism against the contact screw (L150) or the snap switch actuator (EL150K1).

Condensor/Radiator System

- 1. Mount** the L150/EL150K1 so that the horizontal center line of the L150/EL150K1 is approximately 1/4 in. (6 mm) above the minimum coolant level in the engine head.

NOTE: On some engines it is possible to use the back connection option and attach the L150/EL150K1 directly to the engine cylinder. Kits are also available for some engines.

- 2. Attach** a copper tube from the top connection of the L150/EL150K1 to the radiator top tank.

- 3. Wire and test** the system according to above instructions for Pressurized and Atmospheric systems.

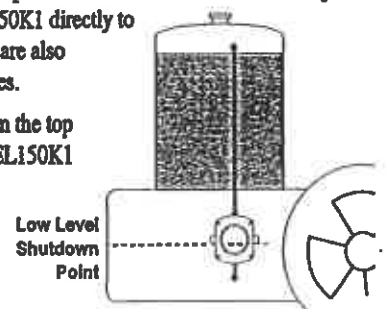
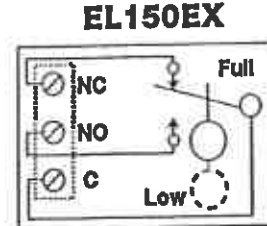
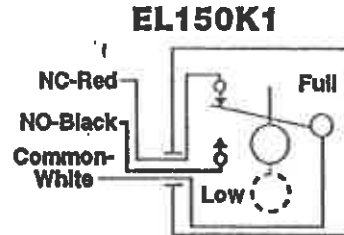
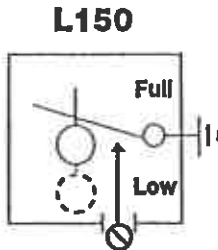


Figure 5:
Condensor/Radiator System

STANDARD ELECTRICAL DIAGRAMS



WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF".



NOTE: All models shown with pointer in full position.

REPAIR KITS

Repair kits are available for the L150, EL150K1 and EL150EX models. When ordering a repair kit specify model repair kit number from chart below:

Model	Components	Repair Kit No.
L150	All parts except case/body	15-00-0138
	Case/body assembly	15-00-0101
EL150K1	All parts except case/body	15-00-0139
	Lens and switch assembly	15-00-0100
	Case/body assembly	15-00-0101
EL150EX	Cover and float assembly	15-00-0110
	Lid assembly	15-00-0108
	Switch/Terminal assembly	15-00-0109

Replacing the Float and Cover Assembly for the L150 and EL150K1



WARNING: Perform the following operation with the power source "OFF". Be sure engine and radiator have cooled and coolant pressure has been relieved. SEVERE BURNS can result. Never remove radiator cap on a hot engine.

- As applicable, shut off liquid to the SWICHGAGE® or drain the system level below the SWICHGAGE®.
- Disconnect electrical lead(s), one at a time and tag for reinstallation.
- Disconnect conduit on EL150K1.

- Remove the four screws that secure the float and glass assembly to the case.
- Remove and discard the old float and cover assembly.
- Remove and discard the old gasket.
- Install the new gasket.
- Install the new float and cover assembly and secure it with four screws.
- Re-connect the conduit on EL150K1.
- Re-connect the electrical lead(s).
- As applicable, open valves to the SWICHGAGE® or refill the system to proper level.
- Check the SWICHGAGE® for proper operation at the full indicating position. (Alarm not operated/engine continues to operate.)
- Check the SWICHGAGE®, alarm/shutdown circuit, by rotating the test knob toward the low level point of the dial: alarm is operated/engine shuts down.
- Check for unrestricted float movement by rotating the switch test knob.
- Replacement of the float and cover assembly is complete.



CAUTION: On some high voltage CD ignition systems, it may be necessary to coat the L150 contact screw head with RTV to prevent "tracking" and false contact operation during wet or high humidity conditions. Use of the EL150K1 is recommended in these cases.

Warning

A two year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.

murphy

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Limited Warranty

MURPHY SWICHGAGE® and MURPHYMATIC® CONTROL SYSTEMS

This Murphy supplied product is warranted to be of good quality materials and workmanship. This limited warranty is for a period of TWO years. Any unit suspected of a quality flaw, verified by Murphy, will be either repaired or replaced, at our option, when returned to our factory, transportation charges paid. If a customer is requesting on-site service assistance for a MURPHYMATIC® control system, we will engage the proper resources to repair, adjust or replace the MURPHYMATIC® control system in accordance with our Service Philosophy and Limited Warranty. We are not responsible for damage caused by improper installation, neglect or abuse and are limited under warranty to repairing or replacing the item only and are not liable for equipment on which this product is installed.

Murphy SWICHGAGE® control instruments, MURPHYMATIC® control systems, or their parts, and supplied product shall be of kind and quality described in the

specifications as supplied and no other warranty except of title shall be implied. All other warranties, express or implied, including but not limited to warranties of merchantability or fitness for a particular purpose, are explicitly disclaimed. The liability of the company shall not in any case exceed the cost of correcting defects in the supplied product; and upon the expiration of above mentioned two years, all such liability shall terminate. The company shall not in any event be liable for indirect or consequential damages.

You have purchased dependable instrumentation and with normal care, it will provide long and faithful service, and enhance the preventive maintenance program on your valuable equipment. Any claim for shortage or damage of this shipment must be accompanied by this Packing Slip within 15 days of receipt or invoice date, whichever is later.

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This Murphy supplied control device is warranted to be of good quality materials and workmanship. Murphy warrants this quality for a period of TWO FULL YEARS. (Parts and systems are code dated.) This is only a time limit extension of the standard warranty; all other statements in the Murphy Limited Warranty remain in effect.

As with any monitoring and/or control system, the purchase, installation and use of SWICHGAGE® control instruments and other Murphy Systems is NOT AN INSURANCE POLICY. It is, however, the simplest means of adding inexpensive, reliable protection—protection that is as sound as the instruments, installation, and follow-up preventive maintenance program that is applied to these instruments and to the equipment they help protect. SWICHGAGE® control instruments, properly installed and maintained, are important and effective tools in any preventive maintenance program.

All "work machines" have life signs such as pressures, temperatures, levels, and overspeed conditions. Each of these vital signs can be monitored by a SWICHGAGE® capable of accurate indication and reliable limit switching. Teamed with Murphy electrical and SELECTRONIC® components, SWICHGAGE® control instruments can constantly monitor pressures, levels, temperatures, vibration, and overspeed conditions and activate alarm and/or shutdown when preset limits are reached. As these vital signs are constantly monitored, the SWICHGAGE® control instruments and their related components must be periodically inspected,

both visually and physically. Look for frozen pointers, bad contacts, kinked or broken pressure tubing or capillaries. Check floats on Level SWICHGAGE® control instruments visually and, if possible, mechanically. Test electric circuits and move limit contacts into the operating range to see that the proper sequence of events occurs when the contacts meet.

If a SWICHGAGE®, TATTLETALB® or other component fails the visual, physical, or electrical check, then repair or replace the unit or its parts as necessary to bring it back to proper operation. When a question exists on warranty, the questionable part should be returned to the factory or affiliate company for warranty inspection. If within the warranty period the unit is found to operate improperly and it appears to be related to material quality or workmanship, Murphy will repair or replace the product. (See Warranty above.)

Murphy SWICHGAGE® control instruments, MURPHYMATIC® panels and SELECTRONIC® systems are not a substitute for, but can be important tools in, a routine preventive maintenance program. Since 1939 we have been building our worldwide reputation as the source for simple, reliable monitoring and protection, featuring simplicity of maintenance. Please refer any questions regarding tests, repair or replacement parts to the factory, your nearest affiliate company, or your authorized servicing dealer.

Garantía Limitada

INSTRUMENTOS MURPHY SWICHGAGE® Y SISTEMAS DE CONTROL MURPHYMATIC®

Los instrumentos Murphy SWICHGAGE® y los sistemas de control MURPHYMATIC® son garantizados por su buena calidad en los materiales de fabricación y la mano de obra. Esta garantía es limitada por DOS años, con la excepción de aquellos artículos manufacturados por terceros pero vendidos por Murphy, que cuentan con la garantía original del fabricante.

Murphy se reserva la opción de reparar o reemplazar cualquier unidad considerada de calidad inferior, siempre y cuando ésta ha sido regrezada a nuestra planta con cargos de envío pagados. No somos responsables de daños causados por la inadecuada instalación del producto, el mal trato o el abuso, todas las partes fabricadas en Murphy son de garantía limitada para su reparación o su reemplazo y no se responsabilizan por ningún equipo en el cual nuestros controles han sido instalados.

Los instrumentos Murphy SWICHGAGE® y los sistemas de control MURPHYMATIC®, así como cada una de sus partes deben ser de la misma

calidad y la misma fabricación a las descritas en las especificaciones suministradas con cada producto, y ninguna otra garantía a excepción del título es implícita. La responsabilidad de la compañía bajo ninguna circunstancia debe exceder el costo de reparación del desperfecto en los sistemas Murphy, instrumentos SWICHGAGE® o sus componentes, una vez cumplida la garantía descrita, por dos años, toda responsabilidad es nula. La compañía por ninguna razón se hace responsable de daños conecuentes o indirectos.

Usted ha adquirido instrumentación confiable, y bajo cuidado normal le proporcionara buen servicio a largo plazo, mejorando el mantenimiento preventivo para su valioso equipo.

Cualquier reclamación de piezas faltantes o daños del envío debe estar acompañada por esta garantía, y formulada en 15 días subsecuentes a la fecha de entrega o de la fecha de facturación.

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Todos los instrumentos de control Murphy SWICHGAGE®, paneles MURPHYMATIC® y sistemas SELECTRONIC® están garantizados en sus materiales de fabricación y su mano de obra. Murphy garantiza esta calidad por DOS AÑOS o la garantía del fabricante original para con nosotros. (Todas las partes y los sistemas están fechados en código.) Esta es solo una extensión del tiempo límite en la garantía estándar; todas las otras cláusulas de la garantía permanecen efectivas.

Como cualquier otro sistema de control y/o monitoreo, la compra, instalación y uso de los instrumentos de control SWICHGAGE® y otros sistemas Murphy NO ES UNA POLIZA DE SEGURO. Pero es, la forma más económica y confiable de dar protección—protección que es tan firme como los productos mismos, instalación y un constante programa de mantenimiento preventivo se aplica a estos instrumentos y a los equipos que estos ayudan a proteger. Instrumentos SWICHGAGE® adecuadamente instalados y mantenidos, son herramientas efectivas e importantes en cualquier programa de mantenimiento preventivo.

Todas las maquinas de trabajo, tienen signos vitales como: presión, temperatura, nivel, velocidad y cada uno de estos puede ser monitoreado por un SWICHGAGE® capaz de dar lecturas de precisión y señales de interrupción. En combinación con componentes eléctricos Murphy SELECTRONIC®, el SWICHGAGE® puede monitorear continuamente la presión, el nivel, la temperatura, y activar alarmas y/o el paro cuando el límite del interruptor es activado. Así como los signos vitales son constantemente monitoreados, los SWICHGAGE® y sus partes deben ser inspeccionados periodicamente tanto visual como físicamente.

Asegurese que la aguja indicadora no esté congelada, que no tenga malos contactos, que las mangueras de presión o los capilares de temperatura no esten torcidos o perforados. Cheque mecánicamente y de ser posible visualmente los flotadores de los SWICHGAGE® de nivel. Pruebe los circuitos y manualmente opere los interruptores para verificar que trabajan en secuencia cuando el contacto se activa.

Si un instrumento SWICHGAGE®, un anunciador TATTLETALE® o cualquier otro instrumento presenta anomalías al chequearse, visual, física o eléctricamente, repare o reemplace la unidad o sus partes como sea necesario para reestablecer su operación normal. Si hay alguna duda en la garantía, la parte en cuestion debe ser regresada a la fabrica o a nuestro distribuidor para una inspección apropiada. Si durante su año de garantía la unidad se ha encontrado defectuosa y todo determina que es debido a mala calidad de sus componentes o durante el ensamblado, regrese la unidad a Murphy para inspeccionarla y posiblemente repararla o reemplazarla por otra bajo nuestra garantía. (Vea la garantía en la parte superior).

Los SWICHGAGE®, MURPHYMATIC®, SELECTRONIC®, no son un sustituto de, pero pueden ser una herramienta importante en el rutinario programa de mantenimiento preventivo. Desde 1939 hemos creado nuestra reputación alrededor del mundo como proveedores de monitoreo y protección simple pero confiable con un mantenimiento mínimo. Por favor dirija sus preguntas referentes a la prueba, reparación o reemplazo de cualquier parte a nuestras fabricas u oficinas o distribuidor autorizado Murphy.

Shock/Vibration Control Switches Installation Instructions

Models: VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94



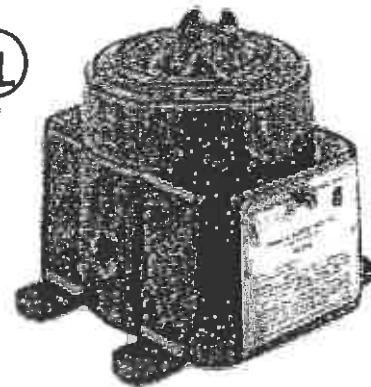
Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

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

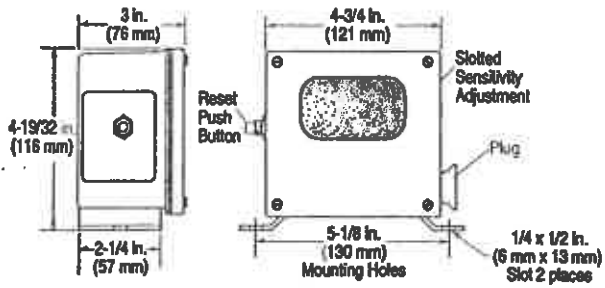
-H24: Space heater for 24 VDC

Warranty

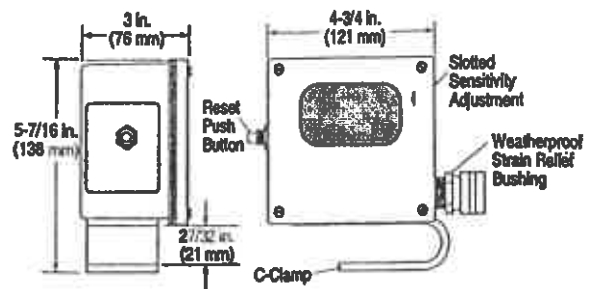
A two-year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.

DIMENSIONS

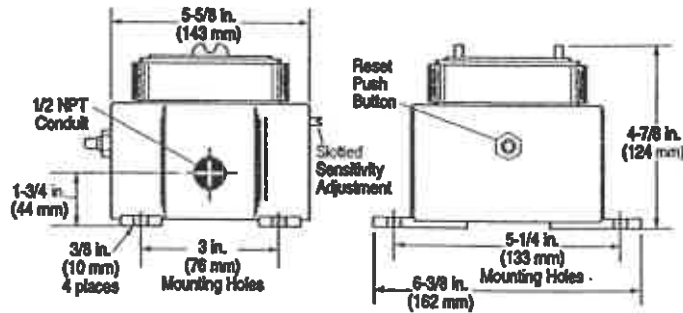
VS2



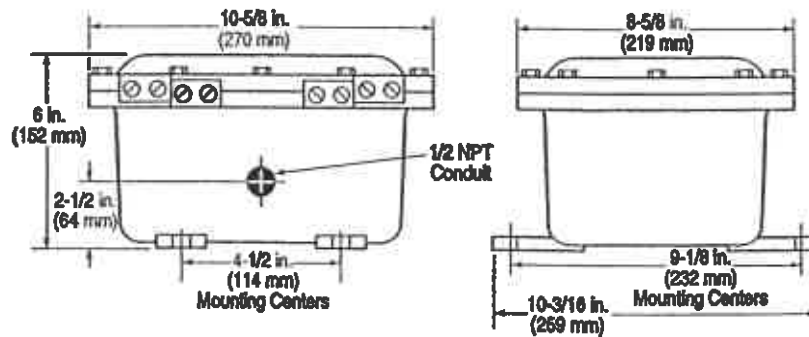
VS2C



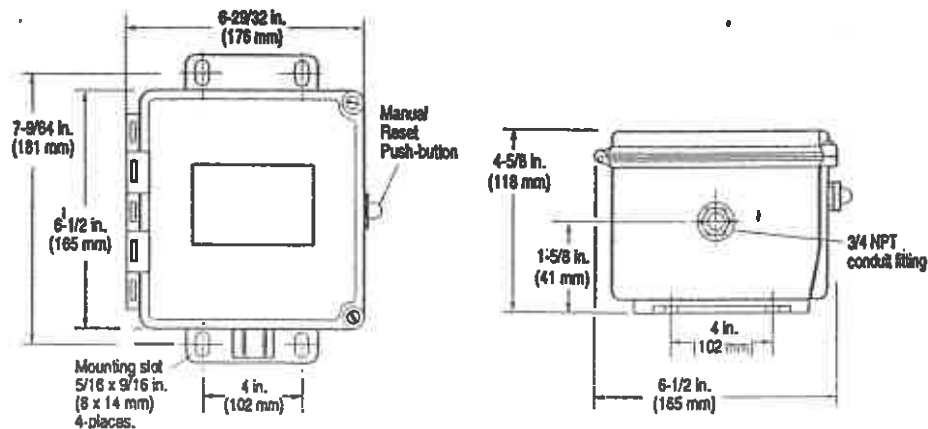
VS2EX and VS2EXR



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 mm²) 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.

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):
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.

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):

Option	Operating Current
H15	.023 A @ 115 VAC
H24	.12 A @ 24 VDC

- Remote Reset (optional):

Option	Operating Current
R15	.17 A @ 115 VAC
R24	.36 A @ 24 VDC

- Time Delay (optional):

Option	Operating Current	Standby Current
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.



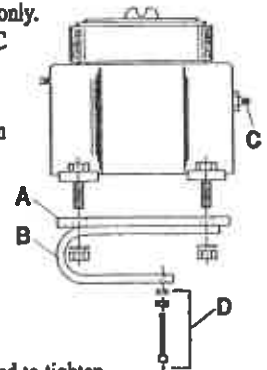
CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting

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.

INSTALLATION *Continued*

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:

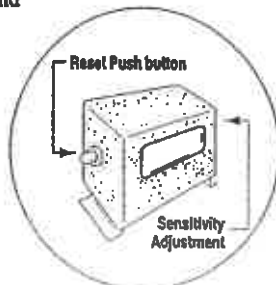
1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.

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.

3. Start the machine.

4. If the instrument trips on start-up.

DETAIL "A"



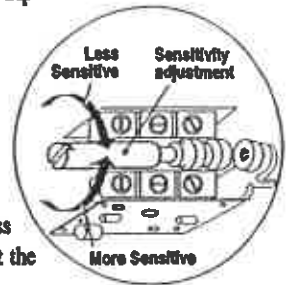
allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL "B").



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, stop the machine. Turn the sensitivity adjustment 1/4 turn counter-clockwise. Repeat the start-up/stop process until the instrument trips on start-up. Turn the sensitivity adjustment 1/4 turn clockwise (less sensitive). Restart the machine to verify that the instrument will not trip on start-up.

6. Verify that the unit will trip when abnormal shock/vibration exists.

VS94 Time Delay Adjustment



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.

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.

3. TURN THE POWER OFF TO RESET THE TIME DELAY CIRCUIT.

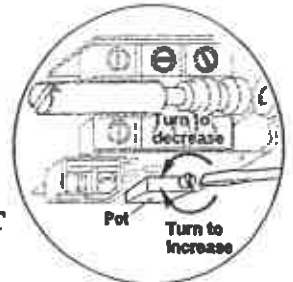
NOTE: Allow 30 seconds bleed-time between turning the power "OFF" and "ON."

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.

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

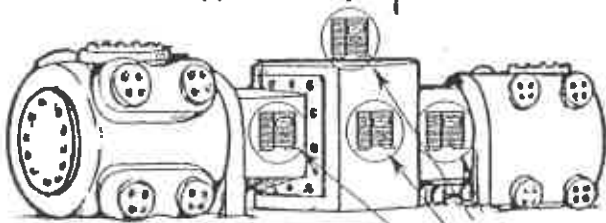
DETAIL "C"



TYPICAL MOUNTING LOCATIONS

NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

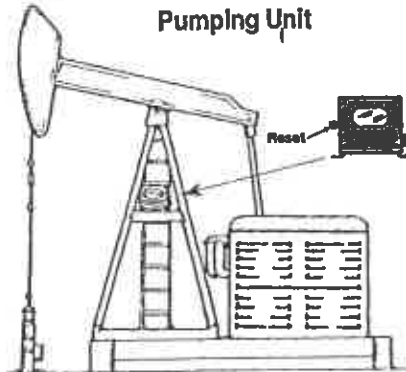
2-Throw Balance-Opposed Compressor



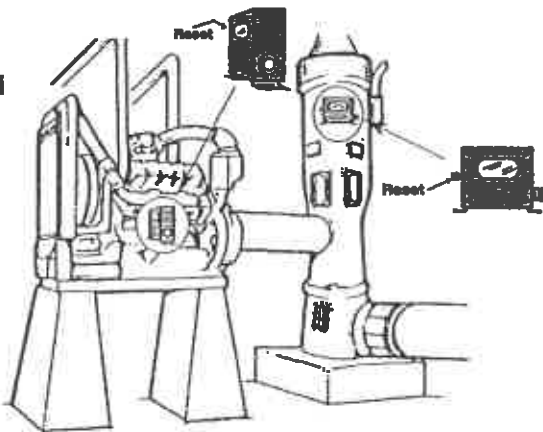
NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



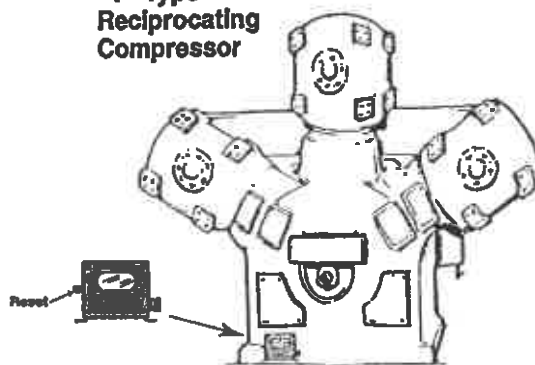
Pumping Unit



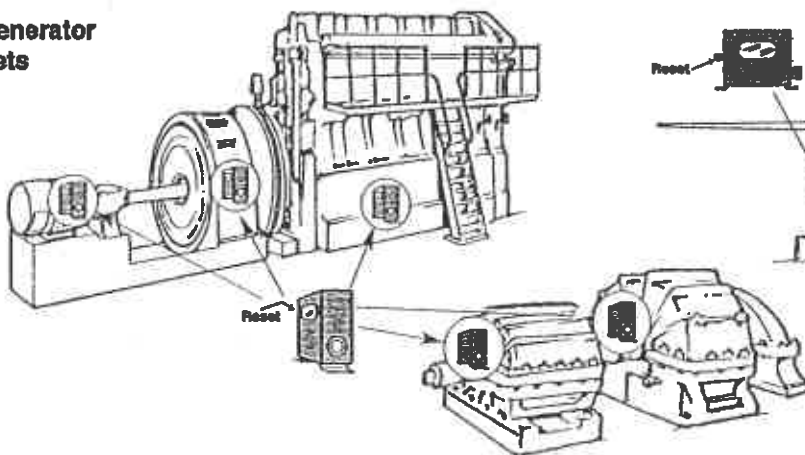
Engine and Vertical Shaft Pump



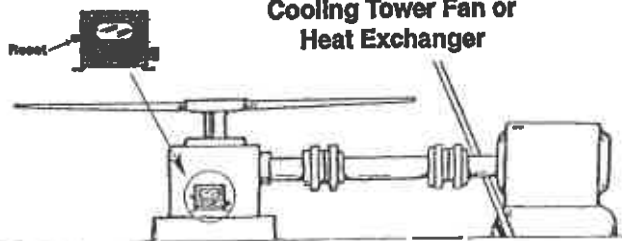
"Y" Type Reciprocating Compressor



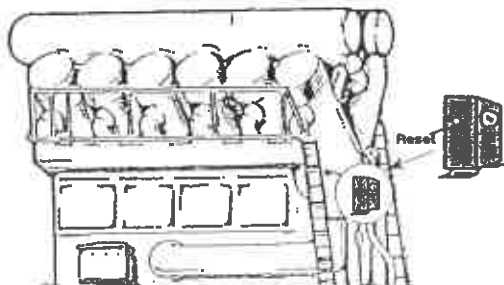
Generator Sets



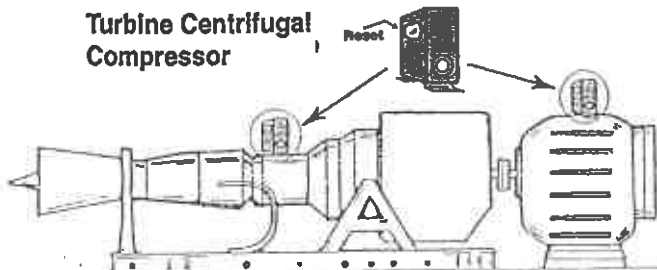
Cooling Tower Fan or Heat Exchanger



Engine Compressor

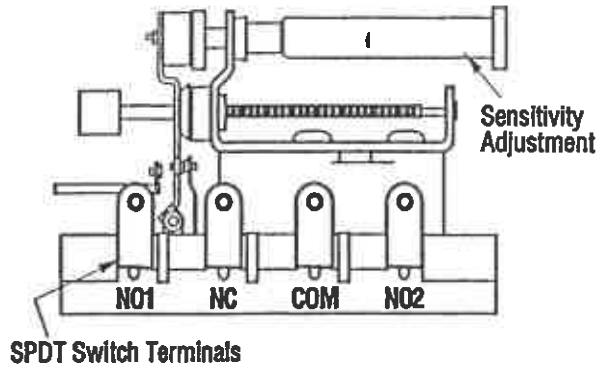


Turbine Centrifugal Compressor

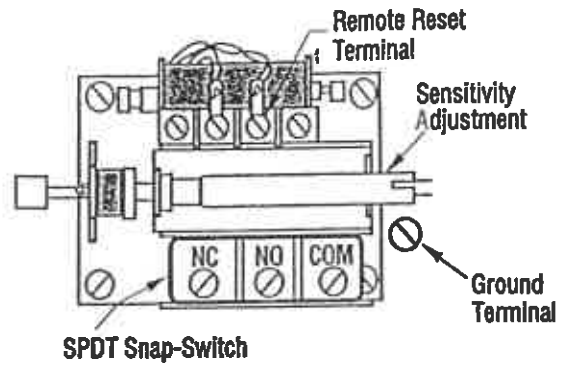


INTERNAL SWITCHES

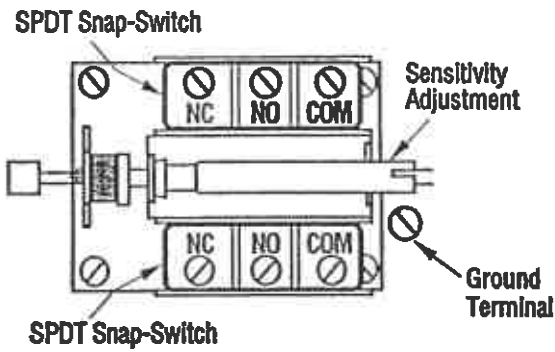
VS2 and VS2C



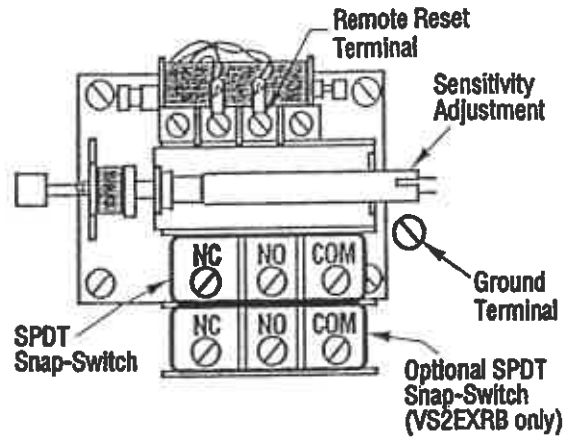
VS2EXR



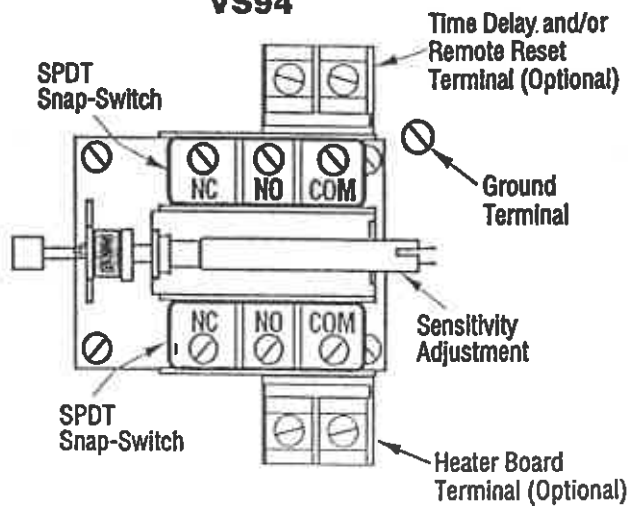
VS2EX



VS2EXB and VS2EXRB



VS94

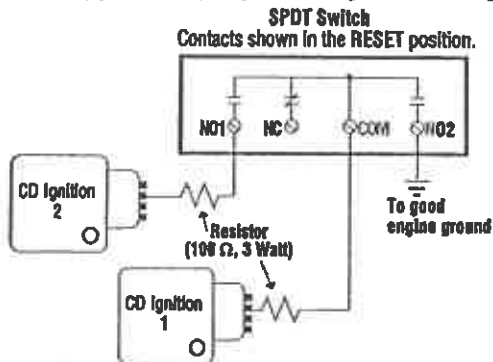


ELECTRICAL

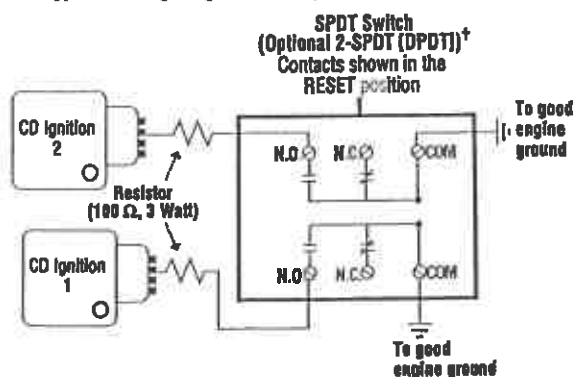


WARNING: REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

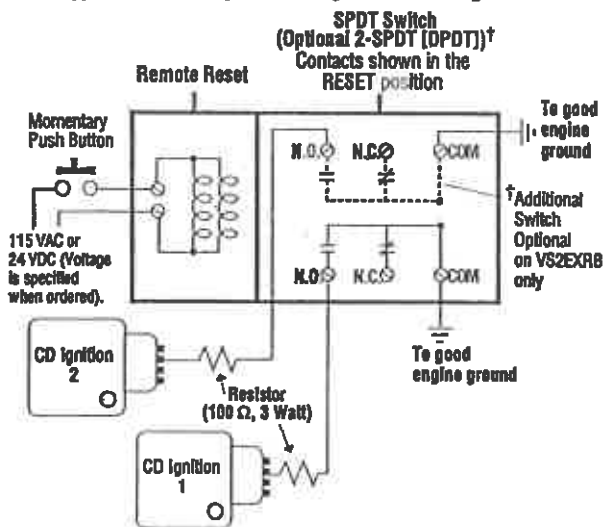
VS2 and VS2C
Typical Wiring Diagram for Single or Dual CD Ignition



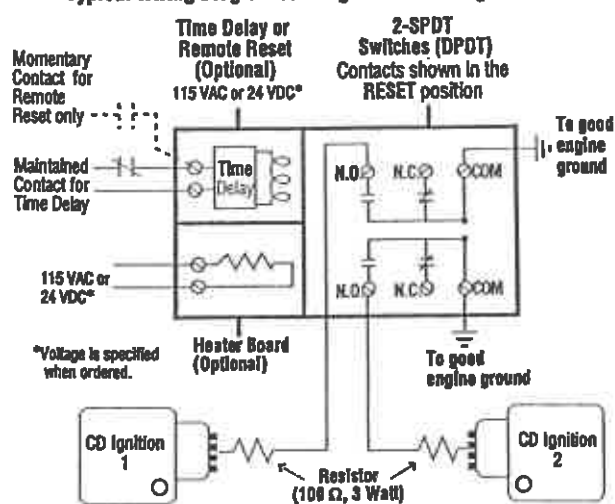
VS2EX
Typical Wiring Diagram for Single or Dual CD Ignitions



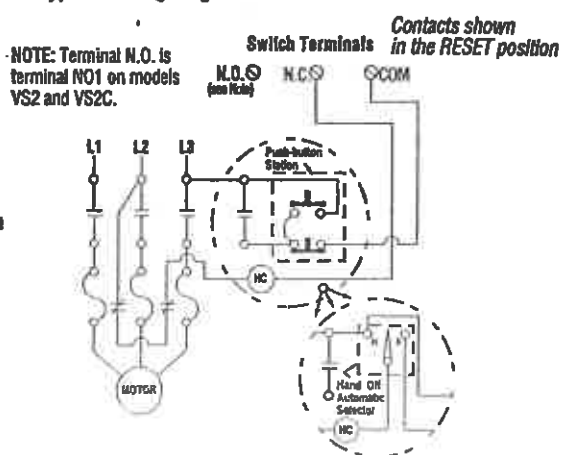
VS2EXR and VS2EXRB
Typical Wiring Diagram for Single or Dual CD Ignitions



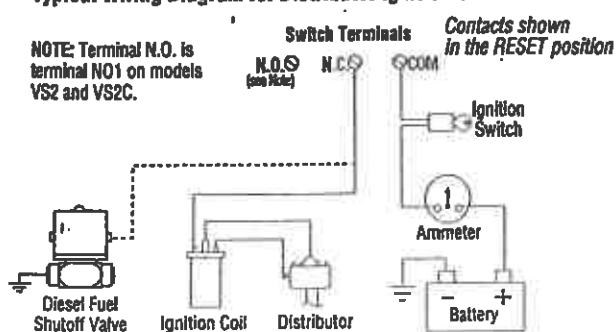
VS94
Typical Wiring Diagram for Single or Dual CD Ignitions



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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1620 Home Highway

Campbellfield, Vic 3061; Australia

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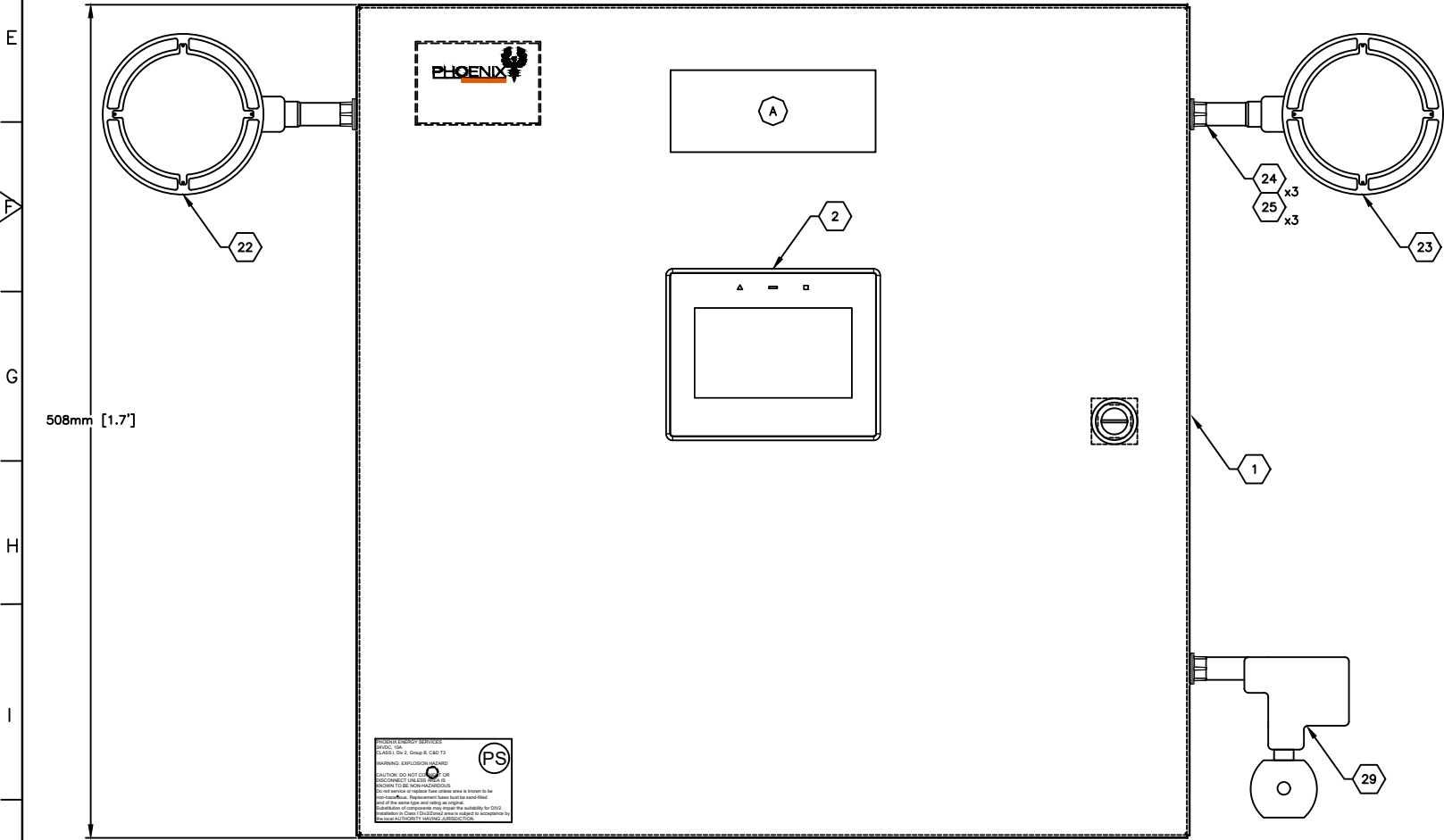
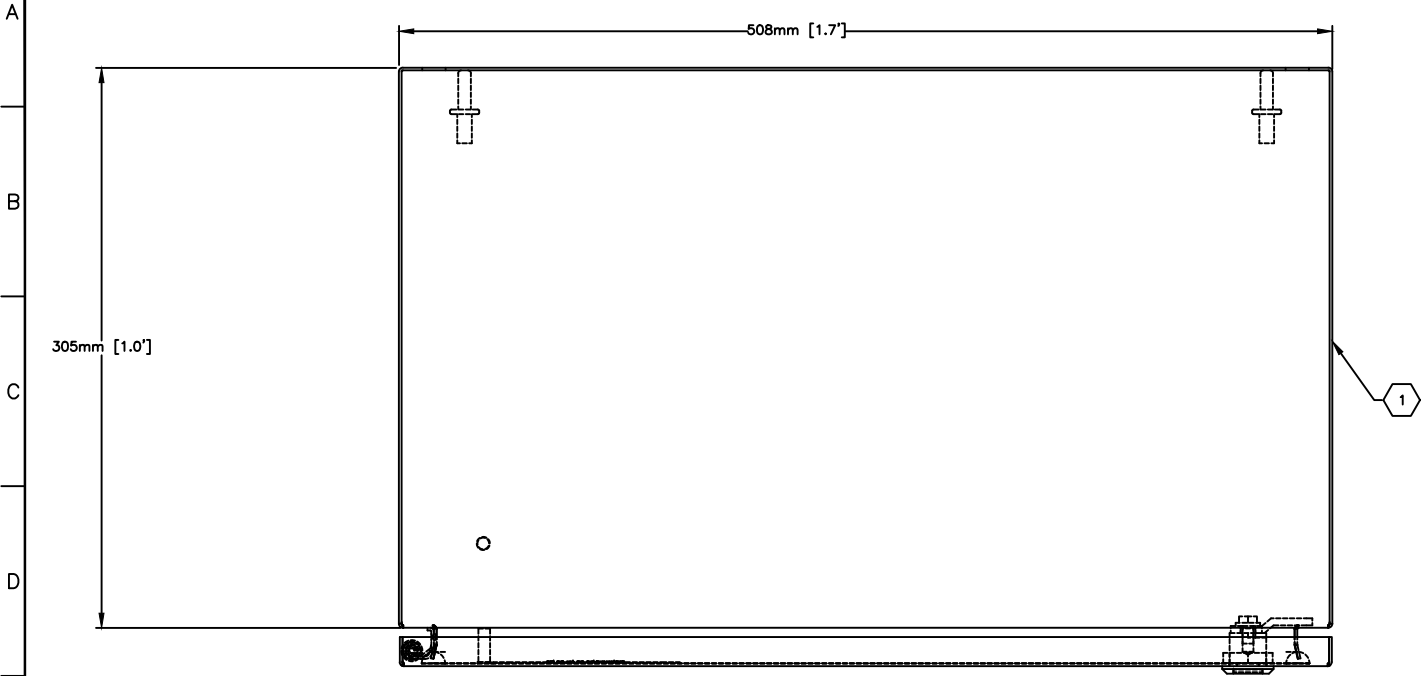
e-mail mmp@macquarrie.com.au



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.

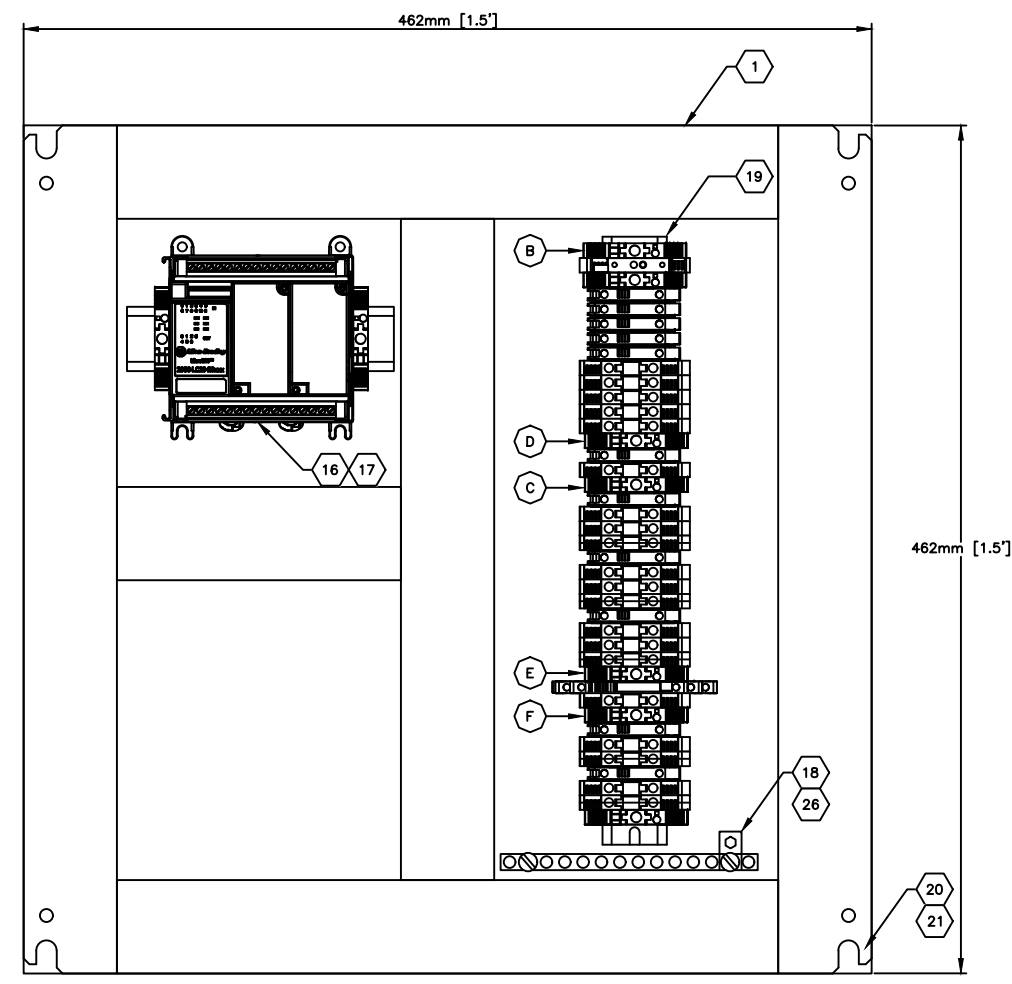
Printed in U.S.A.

0-1-99



BILL OF MATERIALS

ITEM	QTY	DESCRIPTION	PART NUMBER	ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	JUNCTION BOX 20 x 20 x 12 C/W BACKPAN	EN4SD202012GY EP2020	15	10	FUSE, CERAMIC, MINI 0.25A	GSD14
2	1	REDLION DISPLAY, 4"	CR30004000	16	1	ALLEN-BRADLEY MICRO 820 PLC	2080-LC-20-QWB
3	15	FEED THROUGH TERMINAL WDU2.5 WM BG	1020000000	17	1	ALLEN-BRADLEY MICRO800 SERIES 2 CHAN ANALOG	2080-OF2
4	2	END STOP WEW 35/2 WM BG	1061200000	18	1	GROUND BAR, 10 SLOT	GBK10
5	3	END PLATE WAP 2.5 10 WM BG	1050000000	19	AS REQ'D	DIN RAIL, TS35X7, SLOTTED	514500000
6	11	FUSE TERMINAL BLOCK WSI6	1011000000	20	AS REQ'D	PANDUIT, WHITE 2x3	F2X3WH6
7	1	FEED THROUGH TERMINAL WDU6	1020200000	21	AS REQ'D	PANDUIT COVER, WHITE 2"	C2WH6
8	1	FUSE TERMINAL BLOCK WSI4	1880430000	22	1	TRANSMITTER, ROSEMOUNT 0-30 WITH DISPLAY	2088G1S22A1M5C6
9	6	TERMINAL MARKER - SCHT5	2924600000	23	1	TRANSDUCER, I2P 4-20mA, 6-30 PSI XP/IS - FISHER	I2PX2B
10	5	GROUND TERMINAL WPE2.5	1010000000	24	3	NIPPLE ALUM 1/2" x CLOSE	I2PX2B
11	1	INTERPOSING RELAY 24VDC COIL, 1 N.O., 1 N.C.	1122770000	25	3	MEYERS HUB 1/2"	H050GRAC
12	1	FUSE, CERAMIC, MINI 10A	GSD10	26	1	LUG, MECHANICAL GROUNDING 14 - 2/0	ADR21
13	5	FUSE, CERAMIC, MINI 5A	GSD5	27	3	500 OHM RESISTOR	RM60D5000FB14
14	5	FUSE, CERAMIC, MINI 1A	GSD1	28	1	SOLENOID VALVE	EF8003G1



A NAMEPLATE SCHEDULE

ITEM	DESCRIPTION	COLOUR	SIZE
A	VRU PLC CABINET	WHITE WITH BLACK TEXT	125mm x 50mm
B	DC DIST	WHITE WITH BLACK TEXT	SCHT5
C	AI	WHITE WITH BLACK TEXT	SCHT5
D	DI	WHITE WITH BLACK TEXT	SCHT5
E	DO	WHITE WITH BLACK TEXT	SCHT5
F	AO	WHITE WITH BLACK TEXT	SCHT5

NOTES:

PERMIT/SEAL

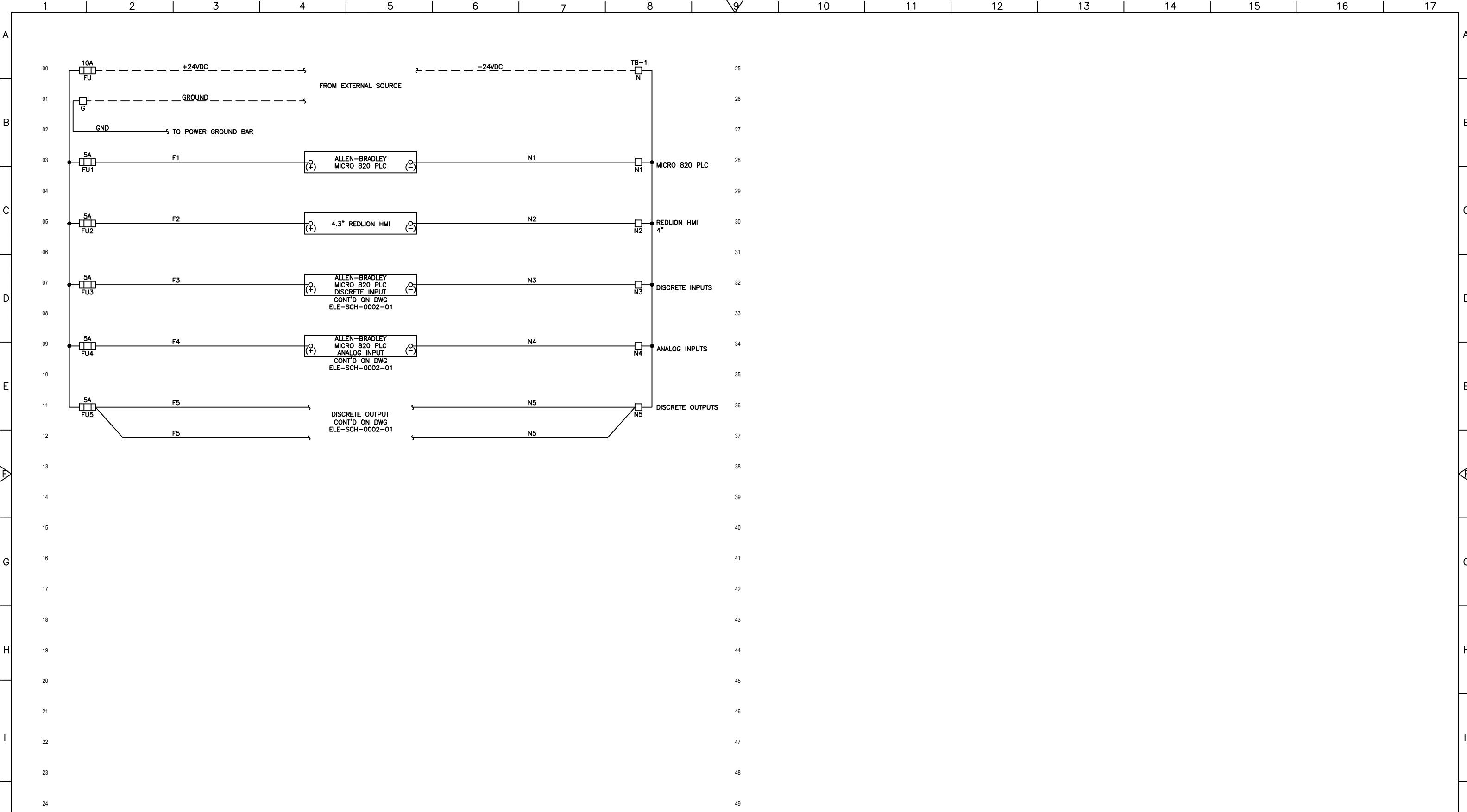
DWG. NO.	REFERENCE DRAWINGS	TITLE

REV NO.	DATE	DESCRIPTION	DWN BY	CHKD BY	APPR BY
0	2021-06-14	ISSUED FOR CONSTRUCTION	SFM	DE	ES

DATE:	21-06-11
DESIGN:	SFM
DRAWN:	SFM
CHKD:	DE
APP:	ES
SCALE:	1:2

VRU COMPRESSOR PLC PANEL LAYOUT & BILL OF MATERIALS

CAD NO. PES-2106039-ELE-LAY-0001-01 REFERENCE DWG NO.	DWG. NO. PES-2106039-ELE-LAY-0001-01	REV. A
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NOTES:

PERMIT/SEAL


REFERENCE DRAWINGS	
DWG. NO.	TITLE

REV NO.	DATE	DESCRIPTION	DWN BY	CHKD BY	APPR BY
0	2021-06-14	ISSUED FOR CONSTRUCTION	SFM	DE	ES

DATE:	21-06-11
DESIGN:	SFM
DRAWN:	SFM
CHKD:	DE
APP:	ES
SCALE:	NTS



PHOENIX



NEXT
COMPRESSION

**VRU COMPRESSOR PLC PANEL
24VDC DISTRIBUTION**

CAD NO. PES-2106039-ELE-SCH-0001-01	DWG. NO. PES-2106039-ELE-SCH-0001-01	REV. A
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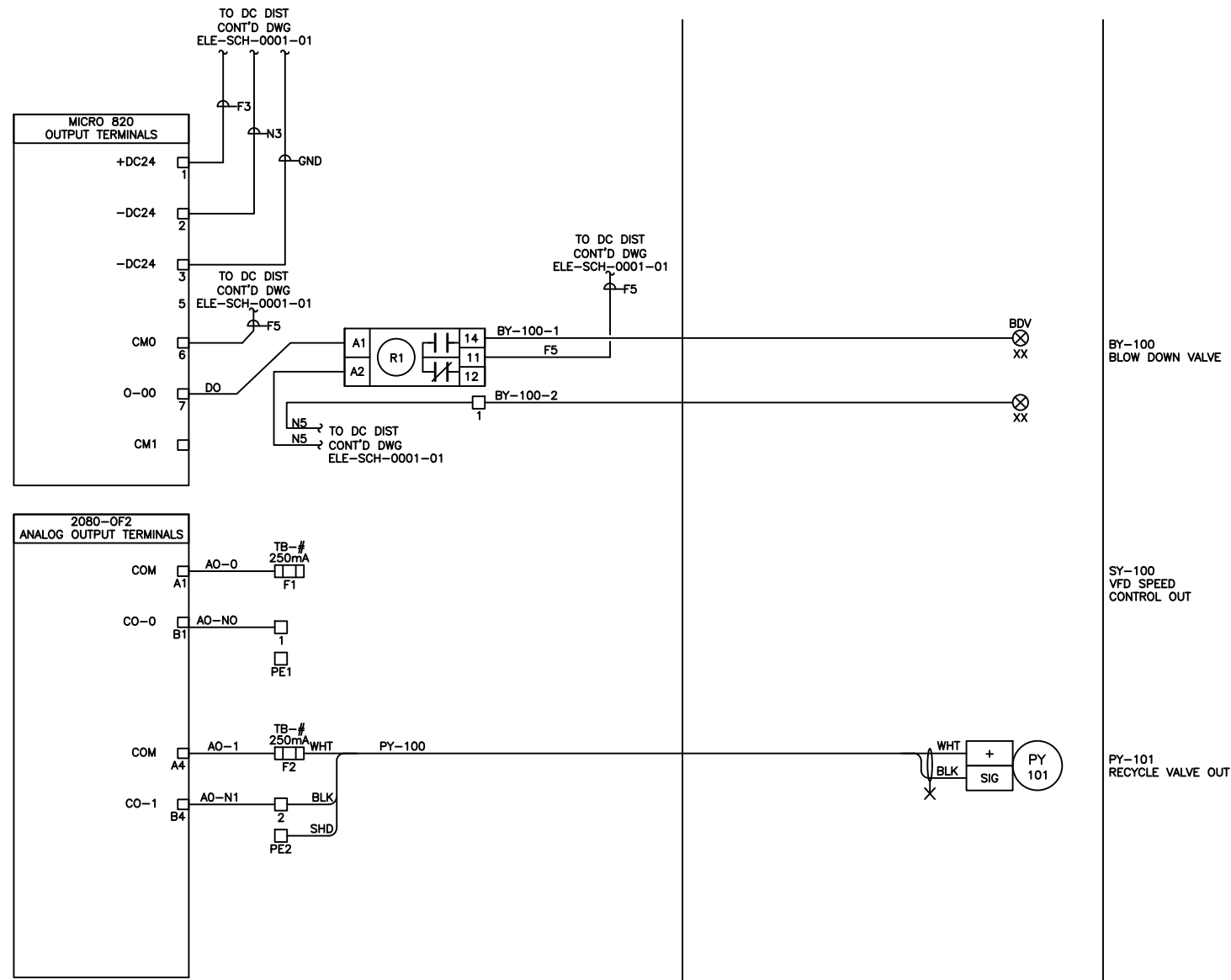
CONTROL CABINET

END DEVICES

DESCRIPTIONS

END DEVICES

CONTROL CABINET



BY-100 BLOW DOWN VALVE

SPARE DISCHARGE PRESSURE TRANSMITTER

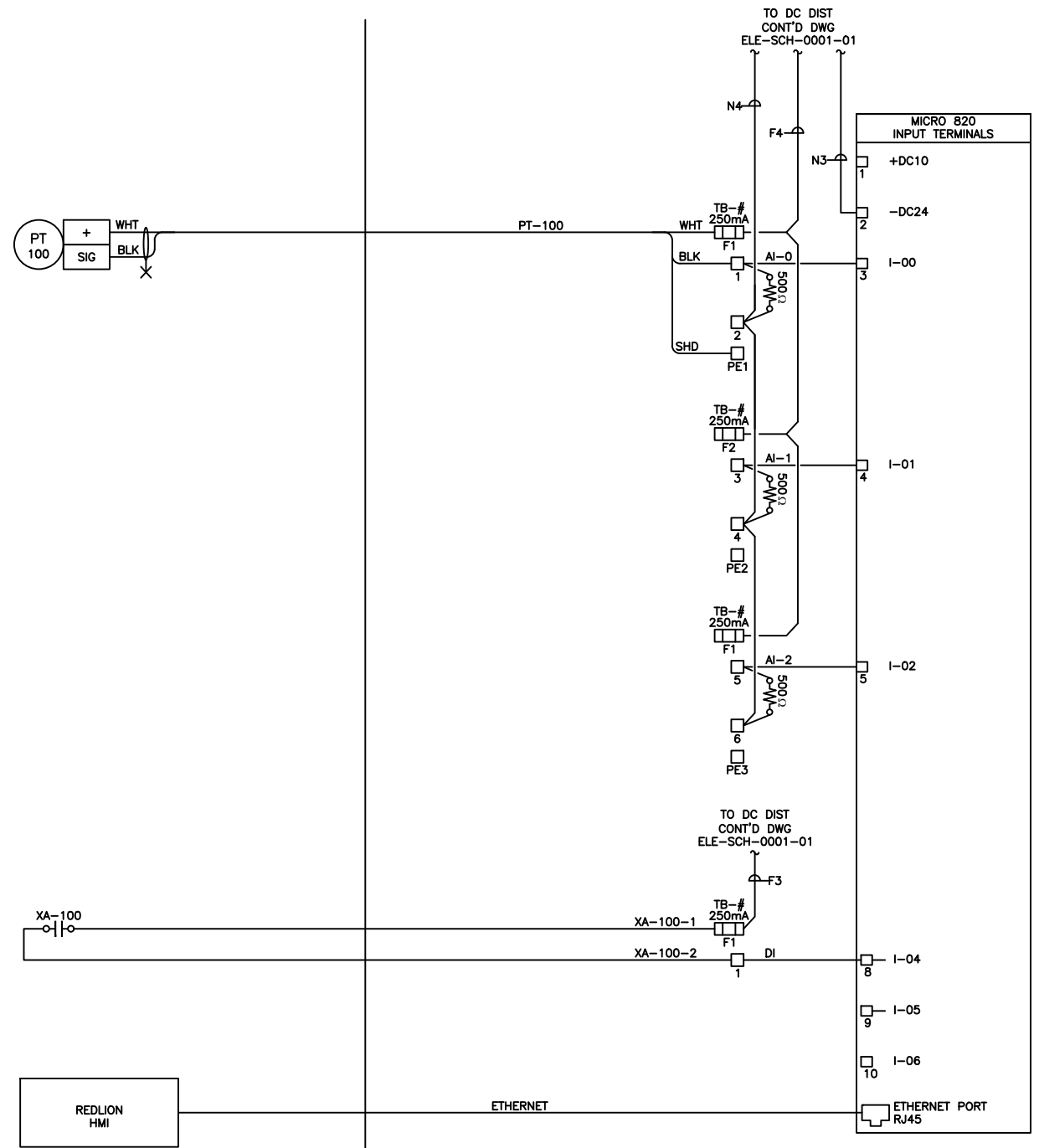
SY-100 VFD SPEED CONTROL OUT

SPARE SPEED FEEDBACK

PY-101 RECYCLE VALVE OUT

XA-100 VRU RUN STATUS

REDLION 4" HMI CR30004000



PIT-100 SUCTION PRESSURE TRANSMITTER

SPARE DISCHARGE PRESSURE TRANSMITTER

SPARE SPEED FEEDBACK

PY-101 RECYCLE VALVE OUT

XA-100 VRU RUN STATUS

REDLION 4" HMI CR30004000



NOTES:

PERMIT/SEAL

REFERENCE DRAWINGS	
DWG. NO.	TITLE

REV NO.	DATE	DESCRIPTION	DWN BY	CHKD BY	APPR BY
0	2021-06-14	ISSUED FOR CONSTRUCTION	SFM	DE	ES

DATE:	21-06-11
DESIGN:	SFM
DRAWN:	SFM
CHKD:	DE
APP:	ES
SCALE:	NTS

**VRU COMPRESSOR PLC PANEL
INPUTS & OUTPUTS**

CAD NO. PES-2106039-ELE-SCH-0002-01 REFERENCE DWG NO.	DWG. NO. PES-2106039-ELE-SCH-0002-01	REV. A
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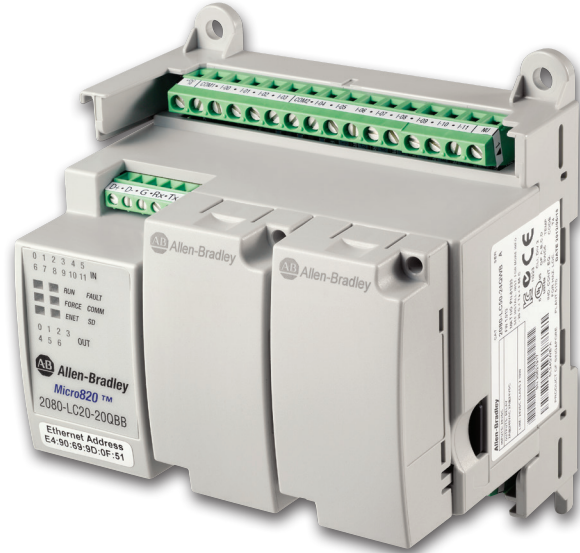
Micro820™ Programmable Logic Controller



Bulletin 2080 Product Profile

Features and Benefits

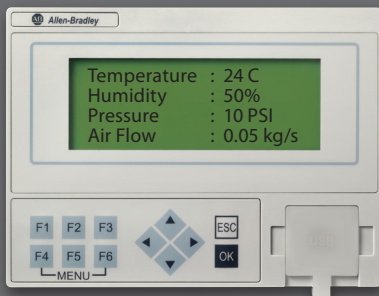
- Features optimized for small standalone machines and remote automation projects
- EtherNet/IP™ for Connected Components Workbench™ programming, RTU applications and HMI connectivity
- Built-in Real Time Clock (RTC) with no battery required
- microSD™ slot for program transfer, datalog and recipe
- Selected models available with removable terminal blocks for easier wiring and installation
- 5 KHz PWM Output for controlling solenoids and valves



The new Allen-Bradley Micro820 20pt controller is specifically designed for small standalone machines and remote automation projects with embedded Ethernet and Serial ports. It can function as a RTU (remote terminal unit) for remote machines with support for Modbus RTU and TCP. It has embedded support for 4 thermistor temperature inputs for use as a DDC (direct digital controller) for Building Management Systems.

Micro800 Remote LCD Display

- USB port for program download to controller
- IP65 for front panel mount
- Configurable start-up screen



*Readings on LCD Display are for illustration purposes only, not actual readings.

The Micro820 supports an embedded microSD slot that can be used for storing large amounts of data that normally cannot fit into memory for applications that require datalog and recipe. All files are stored in CSV text format for easy viewing and editing. The microSD card is also used for backing up and restoring the program, which can be used for duplicating the program in several machines.

The Allen-Bradley Micro800 Remote LCD Display connects to the controller's embedded RS232 port and works as an essential accessory for the Micro820 controller. With 4 or 8 lines of ASCII text and a tactile keypad, it can be used as a simple HMI. Its system menu is available in multiple languages for direct viewing and editing of controller variables. Controller's Ethernet address can also be easily set from the menu. Supports front panel mounting as well as DIN rail mounting next to the controller.

LISTEN.
THINK.
SOLVE.™

Bulletin 2080

Catalog Number	Inputs			Outputs		
	120V AC	24V DC/ V AC	Analog 0-10V (shared with 24V DC)	Relay	24V DC SRC	Analog 0-10V
2080-LC20-20QWB(R)	-	12	4	7	-	1
2080-LC20-20QBB(R)	-	12	4	-	7	1
2080-LC20-20AWB(R)	8	4	4	7	-	1

Removable terminal blocks are available on modules with catalog numbers that end in R. Catalog numbers that do not end in R have fixed terminal blocks.

Micro820	20-pt QWB(R)	20-pt QBB(R)	20-pt AWB(R)
Base Unit			
Power Supply	Base Unit has embedded 24V DC Power Supply. Optional External 120/240V AC via Cat. No. 2080-PS120-240VAC		
Base Programming Port	Embedded Ethernet Port		
Base EtherNet/IP™ port	EtherNet/IP Class 3, Modbus TCP		
Base Serial Port	RS232/485 non-isolated, CIP Serial, Modbus RTU, ASCII		
Plug-in Slots	2		
10V Output for Thermistors	1 Output Reference (supports up to four 10k thermistors)		
PWM Output	5 KHz		
microSD Card Slot	1		
Supported microSD Card Formats	FAT32/16		
microSD Card Size, Max	32GB		
microSD Card Class Speed	Class 6 and 10 SDSC and SDHC		
I/O			
Digital I/O (In/Out)	12/7 (4 Inputs shared with Analog Inputs)		
Analog I/O Channels	4/1		
Programming			
Software	Connected Components Workbench		
Program Steps (or instructions)	10Ksteps		
Data (bytes)	20Kbytes (up to 400bytes non-volatile)		
IEC 61131-3 Languages	Ladder Diagram, Function Block, Structured Text		
User Defined Function Blocks	Yes		
Motion Instructions	No PTO motion supported		
Floating Point Math	32-bit and 64-bit		
PID Loop Control	Yes		
Environments			
Certifications	c-UL-us CL1DIV2, CE, C-Tick, KC		
Temperature Range (Controller)	-20°...65°C		
Dimensions (HxWxD, mm)	90x100x80		

LCD Display	
Communications	
Embedded Serial Port	RS232 (connects to Controller's Embedded RS232 port)
Embedded USB Port	Controller programming port (USB to Serial pass-through)
Environmentals	
Temperature Range (LCD Display)	0°...50°C
Dimensions (HxWxD, mm)	97x130x36

Catalog Number	Plug-in Modules
2080-IQ4	4-pt Digital Input, 12/24VDC, Sink/Source, Type3
2080-OB4	4-pt Digital Output, 12/24VDC, Source
2080-OV4	4-pt Digital Output, 12/24VDC, Sink
2080-OW4I	4-pt Relay Output, Individually Isolated, 2A
2080-IQ4OB4	8-pt Combo: 4-pt Digital Input, 12/24VDC, Sink/Source, Type3, and 4-pt Digital Output, 12/24VDC, Source
2080-IQ4OV4	8-pt Combo: 4-pt Digital Input, 12/24VDC, Sink/Source, Type3, and 4-pt Digital Output, 12/24VDC, Sink
2080-IF2, 2080-IF4	2/4-ch Analog Input, 0-20 mA, 0-10V, non-isolated 12-bit
2080-OF2	2-ch Analog Output 0-20 mA, 0-10V, non-isolated 12-bit
2080-SERIALISOL	RS232/485 isolated serial port
2080-TRIMPOT6	6-ch Trimpot Analog Input
2080-RTD2	2-ch RTD, non-isolated, ±1.0 °C
2080-TC2	2-ch TC, non-isolated, ±1.0 °C
2080-MOT-HSC	High Speed Counter, 250kHz, Differential Line Receiver, 1 Digital Output
2080-DNET20	DeviceNet Scanner, 20 Nodes
Catalog Number	
Accessories	
2080-PS120-240VAC	External 120/240V AC power supply
2080-REMLCD	Remote 3.5 in. LCD Display, 24V DC Power, 4 or 8 lines ASCII text

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www.rockwellautomation.com

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Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846



6. Bill of Materials

Status	Flag	SAP_Part	Tag	Activity Code	Item_Description	Main_Group	Qty	Material Cost each	Currency	Material Cost Total Qty	Short_Description	Manufacturer	Mfg_Part_Number	Material_Description	Supplier
(1),(1), C 16-Jun		2030627		F301	Cooler Motor	Motor Driver	1	\$904.36		\$904.36	Motor Teco 15 HP TEFC 1800 RPM Frame 254T	Teco-Westinghouse	PDH0154	Motor Teco 15 HP TEFC 1800 RPM Frame 254T c/w SR254T Double Adjustable Slide base Sheave & Belts for Cooler Motor Install 1 2868205 MST MASTERDRIVE QD SHAVE 1 S051 5/8 MST MASTERDRIVE QD BUSHING 2 BX100 CAR CARLISLE V-BELT	TECO-Westinghouse Motors Canada Inc
(1),(4), C 16-Jun		Nonstock	215 216	F301	Sheaves & Belts		1	\$113.26		\$113.26	Sheaves & Belts for Cooler Motor Install	MasterDrive	-		Transmission Supplies Ltd.
(1),(1), O 10-Jun (4)		2027707	204	F301	Coupling		1	\$1,176.61		\$1,176.61	Coupling PDR20X with 200E	Sure-Flex	113HS-ALtered 11CMPBK3.375-115C48-11SCHMPB	TB Woods Sure Flex Coupling for PDR20X Screw compressor with 200 hp Electric Motor, 11HS Hyltel sgleth (split), Altered 11CMPB X 3.375 : Type C Flange, 115C48: Type SC Flange, 11SCHMPB: SC hub.	Transmission Supplies Ltd.
(4),(4), C 16-Jun		2030632	205	F301	Engine Driver		4	\$179.55		\$718.20	Mounting Check, Adjustable, 5/8" bolt, 35-45mm height, 80 mm OD, Vibracon SM16-CSTR	Vibracon	SM16-CSTR	Mounting Check, Adjustable, 5/8" bolt, 35-45mm height, 80 mm OD, Vibracon SM16-CSTR	ICI Filtration & Separation Inc
(1),(1), C 16-Jun		2000890	PCV-103	F6101	Instrumentation		1	\$1,677.00		\$1,677.00	valve control D4 1 NPT 3/4 orifice fail open natural gas	Fisher	D4	Fisher D4 Control Valve, 1" NPT Connections, Standard Materials 2250 psi pressure rating 3/4" orifice, 0 to 35 psig, Fail Open Service: Natural Gas Condensate	Spartan Controls Ltd.
(1),(1), C 16-Jun		2000878		F6101	Piping		1	\$19.08		\$19.08	K Valve Needle NPT Carbon Steel 1/4F x 1/4F 600# Sour	WGI	WN1612PN	K Needle Valve, 1/4" FNPT x 1/4" FNPT c/w Carbon Steel Body, Stainless Steel Stem, PTFE Packing, 600# WOG rating	ValSource Equipment Limited
(1),(1), C 16-Jun		2027710		F6101	Drain Pump		1	\$797.00		\$797.00	Yamada Pneumatic Pump (Condensate) 6gpm @ 6scfm, 100psig air supply	Yamada	NDP-15-BAN	Yamada Liquid Pump Flow 6 gpm utilizing 6 scfm, gas supply MAWP 100 psig, Pump casting MAWP 200 psig, Diaphragm material: Buna, Maximum operating temperature 180°F c/w 1/2" FNPT inlet and outlet connections, Air inlet connection 1/4" FNPT & ball valve.	Smith Cameron Process Solutions
Ref'd, DTO =		2028290	PCV-116	F6101	Regulator for Drain Pump	Instrumentation	1	\$137.75		\$137.75	Regulator, Fisher 67CFR, 1/4" NPT, 0 - 125 PSIG, AID Screw, W/Pressure gauge	Fisher	67 CFR/E140955	Regulator, Fisher 67CFR, 1/4" NPT, 0 - 125 PSIG, AID Screw, W/Pressure gauge/Fisher 67 Regulator/1/4" NPT Tapped-Bonnet Type: 67CFR, 0-125 psi, Adjustable Spring Range, 5 Micron Filter, Internal Relief, Yes, Adj Screw with Closing Cap/Winters E140955 Pressure Gauge-160 psi/Apa range, 2" dial / 1/4" NPT center back mount, 316 SST tube & socket	Spartan Controls Ltd.
(1),(1), O 9-Jun (0)		2000946 - S	UY-108	F6101	Amot Shuttle Valve	Valves	1	\$324.22		\$324.22	Valve Solenoid Pneumatic Natural Gas 40570031H2	Amot	40570031H2	Amot 4057 Valve Model 40570031H2 Type CG 3-way Valve Precision Cast Aluminum Body Material 0.031 or 5/16 inch NPT Viton Seal Material Service: Natural Gas	Spartan Controls Ltd.
Ref'd, DTO =		2000820		F6101	Isolation Valves	Piping	2	\$17.68		\$35.36	Valve Ball 1/2 NPT 316SS Reg Port 2000# Locking Handle NACE	Newco	SA-C180S20A21	Ball Valve, 1/2" NPT, Stainless Steel Locking Handle regular port, 2000# WOG, 316 SS NACE trim.	MRC Global (Canada) Ltd
Ref'd, DTO =		2027993		F6101	Y-Strainer	Piping	1	\$48.12		\$48.12	Y strainer threaded ends cast steel 1/2 SS mesh 60#	Predator	5Y160TNO3	Y Strainer, 0.5" NPT, Cast Steel Body, CL 600 rating, stainless steel mesh Model: 5Y160TNO3 Service: Natural Gas / Oil	Cascade Flow Control Solutions
(1),(1), C 17-Jun		2030630	PCV-101	F6101	BPCV	Instrumentation	1	\$3,361.50		\$3,361.50	Valve Control Sur-Flu Wafer Bladder 4 300# c/w Centering Kit	Sur-Flu	SF10V-C-V-563-4.3	4" 300 ANSI Control Valve CS Housing w/ Viton Sleeve & 563 SST Cones MAX OP OF 352 PSI c/w Centering Kit	Sur-Flu Meters & Controls Ltd.
Ref'd, DTO =		2000585	PCV-109	F6101	Regulator for Drain Pump	Instrumentation	1	\$337.50		\$337.50	Regulator 1/4 NPT 5-400psig low bleed MAWP 500psig	Fairchild	102928E	Fairchild Series 10 Outlet Pressure Regulator c/w 1/4" NPT connections, 5 to 400 psi spring range Mounting Bracket Model: EB-09921 Service: Instrument Gas	Telematic Controls Inc.
(1),(1), C 16-Jun		2000415	106	F6101	Instrument Air Filter	Instrumentation	1	\$169.32		\$169.32	Filter Assy, Coalescing 1/2" FNPT MAWP 500psig	Finite	HN2L-10CN	Parker Filter Model: HN2L-10CN Connection: 1/2" NPT c/w Drain valve, CSN, MAWP 500 psig Replacement Element: Model No: 25-178-70C Service: Natural Gas	Twister Instrumentation & Process Solutions Inc
Ref'd, DTO =		2000820		F6101	Isolation Valves	Piping	1	\$17.68		\$17.68	Valve Ball 1/2 NPT 316SS Reg Port 2000# Locking Handle NACE	Newco	SA-C180S20A21	Ball Valve, 1/2" NPT, Stainless Steel Locking Handle regular port, 2000# WOG, 316 SS NACE trim.	MRC Global (Canada) Ltd
(1),(1), C 16-Jun		2000878		F6101	Needle Valve	Piping	1	\$19.08		\$19.08	K Valve Needle NPT Carbon Steel 1/4F x 1/4F 600# Sour	WGI	WN1612PN	K Needle Valve, 1/4" FNPT x 1/4" FNPT c/w Carbon Steel Body, Stainless Steel Stem, PTFE Packing, 600# WOG rating	ValSource Equipment Limited
Ref'd, DTO =		2028289	PCV-110	F6101	Instrument Air Regulator	Instrumentation	1	\$137.75		\$137.75	Regulator, Fisher 67CFR, 1/4" NPT, 0 - 60 PSIG, AID Screw, W/Pressure gauge	Fisher	67 CFR/E140555	Regulator, Fisher 67CFR, 1/4" NPT, 0 - 60 PSIG, AID Screw, W/Pressure gauge Fisher 67 Regulator 1/4" NPT Tapped-Bonnet Type: 67CFR, 0-60 psi, Adjustable Spring Range, 5 Micron Filter, Internal Relief, Yes, Adj Screw with Closing Cap/Winters E140555 Pressure Gauge-60 psi/Apa range, 2" dial / 1/4" NPT center back mount, 316 SST tube & socket	Spartan Controls Ltd.
(1),(1), C 17-Jun		2030633	PSV-100	F6101	Suction PSV	Instrumentation	1	\$337.77		\$337.77	Valve pressure safety 1FNPT x 1FNPT orifice D Set 125psig, fire case, Sour trim	Mercer	91-160S1V07E2	Mercer Pressure Safety Valve, Mercer 91-160S1V07E2, 1" FNPT x 1" FNPT connections, Set pressure 125psi, O Drifice, CS Body,316 Trim, 316 spring, FKM seat and seals/Service: Sour Natural Gas	Mercer Valve Co., INC.
(1),(1), C 17-Jun		2028388	PSV-101	F6101	Discharge PSV	Instrumentation	1	\$265.83		\$265.83	Valve pressure safety 1FNPT x 1FNPT orifice E Set 245psig, fire case, Sour trim	Mercer	81-171S1V10N11	Mercer Pressure Safety Valve, Mercer 81-171S1V10N11, 1" FNPT x 1" FNPT connections, Set pressure 245psi, E Orifice, CS Body,316 Trim, Inconel X750 spring, viton seat, Service: Sour Natural Gas	Mercer Valve Co., INC.
(1),(1), O 10-Jun (4)		2000694	107	F6101	Start-up Strainer	Piping	1	\$155.67		\$155.67	Strainer Cone Wafer CS 8 150# 1/8" Perforation, 150% Open, 20 mesh, Sch. STD	Failure Prevention Services		Strainer Cone Wafer CS 8 150# 1/8" Perforation, 150% Open, 20 mesh, Sch. STD	Failure Prevention Services
Ref'd, DTO =		2030699	FE-101	F6100	Meter Run	Instrumentation	1	\$3,783.06		\$3,783.06	Meter Run, 2" 600 RF, Sch80, Dual chamber, 3 PC, CS, NACE internals	- No Manufacturer -	260RDCR05A00W0WTT-ABA9-FF-CB-N-0	Meter Run, 2" 600 RF, Sch80, Dual chamber, 3 PC, CS, NACE internals, Grease Seal, 600 W/6 Teletaps, AGA 2016 Et, A216WCB (INACE), LEFT HAND, O-PLT 2"x1/8" 1.000" 316SS, K-style 316 SS, HNB, BSD, Pipe: Cold Drawn, A106/ A105N, OAL:57", AGA 2016, Upstream: 600RF, Downstream: 600RF, Contour Flow Cond.: RF, 0.75 Beta, Outlets: 1" TOL, 0.75" TOL, Includes Hydro Test, MTRX, Canalta Inspection, Canalta Standard Paint	Canalta Controls Ltd
stock transfer		2023886		F6100	Coalescing Filter element for Oil Separator	Filters	1	\$397.68		\$397.68	Element Coalescing NEXT 1036H 26" x 11.5", 22.66 ft sq, 99.97% @ 0.1 micron	FPS	NEXT-1036H	NEXT-1036H filter oil compressor element coalescing Open Both ends, Viton O ring seal 26" x 11.5", 22.66 ft sq 99.97 @ 0.1 micron/FPS P/N: FP00110-208H750-016P	Failure Prevention Services
(1),(1), O 9-Jun (-3)		2000418		F7501	Oil Filter	Fluid	1	\$912.44		\$912.44	Filter Assy, Oil Compressor 1-1/2"ZNPt HAK05 (no bypass)	Donaldson	K05-0765NB	Donaldson Oil Filter Housing Model No: HAK05 no bypass K05-0765NB C/W Element Model No:P164697 Replacement Element Model No:P164699 c/w viton seal, 1.5" FNPT connections, 4 micron element, DP indicator mounted on left side. Service: Compressor OILDO NOT PURCHASE THIS - USE PART# 2021854 INSTEAD	LD Filtration
Ref'd, DTO =		2030717		F7501	Extra oil filter	Filters	1	\$110.65		\$110.65	Element Oil Filter	Donaldson	P176221	P176221 filter oil hydraulic spin-on	Corona Supplies LD Filtration
(2),(2), O 14-Jun (-4)		2026819		F7501	Filter Isolation Valves	Valves	2	\$46.33		\$92.66	Valve, Ball, 1-1/2" NPT, Stainless Steel, Locking Handle, regular port, 2000# WOG, 316 SS NACE 1"	Navco	C1-R15S20A	Valve, Ball, 1-1/2" NPT, Stainless Steel, Locking Handle, regular port, 2000# WOG, 316 SS NACE trim.	MRC Global (Canada) Ltd
Ref'd, DTO =		2022934		F7501	Sample/Vent Valve	Valves	1	\$25.88		\$25.88	Valve Needle 1/2" MNPT x FNPT, 10,000PSI NACE	WGI	WN1534N	Needle valve, WGI WN1534N/2" MNPT x 1/2" FNPT, straight, hard seat, standard flow10 000psi, carbon steel, SS Trim,NACE	ValSource Equipment Limited
(1),(1), C 16-Jun		2027341	TCV-201	F7501	Oil Thermostatic Valve	Cooling	1	\$914.07		\$914.07	Thermostatic 3-Way Valve c/w 1-1/2" FNPT 160-180F	Fluid Power	S1530170	Thermostatic 3-Way Valve c/w 1-1/2" FNPT 160-180F (FPE)Model No: S1530-170 1.5" NPTe Element full open at 180 degree F, standard trim, Steel body, MAWP - 500 psig/Service: Oil	Zimco Instrumentation
(1),(1), C 16-Jun		2029116	P-1	F7601	Coolant Pump	Pumps	1	\$1,395.00		\$1,395.00	Pump, Coolant, AG4 service, 3/4"x1/2"x3" IMP, SHP 3600 RPM, 230/460/3/60TEFC	Finish Thompson	AC45T1S1V300B01S0C9	Finish-Thompson Coolant Pump Model: AC45T1S1V300B01S0C9AC4 3/4"x1/2"x3" IMPW/5 HP 3600 RPM 230/460/3/60 TEFC316SS Construction 3.00" Impeller w/ Viton O-Ring/Flow: 15 US GPM @ 37 TDH/Motor: 1/2HP, 3600 rpm, TEFC/Voltage: 230/460/3/60Hz/Service: 50/50 Glycol/Water.	Smith Cameron Process Solutions
Ref'd, DTO =		2028718		F7601	Butterfly Valve (Throttling)	Valves	1	\$28.65		\$28.65	Butterfly Valve Wafer CI/ENP-Di/Buna w/Lever ANSI 125, 2"	Predator	EWS2NBL08	Butterfly Valve Wafer 2", Cast Iron Body, Nickel Plated (ENP) Ductile Iron Disc, 416 SS Stem, BUNA-N Seat Liner,Predator EWS2NBL08	Cascade Flow Control Solutions
Ref'd, DTO =		2018259		F7601	Hub Flanges	Piping	2	\$14.83		\$29.66	Flange THD 2" 150# RF x 2" NPT SA105N	- No Manufacturer -		Flange THD 2" 150# RF x 2" NPT SA105N	Trans Am Piping Products Ltd.
Ref'd, DTO =		2004288		F7601	Pressure Gauge	Instrumentation	1	\$23.30		\$23.30	Gauge Press 60PSI 2-1/2 1/4 CBM	Wika	9207338	9207338 233.53 Gauge Press 0-60PSI 2-1/2 1/4 CBM SS Connection	WIKa Instruments Ltd.
(1),(1), C 16-Jun		2000878		F7601	Needle Valve	Piping	1	\$19.08		\$19.08	K Valve Needle NPT Carbon Steel 1/4F x 1/4F 600# Sour	WGI	WN1612PN	K Needle Valve, 1/4" FNPT x 1/4" FNPT c/w Carbon Steel Body, Stainless Steel Stem, PTFE Packing, 600# WOG rating	ValSource Equipment Limited
Ref'd, DTO =		2004421		F7601	Flexible Coupling	Piping	2	\$71.70		\$143.40	Coupling Assy, 200P	Flexmaster	NH1600C200B0400	Flexmaster coupling, 2.0" 200P	Gregg Distributors
Ref'd, DTO =		2030733	CP-1	F8101	Murphy Panel Components -24VDC relay	Panel	1	\$86.19		\$86.19	RELAY TERM BLK 20MA 24VDC	Murphy	80.010.4005.0	RELAY TERM BLK 20MA 24VDC, 80.010.4005.0	Spartan Controls Ltd.
Ref'd, DTO =		2030734	CP-1	F8101	Murphy Panel Components -Display Head	Panel	1	\$885.58		\$885.58	DISPLAY HEAD ONLY, 48 PT DIGITAL FAULT ANNUNCI	Murphy	TTD-H	DISPLAY HEAD ONLY, 48 PT DIGITAL FAULT ANNUNCI (W), TTD-H	Spartan Controls Ltd.
Ref'd, DTO =		2030735	CP-1	F8101	Murphy Panel Components -Power Supply	Panel	1	\$505.19		\$505.19	POWER SUPPLY (NO TACH) FOR TTD-H, CL 1 BCD DIV 2	Murphy	PSU-2	POWER SUPPLY (NO TACH) FOR TTD-H, CL 1 BCD DIV 2, PSU-2	Spartan Controls Ltd.